Arafura Resources Ltd

Nolans Project
Section 14A Notification

June 2019

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1. Introduction

1.1 Overview

Arafura Resources Ltd (Arafura) proposes to develop and operate the Nolans Project (the Project) which is a rare earth mine located approximately 135 kilometres (km) north-northwest of Alice Springs in the Northern Territory (NT). The Project is situated approximately 10 km west of Aileron Roadhouse. The access to the Project site will be from the Stuart Highway, south of Alyuen community. The majority of the Project site is situated on the Aileron Perpetual Pastoral Lease (PPL 1097), with the exception of the western part of the borefield area, which is situated on the Napperby Perpetual Pastoral Lease (PPL 1178).

The Project site comprises four areas linked by access roads and pipelines:

- The mine site
- Processing site
- Accommodation village
- Borefield.

1.2 Approvals process

The Project has been assessed by the Northern Territory Environment Protection Authority (NT EPA) at the level of an Environmental Impact Statement (EIS) under the *Environmental Assessment Act* (EA Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in accordance with the bilateral agreement between the Australian and Northern Territory Governments.

The Project was declared a controlled action under the EPBC Act controlling provisions for listed threatened species and communities (Section 18 and 18A) and nuclear actions Section 21 and 22A).

A draft EIS for the Project was submitted in May 2016. In September 2016, Arafura notified the NT EPA and the Department of the Environment and Energy (DoEE) of some key project changes including:

- Change the sulphuric acid pre-leach (SAPL) to phosphoric acid pre-leach (PAPL) process
- Reduce output of total rare earth oxide (REO) from 20,000 to 14,000 tpa
- Include production of phosphoric acid as mine output
- Removal of the requirement for carbonate material in processing.

A Supplement to the draft EIS was submitted in March 2017 that addressed these changes, as well as the submissions to the draft EIS. The Project was assessed by the NT EPA and Assessment Report 84 (EPA 2018) was released on the 21st December 2017. Assessment Report 84 outlines the conditions under which the Project can proceed.

The NT EPA identified the following key environmental factors that may be impacted by the project:

- Hydrological processes
- Inland water environmental quality
- Terrestrial flora and fauna
- Social, economic and cultural surroundings
- Human health.

The Project was subsequently assessed by the DoEE and approved, with conditions, by the Australian Government Minister for the Environment and Energy in May 2018.

1.3 Changes to the assessed action

Arafura is proposing changes to the assessed Nolans Project, and submits this document as notification of the proposed alterations, in accordance with Clause 14A of the Environmental Assessment Administrative Procedures.

1.4 Scope and limitations

This report has been prepared by GHD Pty Ltd (GHD) for Arafura Resources Ltd and may only be used and relied on by Arafura Resources Ltd for the purpose agreed between GHD and the Arafura Resources Ltd as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Arafura Resources Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by Arafura Resources Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Scope of project changes

Arafura has updated the scope of the Project, which is now described in terms of:

- The Assessed Project - as described in existing approvals documentation; and
- The Revised Project, including components of the Assessed Project that have been altered, or entirely new components added.

The key project changes are summarised in Table 2-1, which outlines the key differences between the Assessed Project and the Revised Project. More detailed information relating to the project variations is provided below.

Table 2-1 Key alterations to the proposed action

Table Key

Table Key
No change in project component
Change in project component

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
	Project Disturbance				
No	Total potential maximum project disturbance	4161 hectare (ha)	< 4161 ha	Yes	It is likely that actual area disturbed by the project will be about 40 percent of this area based on current project design and planning.
	Project Life				
No	Construction period	2 years	2 years	Yes	
No	Operational life	23 yrs Measured & Indicated (M&I) 55 yrs Life of Mine (LOM)	23 yrs M&I 55 yrs LOM	Yes	Beyond the 23 years, LOM is dependent on exploration and the conversion of inferred ore into a higher category.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
	Production Estimates				
No	Ore mined	54.3 Million tonnes (Mt) LOM	19.2 Mt in the initial 23 years of mining with an additional 11.4 Mt stockpiled pending assessment of the viability of processing. LOM volumes are in accordance with Assessed project although these are subject to change through mine planning/production refinements.	Yes	172 Mt total material movement over the initial 23 years of mining These estimates are currently under review and will be updated in the very near future. They are not expected to alter materially.
No	Waste rock	304 Mt LOM	140 Mt LOM in initial 23 years	Yes	
No	Plant feed	900,000 tonnes per annum (pa)	Average of 894,000 tpa over initial 23 years but up to 1,000,000 tonnes pa	Yes	Feed rate will vary dependant on grade/recovery variability.
No	Production	14,000 tonnes total rare earth oxides from 30,060 tonnes of less refined (cerium and rare earth chloride intermediate) products. 110,000 tonnes per annum (tpa) Phosphoric acid (merchant grade).	When project is fully commissioned, the average outputs are estimated to be 13,343 tpa TREO (i.e., 10,271 tpa of Cerium hydroxide product, 4,379 tpa neodymium/praseodymium oxide and 1,064 tpa SEG-HRE carbonate). In addition, the facility will produce 135,808 tpa phosphoric acid (merchant grade).	Yes	Tonnages of product will vary slightly as they are ore grade dependent. Intend to mine and blend ore to maintain an average grade, and there will inevitably be some variability in outputs
	Mine Site				
No	Pit	Open pit mined to depth 285 metres (m) with surface area of 135 ha	Open pit mined planned to depth 190 m with surface area of approximately 100 ha over initial 23	Yes	Pit design under review. Final design will be available prior to commencement of mining.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
			years of mining. This may vary slightly dependent on grade and mine planning factors.		Design not likely to change materially.
No	Material handling	Conventional open pit methods (drill, blast, load and haul) at a maximum rate of 10 Mt pa	Conventional open pit methods (drill, blast, load and haul) at a maximum rate of 11.2 Mt pa	Yes	
Yes	Waste rock	Up to 5 waste rock dumps (WRD) will receive LOM waste quantity of 304 Mt constructed to a height of 50 m with interspersed berms. Waste rock dumps would have total footprint of 460 ha	2 WRDs will now hold waste volumes generated over the initial 23 years, built to a relative level (RL) 320 m, which is height of 60 m above natural surface and consistent with local topography. Waste rock dumps footprint of approx. 220 ha which is adequate for 23 years waste storage. LOM storage will require the north west WRD1 waste dump footprint to expand to the west in accordance with the area identified in the Assessed project. Design concept is concave slope with no berms	Yes	Closure planning underway using the concave dump design concept described in EIS Supplementary report. A test program to validate this design is being developed to test geotechnical and physical properties of the various waste rock lithology has and will be implemented in the early part of the projects development. AMD barrel leach testing is ongoing and to date has confirmed the project has a very low risk of generating acid metalliferous drainage (AMD) leachate.
No	Topsoil and vegetation storage areas	114 ha storage footprint to height of 3 metres	60 ha storage footprint to height of 3 metres for the initial 23 year mining period.	Yes	Area reduced as tailings storage facility (TSF) no longer at mine site and less waste rock dumps.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
Yes	Tailings storage facility	TSF approx. 195 ha to embankment height of 25 m total storage approx. 27 Mt dry tailings	TSF no longer located at mine site. Now at processing site	Yes	TSF now moved to processing site, and beneficiation tailings will be co-disposed with process residues (gypsum) in a cellular Residue Storage Facility (RSF) constructed in a series of stages over LOM
No	Run of Mine (ROM) pad	ROM pad to provide facility for ore blending and 3 months' supply	ROM pad to provide facility for ore blending and 3 months' supply	Yes	
No	Long term stockpile	Lower grade and non-PAPL (phosphoric acid pre-leach) preferred ore stored for future processing. 8.8-15.7 Mt to be stored	Lower grade and non-PAPL preferred ore stored for future processing. Up to 12.8 Mt to be stored in the initial 23 year mining plan, however further processing will likely result in the processing of a portion of the material in long term stockpiles.	Yes	
Yes	Comminution and beneficiation (crushing, grinding and floating)	Single stage primary crusher with dust suppression will crush to around 50 millimetres (mm) Crusher ore then fed to ball mill for grinding. Ground ore then passes through beneficiation process.	No crushing, grinding or beneficiation at mine site. Now at processing site	Yes	
No	Surface water dams	Dams will be required to manage surface water and pit dewatering. All water recovered will be recycled for dust suppression or use in the processing plant.	Dams will be required to manage surface water and pit dewatering. All water recovered will be recycled for dust suppression or use in the processing plant.	Yes	Preliminary surface water management plan and design now completed for mine site.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
Yes	Kerosene Camp Creek diversion	Diversion of existing ephemeral creek into western tributary of the Kerosene Camp Creek system.	Diversion of existing ephemeral creek into western tributary of the Kerosene Camp Creek system is now planned in two stages. Stage 1 interim diversion alignment will be within the LOM pit shell footprint. Final diversion will be as per design presented in the Assessed Project.	Yes	Diversion will now be staged to reduce upfront capital. Interim diversion, which will be designed to be permanent if mining is ceased prematurely, will be around the western end of the planned open pit and then back into existing creek channel. In around year 6-9 final diversion will be constructed as per design presented in Assessed Project, into western tributary of Kerosene Camp Creek.
Yes	Slurry transfer pipeline	8 km single stage pumping slurry pipeline to transport ground mineral concentrate to processing facility.	No longer proposed.	Yes	All ore will now be trucked to processing site for crushing, grinding and beneficiation. One road train operating on haul road.
Yes	Service corridor between mine site and processing site	Access track/service corridor to be established between mine site and processing site, a distance of about 8 km by road. Delivering reagents to beneficiation circuit at mine site with most traffic at start and end of shift.	Service corridor between mine and processing site upgraded to accommodate one double road train truck operating on 24 hr basis (1 load / hr) to transport ore to crushing circuit at processing site No reagent transport now required to mine site.	Yes	Traffic will be speed limited and traffic management plan implemented with regard to potential vehicle interactions with fauna The road alignment has been altered to avoid a registered sacred site.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
	Processing Plant				
Yes	Comminution crusher	Comminution crusher includes a single stage primary crushing circuit fed by front end loader. Crushed ore is then conveyed to mill for grinding, before it is pumped to a cyclone cluster that will sort the fine from oversize particles. The coarse particles will recycle through the mill whilst the finer particles of <150 μm will move on to the Beneficiation Plant	Relocated from the mine site to processing site. No process change. Crushing operations and ore haulage may occur 24 hours per day.	Yes	Comminution and beneficiation circuit has been relocated from the mine site to the processing site, and ore feed to crusher enclosed in a building, followed by enclosed conveyer to mill.
Yes	Beneficiation plant	The mineral concentrate from the beneficiation circuit is pumped by an overland slurry pipeline to the processing plant. Beneficiation tailings are pumped to a tailings thickener to improve solids density and recover process water. The solids slurry is then pumped to a beneficiation TSF located at the mine site.	Beneficiation circuit relocated from the mine site to the processing site, and mineral concentrate will be fed from the beneficiation circuit directly to the downstream process at the processing site. Beneficiation tailings in a slurry will be pumped to a residue storage facility that is also the location for other process residue disposal (i.e. gypsum by-product) from the processing plant. Co-location of beneficiation tailings and other residue improves settlement and consolidation. Decant water goes directly to the processing plant.	Yes	Beneficiation plant now located at process plant, no slurry pipeline. Process is wet.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
No	Extraction processing	Phosphoric acid pre-leach produces a solid feed containing the majority of rare earths (RE). Solid feed then passes through a sulphation process to liberate rare earths for subsequent processing and extraction. A water leach process recovers rare earths. Rare earths converted to RE hydroxide which is then mixed with hydrochloric acid and crystallised to produce RE chloride and RE cerium carbonate product. RE Cerium then packaged for sale to market and RE chloride sent to separation facility overseas.	No change to extraction process. RE chloride product now passes through on-site separation process to produce final RE products - neodymium, praseodymium and heavy rare earths (SEG-HRE) mixed product at site.	Yes	Separation facility now proposed at site within processing plant footprint. Total plant footprint including separation facility, product and reagent storage, etc. is all accommodated within ≈46 ha process plant site. Lanthanum will no longer be produced at the commencement of processing as a product for economic reasons.
Yes	Separation facility	A separation plant will be constructed within an established chemical precinct at an offshore location	Separation facility now proposed at site within processing plant footprint. Total plant footprint including separation facility, product and reagent storage etc. is all accommodated within 46 ha process plant site.	Yes	This small facility fits with anticipated footprint of processing facility.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
Yes	Residue storage facilities	The proposed residue storage facility (RSF) stores processing plant impurities including some phosphate, gypsum and the removed radionuclides. Planned to cover an area 345 ha with embankment height of 14 m.	The proposed RSF will be built in stages. Each stage will contain two cells, one of which will store combined beneficiation tailings and gypsum in a co-disposal arrangement, and the other will store water leach residue. Planned to cover an area about 240 ha in first 23 years of operation and store about 20 Mt of tailings and residues including: Beneficiation tailings – 13.0 Mt Gypsum – 6.9 Mt Water Leach Residue – 3.1 Mt LOM these facilities will occupy an area of about 720 ha with embankment height of 25 m.	Yes	Preliminary design completed. Facility will be constructed in stages which enables progressive closure and rehabilitation as cells are filled. Each stage comprises 2 cells, with lifts approximately every 2 years, and a new stage every 7-9 years. Subsequent cells will be constructed immediately adjacent to the initial cells. The focus of the design has been security of the materials and to ensure progressive closure of the facilities was achievable. Radionuclide content will be consistent with Assessed Project. Design of this facility includes a double liner system of clay and a HDPE liner in the water leach residue cells for added security due to the slightly higher (less than 5%) level of radionuclide in the residue. The focus of the design is security of the materials and progressive closure of these facilities.
Yes	Evaporation ponds	Evaporation pond consisting of a number of small cells (up to six about	Water leach residue (WLR) cells (about 10 ha each) will be	Yes	No evaporation ponds planned. All final processing

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
		10 ha each) with embankment of 2.5 m to enable concentration of brine concentrate for recycle through the processing circuit. Excess process liquor plus reverse osmosis (RO) plant reject	integrated into RSF design. Embankment height is 25 m. These will store all brine and water leach residues with any excess water recycled back to the process. In the first 23 years of operation these facilities will store about 11 Mt of process residues. As WLR cells are filled, a layer of tailings will be pumped over the water leach residue to seal the chemical precipitates, prior to closure including capping. Closure will be progressive.		residues will go into the water leach residue storage dams or tailings/gypsum residue storage dams. Material testwork is complete. Final impurities for water leach residue not known until operations commence, and closure and capping methodology will be dependent on composition of material including solubility. Based on extensive understanding of the deposit geochemistry it is unlikely that the residue chemical composition will pose closure risk.
No	Sulphuric acid plant	The RE processing requires sulphuric acid and this will be provided by an on-site sulphur burning plant.	The RE processing requires sulphuric acid and this will be provided by an on-site sulphur burning plant. Sulphuric acid plant constructed in three modules with two deferred for construction in the second year of processing due to ramp up. Acid supply will be supplemented with liquid acid when single module cannot supply sufficient acid.	Yes	Construction of this facility will be staged with Stage 1 constructed during project start up. Initial sulphuric acid requirements will be supplemented by importation of liquid sulphuric acid delivered to site in ISO containers via railway to Alice Springs. The remaining modules of the sulphuric acid plant will be during the ramp up period of the plant.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
Yes	Power requirement	Power will be co-generated from sulphuric acid plant and gas fired generation. Power requirement estimated at 12.5 megawatts (MW).	Power will be gas-fired generation. Power requirement of total facility is now estimated at 33 MW. Waste heat from sulphuric acid will be used for generation of all steam for use in the process, with back-up gas fired boilers when sufficient steam is not available.	Yes	
Yes	Topsoil and vegetation storage areas	Topsoil and vegetation storage footprint of 40 ha.	Topsoil and vegetation storage footprint of 60 ha. LOM area required should be accommodated within this footprint.	Yes	Topsoil will be progressively used on external batters of RSF
Yes	Gas off-take	Offtake pipeline to connect to the Amadeus Basin	Offtake pipeline to connect to the Amadeus Basin	Yes	Gas volume can be met by existing suppliers. Connection to pipeline will be as per Assessed Project. Processing plant includes power station, and is being positioned in close proximity to the natural gas pipeline.

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
Yes	Raw materials and reagents	Estimated 90,000 tonnes of inbound raw materials including sulphur, sulphuric acid, caustic soda, hydrochloric acid, carbonate material, and fuel supplies. Outgoing freight will be around 140,000 tpa consisting of phosphoric acid, Cerium oxide product, mixed RE chloride product.	Inbound freight requirements with the separation facility increase and with the deferred construction of the sulphur burning, sulphuric acid volumes increase for the initial 2 to 3 years until this facility is fully constructed. Freight inbound will peak at around 196,000 tpa once at steady state. Outbound freight will be around 152,000 tpa.	Yes	Detailed logistics study completed and all inbound and outbound freight can be adequately met by existing infrastructure in Alice Springs and the Stuart Highway. The additional freight will require 2 additional road trains included in the transportation fleet coming daily to the project. Freight volumes and highway capacity has been discussed with the NT Regulator and there are no issues identified. Intersection design of the project access road and Stuart Highway is currently with the NT Regulator.
No	Waste water	All waste water will be pumped to a treatment facility.	All waste water will be pumped to a treatment facility.	Yes	
	Workforce				
No	Construction period	500-600 housed in construction and permanent camp	500-650 housed in construction and permanent camp.	Yes	
Yes	Operations	300 housed in permanent camp	270-300 personnel, majority housed at site in permanent (300 person capacity) camp	Yes	Support facilities and staff will be located in Alice Springs to maximise benefit to the community by having non-essential support staff

Project Changed	Project Component	Characteristics of Assessed Project	Proposed Revision to Project	Existing Assessment Conditions Adequate	Comment
					operating from Alice Springs rather than site based.
	Borefield				
Yes	Project water balance	Water demand for project 2.7-3.2 gigalitres per yr (GL/yr)	Water demand for project 3.4 GL/yr Note: Water licence is seeking approval for up to 4GL/year to allow for demand variations should they be required	Yes	Ongoing groundwater modelling of the borefield is being undertaken to increase confidence in understanding Southern Basins and the likely responses to the projects water demand for the duration of the project and beyond. A water abstraction management plan has been developed to provide guidance on how this resource will be managed. A network of groundwater level data loggers have been installed and monitoring will continue up to during and beyond the life of the project.

3. Project changes

3.1 Introduction

The key changes to the Project (i.e., the key differences between the Assessed Project and the Revised Project) are discussed below. The layout of the Project and the Surface Water Management General Arrangement - Stage 1 and Stage 2 (as prepared by Knight Piésold Consulting) are presented in Appendix A.

3.1.1 Production estimates

Arafura proposes to mine and process rare earths over a life of Mine (LOM) period of 55 years, based on the current total global resource of 56 Mt (i.e. Measured, Indicated and Inferred Resource) including a construction period of two years. The current mining feasibility study are focused on the development of the project over the initial 23 years of M&I resource, targeting the phosphoric acid pre-leach preferred material within that part of orebody. Proposed future work on the global resource, and additional exploration below this resource, will likely see increases in material available for processing, thus extending LOM beyond 55 years.

Expected production rates are largely unchanged at 13,343 tpa of TREO comprising of 10,271 tpa Cerium hydroxide and 5,443 tpa mixed rare earths, including neodymium (Nd) / praseodymium (Pr) oxide and Heavy Rare Earth (HRE) carbonate products.

It is proposed that the intermediate rare earth products (i.e. products from extraction processing) will be separated on site at a separation facility contained within the processing site footprint, rather than being transported offsite to be separated at an offshore facility as was proposed in the Assessed Project.

The Project will also produce an average of approximately 135,000 tpa merchant grade Phosphoric Acid, up somewhat from the 110,000 tpa anticipated in the Assessed Project. Tonnages of products will vary slightly due to variations in ore grade.

The most valuable components of the Nolans rare earth oxide, Nd and Pr, will be used to make permanent high-powered magnets for technological applications including in the clean energy industry. The Phosphoric Acid will be sold to the chemical industry for use in fertilisers or other products.

3.1.2 Water demand

Water demand for the project has changed slightly. The Assessed Project had a water demand in the range 2.7 to 3.2 GL/yr.

The water demand for the Revised Project is estimated to be 3.4 GL/yr. The Company has updated the water extraction licence application currently lodged with DENR to 4 GL/yr to allow for variability in water demand which may occur.

3.2 Mine site alterations

The Revised mine site general arrangement is contained in in Figure 3-1 and Appendix A, Drawing 801-140-A5001-050. Key changes include the removal of tailings storage facility from the mine site and relocation to the processing site as part of a combined tailings and residue storage facility.

Potential impacts on downstream sensitive receptors in the Ti Tree basin from a catastrophic failure of, or significant seepage from, the TSF therefore no longer apply.

The crushing, grinding and beneficiation circuits will also be relocated to the processing site.

3.2.1 Waste rock dumps

Mining operations will be 24 hours/day. Overburden and waste rock will be deposited in 2 purpose-constructed WRDs over the LOM (Figure 3-1). This is a reduction from the 6 WRDs proposed in the Assessed Project.

Each of the two waste dump locations have been divided into a number of discrete dumps to allow staged encapsulation and progressive rehabilitation. The maximum height for all dumps and stockpiles is the 720 m level, approximately 50 to 60 metres above the 660 m existing ground level.

During the initial project development the mining infrastructure and waste rock dumps will only be located to the east of the pit, towards Nolans Creek. Two sediment control dams will be built downstream to capture all runoff from these areas (refer Drawing 801-140-A5001-101 in Appendix A). These will overtop into a polishing pond which then will discharge off-site. A sediment control dam will be built near the mining maintenance area to the south of the pit which will capture the runoff from the nearby infrastructure there, as well as from the ROM pad.

In Year 8 the pit, as well as the waste dump development will expand towards the west. At this stage an additional sediment control dam will be built to the west of the polishing pond to capture the run-off from the new waste dump.

The general arrangement of the Stage 1 and Stage 2 sediment management structures that will support the development of the waste rock dumps are shown in Drg. No. 801-140-A5001-101 and -102 in Appendix A. These sediment management structures are not themselves proposed project alterations, rather they are the result of ongoing project design.

3.2.2 Top soil storage areas

The topsoil storage areas have changed from the Assessed Project due to the change in size and location of other facilities. The topsoil storage area at the mine site will decrease from 114 ha to 40 ha and at the processing site, it will increase from 40 ha to 60 ha. The topsoil storage areas will have a maximum height of 3 m (unchanged from the Assessed Project).

3.2.3 Long term stockpile

Low grade ore will be stockpiled in a long term stockpile at the mine site. The long term stockpile will store lower grade and non-PAPL preferred ore for future processing (see Figure 3-1). The revised Project has the long-term stockpile (LTS) located adjacent to WRD1 East which will enable simple future rehabilitation of this ore, if a decision is made to not process this ore. The LTS will be built on a compacted layer of material and rehabilitation would involve covering the ore with a 2m capping of benign waste rock to minimise erosion and provide shielding as with the waste rock dumps.

3.2.4 Slurry pipeline

The slurry pipeline that was a component of the Assessed Project has been replaced by a road trains that will collect blended ore from the ROM pad and haul the ore approximately 8 km from the mine site to the processing site along the service corridor. The service corridor is a component of the Assessed Project.

Potential impacts associated with a leak in the slurry pipeline between Mine Site and Process Site no longer applies.

3.2.5 Haul road

The service corridor between the mine site and process site will be upgraded to 20-30 m width to accommodate conventional road train traffic as well as general access to the mine site. ROM material will be loaded on to a conventional road train at a haulage rate up to 1.0 Mtpa, and delivered to the process plant 8 km to the south.

The alignment for the service corridor has been aligned to avoid impacting RWA 8 (i.e., sacred site). The final alignment is presented in Drawing 801-140-A5001-050 in Appendix A., This alignment may vary slightly once accurate survey and detailed design is completed.

3.2.6 Crushing, grinding and flotation

The crushing plant, comminution and beneficiation plant has moved from the mine site to processing site.

The Assessed Project described reagents being transported along the service corridor to the mine site for storage and use in the beneficiation process. These reagents will no longer be required at the mine site in the Revised Project. All reagents transported to site will now be stored at the processing site in a secure compound with containment in accordance with Australian Standards.

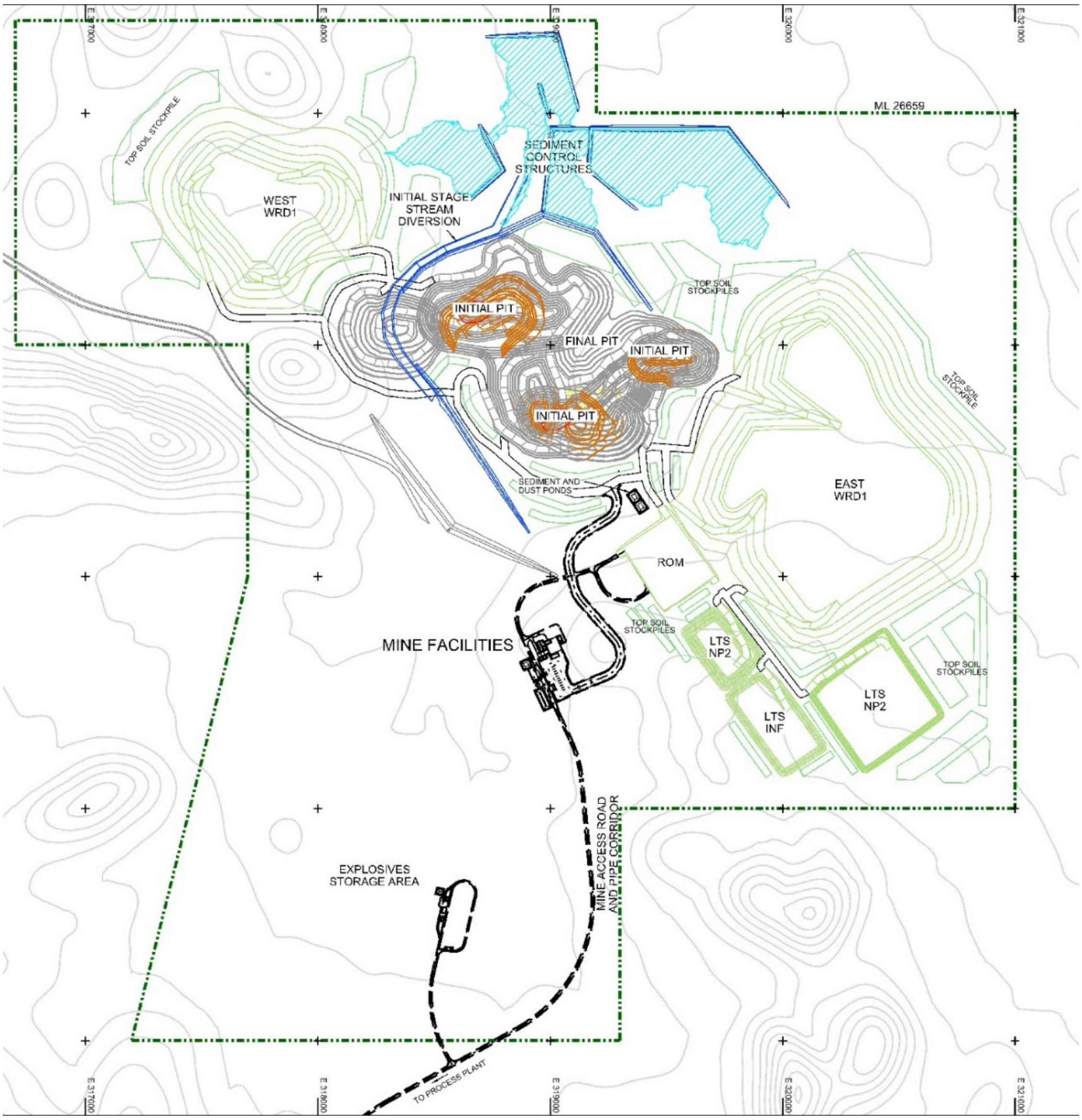


Figure 3-1 Mine site revised general arrangement

3.3 Kerosene Camp Creek diversion

Construction of the open pit located at the mine site will require diversion of the ephemeral Kerosene Camp Creek. The Assessed Project proposes to divert surface and subsurface flows into the western tributary of the Kerosene Camp Creek to prevent inflow to the pit and minimise the risk of contamination of clean surface water from mining activities.

The Assessed (stage 2) diversion (Appendix A. Stage 2 general arrangement) is approximately four kilometres in length and will require significant excavation through a saddle, exceeding depths of six m for over two km and reaching a maximum depth of 22 m (GHD, 2017). It will be approximately eight m wide in the shallower sections and up to 27 m wide in the deepest sections (GHD, 2016). The resulting diversion will have an average gradient of 0.1 percent (%), significantly lower than the 0.25% gradient of the existing creek (GHD, 2016).

The Revised Project proposes a staged approach to defer the significant excavation and embankment construction costs required as long as possible without impacting the pit development as currently scheduled; thus reducing upfront capital requirements (Knight Piésold, 2018a). An interim diversion (Stage 1, until year 6-9) will be constructed that bypasses the mining infrastructure and diverts rainfall runoff to the west around the mining area. The interim diversion alignment is depicted in Appendix A, Drawing 801-140-A5001-101, Stage 1 general arrangement. A typical Stage 2 diversion section is presented in Appendix B.

As a contingency, if mining were to cease prior to the Stage 2 diversions excavation, the Stage 1 channel has been designed to enable the system to remain operational and meet closure requirements.

Both stages of the diversion system have been designed to control and discharge a 1,000 yr Average Return Interval (ARI) storm event through the mining area during operations. Detailed information relating to key design parameters for the Stage 1 and Stage 2 diversions is contained in Table 3-1 below and Appendix B. The general arrangement of the diversion channels for Stage 1 and Stage 2 are shown in Appendix A, Drawing. No. 801-140-A5001-101 and -102 respectively. Typical details of the diversion channel are shown on Appendix B, Drawing. No. 801-140-A5001-303.

The interim (Stage 1) diversion will be located adjacent to the western edge of the starter pit, with a 35 m wide channel. The maximum flow depth will be 4 m for a design 0.1% ARI (1 in 100 year) rainfall event.

In rock the channel will be excavated with 0.5H: 1V side slopes which will be flattened to 3H:1V in soil batters (nominally average 2H:1V). Material sourced from the channel excavation will be used to construct bunds towards the pit in areas where the storm flow depth in the channel exceeds the natural ground elevation. The base of the channel is expected to be located in rock. Along with the small design grade and the relatively slow flow velocity it is not expected that erosion protection will be required. It is possible that some erosion protection material needs to be added in areas with softer underlying soils.

A backwater bund is also included downstream of the pit to prevent inflow during flood conditions (due to the expected flood depth and very flat topography), and sediment control structures will be built downstream of the mining area which are expected to minimise sediments escaping from the project area.

It is not expected that any waste haulage across the channel is required as the mining fleet will focus on material movements to the east. Potential impacts associated with the interim diversion channel are addressed in Section 4.2.

The interim diversion will be operational during the first 6-9 years of mining. During this time the final (assessed) diversion channel will be built to permanently divert the upstream runoff past the pit development.

Table 3-1 Kerosene Camp Creek diversion(s) - key design parameters (Knight Piésold 2018c)

Surface water management key design criteria	
Design Climatic Conditions	Annual Rainfall: Average: 291 mm 1% AEP Dry: 30 mm 1% AEP Wet: 847 mm Design Storm Depth: 1% AEP 24 hour storm: 196 mm 1% AEP 72 hour storm: 298 mm PMP 24 hour storm: 670 mm PMP 72 hour storm: 1,090 mm Annual Penmen Lake Evaporation: 1,982 mm Dominant Wind Direction: SEE to NWW
Catchment	Area Upstream Pit: 2,265 ha Peak Upstream Runoff: 10% AEP: 64 m3/sec 1% AEP: 164 m3/sec 0.1% AEP: 324 m3/sec
Diversion Channel Hydraulic design	Channel / erosion protection sized to accommodate: Stage 1 diversion – 0.1% AEP storm event Stage 2 diversion – 0.1% AEP storm event
Embankment Freeboard	The critical elevation out of: Minimum of 1.0 m to maximum design pond. Minimum of 0.1 m for maximum spillway flow (1% AEP). Dedicated embankment overflow sections to manage up to PMP flow.
Sediment Management Structures	Sized to remove particles up to the medium to coarse silt fraction for flows up to 1 % AEP Storms.
Sediment Management Structures - Spillway capacity	Sized to safely discharge: 1% AEP Storms. Embankment designed to manage overtopping for flows up to PMF.
Design earthquake loading	OBE 1 in 1,000 year: 0.024g MDE 1 in 10,000 year: 0.045g Post Closure MCE: 0.053g

Surface water management key design criteria	
Stability minimum factor of safety	Long term drained 1.5 Short term undrained Potential loss of containment 1.5 No potential loss of containment 1.3 Post seismic: 1.0 to 1.2

3.4 Processing site alterations

The processing site is located approximately eight km south of the mine site in a separate catchment, i.e. it drains away from the sensitive Ti Tree catchment. This location was chosen for having near-surface basement rock, thereby limiting the potential for soil and/or groundwater contamination arising from beneficiation or processing activities.

Key alterations at the process site include introduction of the separation plant, relocation of the crushing, grinding and floatation circuits, and a redesigned waste storage facility for tailings and residue from the beneficiation circuit, extraction (intermediate) and separation processes.

3.4.1 Crushing, grinding and flotation

Blended ore from the mine site will be direct tipped into the crusher at the processing site. Hauling and crushing operations will be daylight hours only.

Tipping and crushing operations will be undertaken inside a controlled, covered area to prevent dust from being mobilised across the processing site. Crushed ore will then be conveyed (via covered system) to the ball mill for grinding before passing through the floatation process.

The mineral concentrate from the flotation circuit will be pumped to the processing plant, and tailings will be pumped from the beneficiation plant at the processing site to the combined tailings and residue storage facility located at the processing site.

3.4.2 Separation plant

Located at the process plant, the separation facility and product handling area will separate the SEG/HRE and NdPr into final rare earth products. The separation plant requires an additional 300-500 ML/ year of raw water, which increases the overall water demand for the Revised Project. This has been addressed in Section 3.1.2 and 4.1.

The separation plant generates additional raw materials requirements. The key difference is that the separation plant requires additional hydrochloric acid, caustic soda and sodium carbonate. For the Revised Project this increases the inbound raw materials by approximately 34,000 tpa. Increased traffic has been addressed in Section 4.3.

Outputs from the separation process include a small amount of waste water, dry RE products and a raffinate (effluent) stream. The raffinate contains hydrochloric acid and sodium chloride in solution that will be neutralised with the water leach residue with lime, before pumping to the WLR cell in the RSF. The raffinate also contains lanthanum and actinium.

The raffinate from the separation plant is approx. 9.5 t/h with a liquor composition of 1.8 g/L HCl, 164 g/L NaCl, 44.6 g/L La, 1.7 g/L Ca, and 0.7 g/L Mg. See Table 3-2 below for the mass balance. The WLR residue stream is 95 t/h so the separation plant contributes only 10% of this residue stream.

Table 3-2 Separation plant mass balance incl. radionuclides

4400 - Effluent Treatment		Unit	La_Ac227_Raff_from_5120 to nuetralise_acid_in_tails
Mass	Total	t/h	9.50
	Solids	t/h	
	Liquid	t/h	9.50
	Vapour	t/h	
	Water	t/h	7.73
Density	Total	kg/m^3	1136
	Solids	kg/m^3	
	Liquid	kg/m^3	1136
Composition	Solids	% w/w	
Volume	Total	m^3/h	8.36
Temperature		°C	52.33
Aqueous	HCl	g/L	1.83
	H3PO4	g/L	
	HF	g/L	
	H2SO4	g/L	
	NaOH	g/L	
	C	g/L	0.00
	F	g/L	0.00
	Na	g/L	48.44
	Mg	g/L	0.73
	Al	g/L	0.04
	Si	g/L	0.00
	P	g/L	0.00
	S	g/L	0.00
	Cl	g/L	115.94
	K	g/L	0.00
	Ca	g/L	1.68
	Fe	g/L	0.00
	Y	g/L	
	Ba	g/L	0.05
	La	g/L	44.55
	Ce	g/L	0.00
	Pr	g/L	0.08
	Nd	g/L	0.04

4400 - Effluent Treatment		Unit	La_Ac227_Raff_from_5120 to nuetralise_acid_in_tails
	MRE	g/L	
	HRE	g/L	
	TREE	g/L	44.68
	Th	mg/L	0.00
	U	mg/L	0.21
	SO4	g/L	0.00
	PO4	g/L	0.00
Radionuclides	Ac227	Bq/g	0.74
	Pa231	Bq/g	0.00
	Pb210	Bq/g	0.00
	Po210	Bq/g	
	Ra226	Bq/g	0.00
	Ra228	Bq/g	0.00
	Th228	Bq/g	0.05
	Th230	Bq/g	0.01
	Th232	Bq/g	0.05
	U234	Bq/g	0.00
	U235	Bq/g	0.00
	U238	Bq/g	0.00
	Total activity 1-year	Bq/g	6.09
	Total activity 5-years	Bq/g	5.33
	Total activity 10-years	Bq/g	4.68
	Total activity 100-years	Bq/g	0.82

3.4.3 Sulphuric acid plant

The rare earths processing circuit requires sulphuric acid and this will ultimately be provided by an on-site sulphur burning plant. The sulphur burning acid plant is a component of the Assessed Project, however for the Revised Project the proposed sulphur burning acid plant consists of three modules of which only one will be constructed prior to the commencement of processing. The remaining two modules will be constructed during the ramp up of the processing plant in the second year of operations and commissioned at the commencement of the third year of operations. Acid shortfall, which will occur in the second year of operation, will be imported in ISO containers via railway to Alice Springs, and via road to site.

3.4.4 Residue storage facility

The processing site plant will produce three individual residue streams:

- Beneficiation Tailings (Tailings)
- Gypsum Residue (Gypsum)
- Water Leach Residue (WLR)

The combined tailings and residue storage facility (referred to as the RSF) will comprise two individual cells operating concurrently. Gypsum and beneficiation tailings will be combined and will report to a combined larger cell in the RSF. Decant water will be recycled to the beneficiation plant process water circuit. The other smaller cell will store water leach residue (WLR) i.e. neutralised residue from the extraction process including most of the thorium and uranium present in the processed ore and also a mixture of other gangue elements, waste brine and separation plant residue. Approximately 36.4% of the Uranium and 33.3% of the Thorium report to the combine bene tails/gypsum with the remainder reporting to the WLR stream.

Each cell will operate for approximately 7 to 9 years and then will be decommissioned, capped, and progressively rehabilitated. Deposition will continue in additional cells built immediately adjacent to the initial structures and sharing internal walls. After 23 years, the RSF will consist of three beneficiation tailings and gypsum residue cells, and three WLR cells covering an area of 240 ha. (Knight Piésold, 2019). Over 23 years the RSF will accumulate approximately 13 Mt of tailings, 6.9 Mt of gypsum residue and 3.1 Mt of WLR. Over the potential LOM (55 years) the RSF may cover an area of 720 ha dependant on the success of future proposed exploration and metallurgical test work.

Process residue will be deposited into the purpose- built RSF as a slurry. Solids will settle out and any excess water will be recovered during settling and returned to the process plant for reuse via decant towers and sub-drainage located in each cell.

The Revised Project RSF comprises two operational cells, built as multi-zoned earth and rockfill embankments in a paddock configuration with a treated basin.

The Stage 1 construction of the initial RSF cell embankment will be a maximum of 10 m high and will provide storage capacity for the initial 3 years of production. The cells will then be raised over the subsequent years, based on a two year construction schedule to a maximum height of 25 m above ground level.

The combined beneficiation tailings and gypsum residue cells will be raised using a centreline construction methodology, and the WLR cells, being HDPE lined will be raised using a downstream method. At this stage new cells will be built immediately to the west of the initial cells and deposition shifted to the newly constructed cells. The old cells will be progressively rehabilitated.

From a visual perspective, the RSF embankment will not protrude above the natural hills to the north of the RSF. The Napperby Road, which is located approx. 10 km to south of the RSF

southern embankment rises to approx. RL 645m. The natural hills to the north of the embankment rise to an RL of about 730 m. During the early stages of development, the embankment will be visible, but once vegetation is established, the embankment will effectively blend into the landscape.

Facility hazard rating

In accordance with Australian National Committee on Large Dams (ANCOLD) guidelines, design criteria have been based on a hazard rating of "High C" for the facility.

In addition to the residue storage, each cell is sized to contain the rainfall runoff due to a longer duration 1 percent Average Exceedance Period (AEP) rainfall event or due to a short term extreme storm (1% AEP 72 hour storm) in addition to the maximum average climate operational pond. An emergency spillway, sized to pass the Probable Maximum Precipitation (PMP) rainfall event, after attenuation in the facility, will be installed at each cell to prevent overtopping of the embankment in an uncontrolled manner if the design rainfall event is exceeded.

Knight Piésold (2019) modelled various rainfall conditions for selected development years to determine the required storage, associated embankment crest elevations and make up water supply requirement. The following rainfall sequences were modelled:

- Average climatic conditions
- A 1% AEP wet precipitation sequence occurring in any year of the operation
- Average climatic conditions with a 0.1% AEP 72 hour storm event (298 mm) on the RSF occurring at any time of the operation with no decant or evaporation during the event
- A 1% AEP dry precipitation sequence occurring in any year of the operation.

Based on the modelling, the facility will be strongly water negative and minimum pond volumes (limited by the ability to recover decant) will be maintained on the facility during most months of the year. On average, approximately 10% of the water in the slurry discharged to the RFS can be recovered over the course of a year with no recovery expected during prolonged dry conditions (Knight Piésold 2019).

Additional design, construction and operation, monitoring and closure information relating to the Revised Project RSF is available in Knight Piésold 2019 which is appended at Appendix D.

The general layout of the RSF over the development stages is shown in Appendix D, Drawing No. 801-140-A3001-101, 801-140-A3001-110, 801-140-A3001-140 and 801-140-A3001-170.

Typical embankment sections are shown in Appendix D, Drawing No. 801-140-A3001-301 to 304 and 01-140-A3001-401 to 403.

Residue storage facility construction

The beneficiation tailings/gypsum residue cells will comprise a reworked soil lined basin with a full piped underdrainage network to provide seepage control and reduce seepage losses.

The embankments will have a low permeability (10^{-8} m/s) soil upstream fill zone and will be built using modified centreline construction techniques. A continuous cut-off trench will be constructed beneath the entire length of the embankment and will be excavated into a competent foundation layer to provide further near surface seepage control.

The water leach residue cells will comprise of two basin liners, a primary high-density polyethylene (HDPE) geomembrane overlying a secondary engineered, low permeabilitysoil liner (10^{-8} m/s), with a full piped underdrainage network, in addition to a leak collection and recovery system. The embankments will have a low permeable upstream fill zone as well as a HDPE geomembrane liner. A cut-off trench will be located beneath the entire length of the

embankment and will be excavated into a competent foundation layer to provide further near surface seepage control. To facilitate full and continuous installation of the geomembrane and engineered soil liners, the embankments will be constructed using full downstream construction techniques.

Earthworks will be supervised by a qualified engineer on behalf of the Engineer of Record with full quality assurance and quality control (QA/QC) testing during construction. Records will be compiled in a formal construction report for sign off at the end of each construction phase.

3.4.5 Power

For the Assessed Project the estimated power requirement was 12.5 MW with power co-generated from the waste heat from the sulphur burning acid plant and a gas fired power station. Additionally, for the Assessed Project the processing had steam requirement of 100 tph for process uses.

For the Revised Project the estimated power requirement has increased to 33 MW and the process steam requirement has decreased to 52 tph. Power for the Revised Project will be generated in a gas-fired power station with all steam requirements generated from the waste heat from the sulphur burning acid plant. During times of acid plant outages, and during ramp up period when the second two modules of the acid plant are in construction, the additional steam requirement will be provided by gas-fired back-up boilers.

3.4.6 Accommodation village

The accommodation village is located 5 km east of the processing site and occupies approximately 32 ha.

The Revised Project has approximately 270-300 workers housed on site at the accommodation village. Additionally, the Company is locating the support facilities in Alice Springs, to maximise benefit to the community by having non-essential support staff operating from Alice Springs rather than site.

4. Impact assessment

In the preparation of this report, the environmental risk register developed for the Nolans Project EIS and EIS Supplementary Report was fully re-evaluated in a workshop setting and with a range of stakeholders.

All proposed project changes were considered in the context of the existing approval conditions i.e. Assessment Report 84, to determine if those conditions would be adequate to manage the proposed project changes. The findings of that process have guided the preparation of this document, and the supporting appendices provide additional information in some key areas, in support of those findings.

Additional new infrastructure is accommodated within previously identified footprint areas identified in the EIS. Project configuration changes have resulted from detailed engineering and planning. These changes will provide operational efficiency, reduce on-ground impacts and lower the operational and environmental risk of the project.

To understand the impacts associated with the proposed alterations the changes have been reviewed in the context of the NT EPA Assessment report 84, and the environmental factors and objectives.

4.1 Water demand

Theme	Factor	Objective	Potential impact from proposed alteration
Water	Hydrological processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	Abstraction of additional groundwater and subsequent change in the long term drawdown at the borefield

The NT EPA has identified potential significant impacts on environmental values that depend on the existing hydrological groundwater regime. Specifically, groundwater drawdown may contribute to a reduction in the volume of groundwater available to current and future users of regional aquifers, and may impact significant ecosystems due to abstraction of groundwater and subsequent long-term drawdown at the borefield. The water demand for the Revised Project is marginally increased.

Ongoing groundwater modelling of the borefield is in progress by Arafura to further increase confidence in understanding the Southern Basins and the likely response to the project revised water demand for the duration of the project and beyond. A water abstraction management plan (WAMP) has been developed to provide guidance on how this resource will be managed. A network of groundwater level data loggers have been installed and monitoring will continue up to, during, and beyond the life of the Project. In accordance with the NT EPA Assessment Report 84, the WAMP will be independently reviewed.

4.1.1 The water abstraction management plan (WAMP)

The WAMP documents the predicted groundwater extraction for the Project, and how the predicted drawdown will be compared to observed groundwater levels. The observed groundwater levels will be considered alongside the monitoring of soil moisture and vegetation health. This monitoring will inform any potential impact to ecosystem function and cultural values associated with the water abstraction from the Project.

Adaptive management actions are proposed shouldany impact to groundwater levels (above prescribed triggers), soil moisture, vegetation, fauna, ecosystem function or cultural values be determined. A recommendation in the annual reporting proposing an adaptive management action would prompt an amendment to this WAMP. Likewise, additional infrastructure, on-ground works, studies or new data would also prompt amendments or addendums to the WAMP. Thus the WAMP is considered an ongoing work that requires updating over the life of the Project.

The southern basins borefield is focused on the Reaphook palaeochannel aquifer, which has been delineated using a combination of drilling and geophysical interpretation. The hydraulic properties of the aquifer have been interpreted based upon a combination of airlift yields, pumping tests, grain-size analyses and steady-state numerical modelling. Given the arid climate, it is considered that recharge is likely to be significantly lower than the volume of extraction. Despite low recharge volumes, calculations at a range of specific yields demonstrates the groundwater in storage is significantly larger than the volume of planned extraction.

The design of the borefields allows for nine new production bores to pump at an average of 12 L/s each. The borefields are a nominal 1 km apart, primarily at locations with proven high yields. Within each borefield, individual bores are designed a nominal 100 m apart. The borefield has been designed to concentrate the drawdown on the easternmost portion of the Reaphook palaeochannel and extract additional groundwater resource from the feeder channels to the east. This design also allows extraction within a relatively close proximity of the Nolans site while minimising the impact on areas thought to have the potential to contain groundwater dependent ecosystems (GDEs) to the west and south. Other design scenarios, with a greater spread of borefields further to the west, do decrease the maximum drawdown at the pumping bore locations but result in significantly more interaction with areas that are more likely to contain GDEs.

Numerical modelling has been undertaken to display a range of groundwater drawdown impacts in the borefield area. In all scenarios, the outcomes for the aquifer are relatively similar, in that drawdown is significant in the centre of the borefield, and takes decades to hundreds of years after closure to recover. This drawdown is not anticipated to impact any current known beneficial uses. In the scenarios where the specific yield is modelled at the unlikely low value of 0.01, drawdown does impact on an area considered the most likely to contain potential GDEs, in the vicinity of Day Creek and the Reaphook Hills. Numerical modelling has demonstrated how such drawdown could be managed and mitigated locally, through targeted re-injection in the unlikely event of such low specific yields being observed once pumping commences.

A significant groundwater monitoring program has been designed to provide ongoing information on aquifer properties, groundwater modelling validation and drawdown impact. The current model is considered a Class 1 model and the steps required to achieve a Class 2 groundwater model have been documented as part of these works.

The mining of the Nolans pit will completely extract the small aquifer (both the rock and water) associated with the orebody. The current use of the Nolans orebody aquifer is for stock watering and this beneficial use will be removed by the Project. Drawdown is highly unlikely to be measureable in the Ti Tree Basin. Our modelling of this aquifer indicates that the pit is highly likely to be isolated from the basin by a basement groundwater divide, much higher in the landscape and hydrogeological regime than the basin standing water level.

The NT EPA Assessment Report 84 made 16 recommendations for the Proponent and decisions-makers to consider. The WAMP addresses a number of these recommendations (3, 4, 5 & 6) and comments in relation to the environmental commitments, safeguards and recommendations set out in the Assessed project.

The requirement for Arafura to meet the current recommendations 3, 4 and 5 contained within the Assessment Report 84 adequately address the potential impacts associated with an increase in the water demand for the project.

4.2 Kerosene Camp Creek - Stage 1 interim diversion

Theme	Factor	Objective	Potential impact from proposed alteration
Water	Hydrological processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	Stage 1 diversion (to Year 6-9) impacts localised hydrological processes and fails to maintain existing regional hydrologic regime and effectively deliver the natural flows of Kerosene Camp Creek to the downstream environment
	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.	Leachate from the interim diversion basement rocks has the potential to impact on surface water and/or groundwater quality

4.2.1 Hydrological processes

It is a condition of the Assessed Project that Arafura maintain the existing regional hydrologic regime by effectively delivering the natural flows of Kerosene Camp Creek. This will apply to the interim diversion as well.

Knight Piésold (2018c) was engaged to conduct a definitive feasibility study, surface water management report including Stage 1 and Stage 2 diversion designs. Following a hydrologic assessment to determine catchment response and peak flows, both diversion channels have been designed to control and discharge the upstream runoff of a 0.1% Average Exceedance Probability (AEP) rainfall event (Knight Piésold, 2018a).

Prior to construction of the interim channel, recorded Kerosene Creek flows will be used to calibrate the runoff model with site specific monitoring data, allowing any design adjustments required to be made at that time to effectively deliver creek flows to the downstream tributary.

It is proposed that an automatic flow monitoring station is installed at the inlet to the pit diversion channel as well as a rainfall monitoring station within the mining area. This will allow the back-calculation of the rainfall runoff specifics for the actual catchment and calibration of the computer model, which will subsequently be used in the design of the final diversion channel to the west, which was part of the Assessed Project.

4.2.2 Quality of groundwater and surface water

The interim diversion channel will be crossing an area of the future pit excavation. It is possible that some mineralisation (approx. 5-10%) is encountered within channel excavation. Potential leachate from basement rocks has some potential to contaminate surface water in the diversion channel and groundwater via infiltration.

As part of the continued assessment of the potential impact of acid, saline or metalliferous drainage (collectively referred to as AMD), Arafura has established field leachate testing barrels to assess the release of soluble metals, metalloids and other environmentally significant solutes. These are referred to as barrel leach tests. Eleven leachate cycles have been completed over a 42 week period and the leachate analysed.

Sections of the interim diversion channel will also pass through mineralised areas where there may be potential acid and metalliferous drainage and/or NORM which may pose a risk. This alignment will be logged in detail and if required it will be treated with an appropriate surface treatment e.g. will be over-excavated and backfilled with benign compacted material or sealed with a thin concrete layer to prevent water flowing through the channel coming into contact with potential AMD or NORM material. It should be noted that the current path of the Kerosene Camp Creek encounters the same basement rocks and the Nolans orebody. Based on results of periodic water quality sampling of this stream, there is no evidence of any water quality issues downstream of the Nolans site.

Impacts to hydrological processes and inland water environmental quality associated with Kerosene camp creek interim diversion remain unchanged from the Assessed Project. The recommendations identified by the Assessment Report 84, Recommendations 8 and 9, will be implemented prior to construction of the diversions, and are adequate to address these potential impacts.

4.3 Traffic and consumables

Theme	Factor	Objective	Potential impact from proposed alteration
People and communities	Social, economic & cultural surroundings	Protect the rich social, economic , cultural and heritage values of the Northern Territory	Increase in traffic on local and Alice Springs roads, and on the railway
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.	Uncontrolled release of hydrocarbons or reagents through inappropriate transport resulting in the contamination of surface water

4.3.1 Increase in transport on public roads

The risks associated with the transport of materials and personnel on public roads during project operations leading to impacts on the operational network capacity and road network conditions were assessed for the Assessed Project. The full report is available at Appendix C. The traffic assessment for the Assessed Project forecast a 4% increase in daily traffic on the Stuart Highway at the proposed intersection with the Project access road. Arafura suggested the impact on road users is unlikely to be significant due to the small number of vehicle movements per day (predicted total 26) and the road capacity.

Review of the Revised Project shows that there is a small increase in generation of truck trips to and from the project site. This is due to a combination of factors including a reduction in the size of trucks to triple road trains, limited back freighting of mine products and more detail regarding consumable products on site. Total daily trips generated by the site will increase from 26 as assumed in the Assessed Project to 40 at full production i.e. three years into operations,

and with the full Acid Plant in operation on site. The difference in peak period impact on the road network will increase marginally to that assumed in the Assessed Project, and there continues to be sufficient capacity to cater to this incremental traffic.

Table 4-1 below provides a summary of the difference between peak period trip generation by the mine, as assumed in the Assessed Project with ranges from the Revised Project. This table shows that the net impact for daily trips is to increase from 26 to 40 trips. In the peak period, trips are only expected to increase from 16 to 18 trips. Appendix C provides a more detailed description of the changes in the Revised Project associated with traffic generation.

Table 4-1 Comparison of EIS and Updated Peak Hour Trip Generation

	EIS			Updated Operations	
Trip purpose	No. of daily trips	Peak hour proportion	No. of peak hour trips	No. of daily trips	No. of peak hour trips
Imports of consumables	12	10%	2	15	2
Exports of products	0	10%	0	11	2
Transportation of site workers from Alice Springs	2	100%	2	2	2
Transportation of site workers from north of Aileron	2	100%	2	2	2
External contractors' vehicles (assume from Alice Springs)	10	100%	10	10	10
Total (from Alice Springs)	**26**		**16**	**40**	**18**

4.3.2 Uncontrolled release

The potential risk of an uncontrolled release, spill or discharge of hydrocarbons or reagents through inappropriate handling, transport or storage resulting in the contamination of surface water was identified in the Assessed Project. This risk has not changed in the Revised Project and will be managed in accordance with the hazardous substances management plan that will be reviewed during the mining authorisation process.

Therefore, the risk of an uncontrolled release, spill or discharge of hydrocarbons or reagents is unchanged from the Assessed Project.

4.4 Air quality

An updated air quality model has been produced to account for the changes to the proposed mine site configuration and to include additional sources not previously considered. The full report is appended at Appendix E. The following primary differences are observed between configuration of the Assessed (2016) and Revised Project (2018) air quality models:

- General increase in level of detail provided (based on the development of DFS) has led to inclusion of some additional sources e.g. number of equipment, transfer points etc.
- An increase in number and size of exposed areas (e.g. stockpiles)
- Additional haul road for transport of ore to processing plant
- Increase in hourly emission rates based on utilisation factors

Theme	Factor	Objective	Potential impact from proposed alteration
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.	Wind mobilising dust from WRDs and haul roads including between the mine site and processing site leading to potential impacts on surface water quality and/or air quality
Air	Air quality and greenhouse gases	Maintain air quality and minimise emissions and their impact so that environmental values are protected	
Land	Terrestrial flora and fauna	Protect the NT's flora and fauna so that biological diversity and ecological integrity are maintained.	
Air	Air quality and greenhouse gases	Maintain air quality and minimise emissions and their impact so that environmental values are protected	Release of greenhouse gases into the atmosphere

4.4.1 Wind mobilising dust from exposed surfaces

The total annual emission rate from the site for the Revised Project is estimated at 942,730 kg of PM_{10} per year, representing an approximate 80% increase in total PM_{10} emissions from the Assessed Project assessment. The observed increase in predicted ground level concentration is commensurate with the calculated increase in PM_{10} emission rates. A significant increase in the footprint of the 60 µg/m³ contour (without background) is observed (Figure 2 in Appendix E), however the contour does not extend to any identified human sensitive receptors. Furthermore, no exceedances of the 60 µg/m³ criteria are predicted with the inclusion of a 24-hour average background PM_{10} level of 15 µg/m³.

GHD (2018) undertook revised dust modelling to determine change in risk profile associated with changes in mine site arrangement and mining operations. This report is available at Appendix E.

The increase in emissions is due to the following primary differences between configuration of past and current models:

- General increase in level of detail provided has led to inclusion of some additional sources (number of equipment, transfer points etc.)
- An increase in number and size of exposed areas (pit, stockpiles)
- Additional haul road for transport of ore to processing plant
- Increase in hourly emission rates based on utilisation factors

The Air Quality and Dust Management Plan will be provided as part of the mining authorisation. The risk remains the same as the Assessed Project. Waste rock dumps and stockpiles will be managed in the same way as the Assessed Project, with measures such as:

- Application of water for dust suppression on waste rock dumps during operation
- Revegetation of Waste Rock Dump post-operation
- Ongoing dust monitoring program.

The controls in place already for other haul roads in the mine site, as part of the Assessed Project, will also be applied to hauling ore along the service corridor.

Surface water quality monitoring will be implemented upstream and downstream of the mine site, and sediment control dams will be built downstream of the mining area to allow for settling out of sediments that may accumulate in drainage lines. These dams will also form surface water sampling points to confirm the water quality is acceptable for release / reuse.

4.4.2 Impact on listed, threatened species

Mining activity under the Revised Project would increase the ground level concentration of dust, which could impact on individual *Petrogale lateralis*. However the modelled distribution of all dust pollutants for the Assessed Project was below the relevant criteria within three kilometres of the proposed mine site. Whilst it is potentially higher under the Revised Project, it is unlikely that this level of dust would have a significant impact on *P. lateralis* in the context of available habitat for the population within the region. An assessment of the likelihood of individual *Petrogale lateralis* occurring in the area impacted by dust levels 60 $\mu g/m^3$ has been undertaken (see **Error! Reference source not found.** below), and it appears that areas identified during survey as having recent *Petrogale lateralis* activity are outside the affected areas.

Therefore the risk remains unchanged from the Assessed Project.

There are no other listed threatened species that would potentially be impacted by the change.

4.5 Haul road

Theme	Factor	Objective	Potential impact from proposed alteration
Land	Terrestrial flora and fauna	Protect the NT's flora and fauna so that biological diversity and ecological integrity are maintained.	Increased potential for road-strike which could kill or injure individual *Petrogale lateralis*.
People and communities	Social, economic & cultural surroundings	Protect the rich social, economic , cultural and heritage values of the Northern Territory	Upgrades to road capacity to accommodate road trains impacting on sacred site

4.5.1 Increased mortality due to road-strike

Mining activity under the Revised Project would increase vehicle movements along the service corridor between the mine site and processing site, which may increase the risk of road-strike which could kill or injure individual *Petrogale lateralis*. It is anticipated that one truck will operate on the haul road, with one movement from the mine to the process plant and return each hour.

To reduce the risk of road traffic on threatened species including *Petrogale lateralis*, Arafura has committed to preparing and implementing an Assessed Project Transport Management Plan which includes measures for reducing the risk of road-strike, as per the recommendations in the NT EPA Assessment Report 84. The Plan would include controls on driving at night when the highest risk to the species would occur as individuals leave the outcrops and disperse. Controls will include signage and speed limits. A restricted speed limit will be applied in the areas where rocky outcrops occur in close proximity to the road. Arafura will maintain a register of Rock Wallaby sightings along the haul road, and will record any deaths, in order to understand whether additional controls e.g. fencing are required.

Therefore, whilst the Revised Project includes an additional haul road, the risk remains unchanged from the Assessed Project.

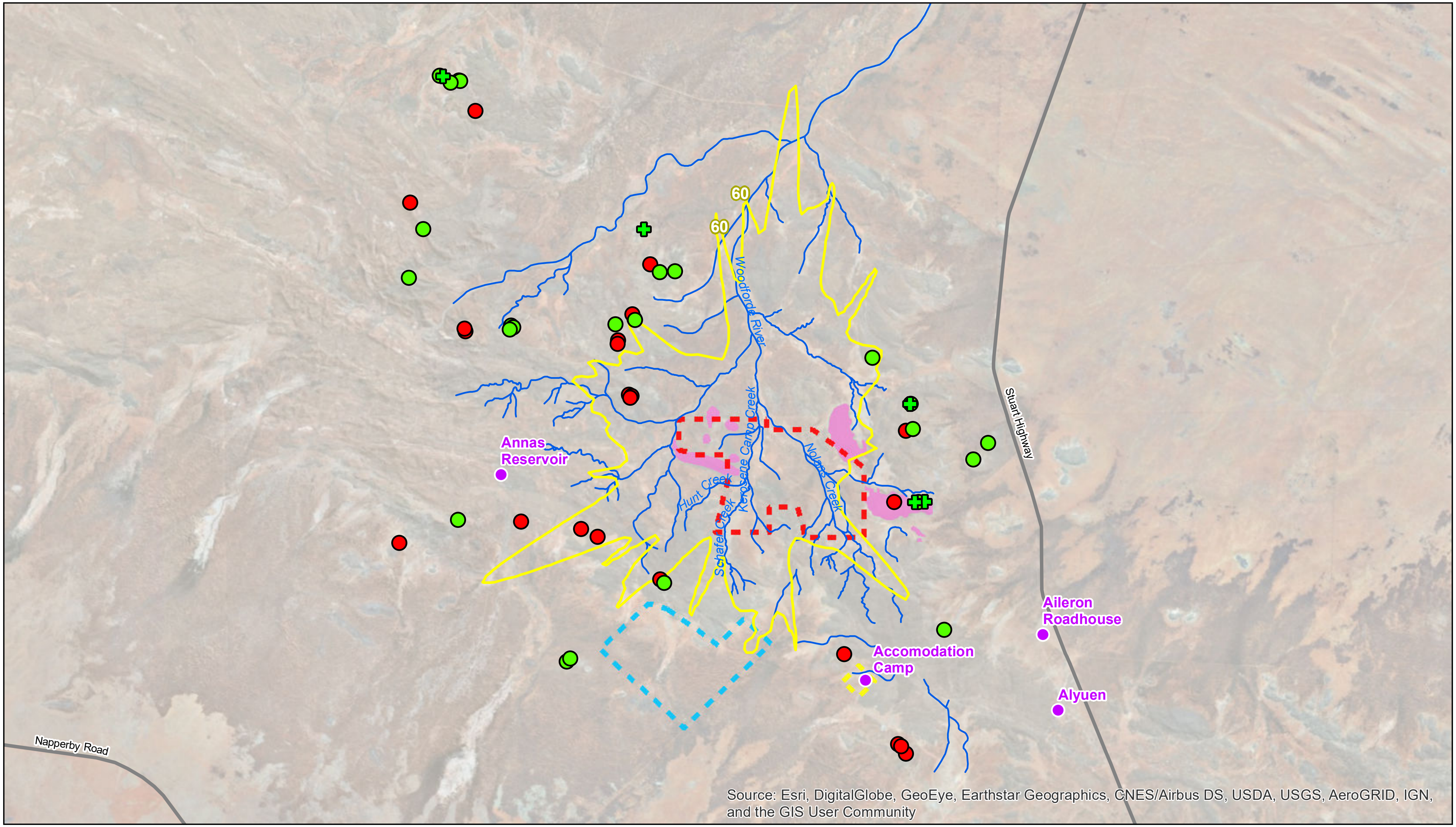
4.5.2 Vehicle movements along haul road result in damage to sacred sites

The most significant area of potential heritage impact is RWA 8 (Aboriginal Areas Protection Authority Certificate Restricted Works Area) which contains objects of high archaeological and cultural significance. To avoid impacts to RWA 8, the Company has altered, under the Revised Project, the alignment of the service corridor between the mine site and the processing site to avoid impact to RWA 8.

4.5.3 The release of greenhouse gases into the atmosphere

No greenhouse gas assessment was required for the Assessed Project. Based on currently available data, the worst case, annual GHG emissions for the project are estimated as approximately 0.144 Mt CO_2-e per annum. This is estimated to be approximately 0.9% of the Territory's annual GHG emissions. Given these predicted emissions, the project would be obligated to register and report under the National Greenhouse and Energy Reporting Act 2007.

The greenhouse gas assessment is included in Appendix F.



1:200,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Identified Sensitive Receptors
- Adult rock-wallaby present
- Adult and juvenile rock-wallaby present
- Rock-wallaby not present
- Roads
- 60 ug/m³ PM10 Contour - 24-hour Maximum
- Accomodation Camp Boundary
- Mine Site Boundary
- Processing Site Boundary
- Indicative Rock Wallaby Habitat Boundary

ARAFURA RESOURCES LIMITED

GHD

Arafura Resources Limited
Nolans Project

Job Number 4322301
Revision 0
Date 18 Jun 2019

Air quality assessment 2018 and Rock wallaby habitat

Figure 4-1

G:\43\22795\GIS\Maps\4322795_06_RockWallabyHabitat.mxd

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Data source: GA - Roads (2015). GHD - Study Area, Features, Black-footed rock-wallaby data, Air Quality Modelling (2010-2019). Black-footed rock-wallaby data (2015). Created by: ecastelblanco

4.6 Mining area alterations

Theme	Factor	Objective	Potential impact from proposed alteration
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.	Redirection of surface water flows, resulting in a potential increase of surface water runoff that could potentially lead to localised erosion or deposition in creek beds.
Land	Terrestrial environmental quality	Maintain the quality of land and soils so that environmental values are protected	

4.6.1 Erosion and sediment control

Construction of the mine including the pit, redesigned waste rock dumps, roads, etc. requires the installation of new hardstand areas and the redirection of surface water flows, resulting in a potential increase of surface water runoff. These could potentially lead to localised erosion or deposition in creek beds.

The Revised Project mining area impacts two main drainage courses (Appendix A):

- Kerosene Camp Creek (see Section 3.3 and section 4.2) which currently flows through the ultimate pit area
- Nolans Creek, a significant catchment to the east of the mining infrastructure area.

The Company proposes to use engineering controls that assist in maintaining surface water flows, including culvert designs, longitudinal drainage and floodway crossings. In addition, Arafura has committed to diverting all runoff from disturbed areas into sediment ponds.

The planned changes to infrastructure (e.g. removal of the TSF, and changes in the footprint of waste rock dumps) has been designed and located so that disturbed areas do not generally impact the Nolans Creek water course.

Later stages of the eastern waste rock dump do encroach into the flood plain of Nolans Creek and measures have been included to direct sediment from this disturbed area back into the sediment control management systems to maintain Nolans Creek discharge as clean water (and 801-140-A5001-900, Appendix B).

Limited / minor changes to the flood depth are forecast due to the minor reduction of the flood plain extent. A flood protection bund will be constructed between the mining area and the creek alignment to protect the waste dump and stockpile batters from flood damage / erosion and sediment generation during extreme storm events (refer Appendix A, Drawing no. 801-140-A5001-101).

The construction of the sediment control dams, in conjunction with the minor surface water diversion channels required to intercept and convey the sediment laden runoff from disturbed areas into the dams, will be staged to match the mining development. In general, it is intended that the bulk of surface water runoff from disturbed areas will pass through three structures operating in series in order to obtain the best performance possible from the system operating within the current available land constraints. Depending on the storm event, coarse sands and gravels would typically be intercepted in the first structure, fine sands and coarse silts in the second structure and medium to coarse silts in the third. For small storm events, the bulk of the runoff may be contained without overflowing and subsequently all sediments would be

contained. Additional information mining area flood and sediment management is contained in Appendix B. The general arrangement of the diversion channels and surface water dams is depicted in Appendix A, Drawing no. 801-140-A5001-101 and 102.

Impacts to surface water flows do not change as a result of the Revised Project, and the current proposed management plans, and recommendations identified by the Assessment Report 84 are adequate to address these potential impacts.

4.7 Residue storage facilities

Theme	Factor	Objective	Potential impact from proposed alteration
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.	Infiltration or leachate from RSF seeping into the groundwater
			Overflow or catastrophic failure of RSF causing uncontrolled release of contaminants to enter surrounding land, groundwater and/or surface waters.

4.7.1 Infiltration or leachate from RSF seeping into the groundwater

The Assessment Report 84 describes the potential for acidic, neutral metalliferous or saline leachate from the TSF and/or RSF. Radioactive materials including uranium and thorium could also be a component of contaminants mobilised into groundwater from tailings and residues.

To mitigate seepage of leachate or radioactive material contaminants from the RSF into the groundwater, the design, construction, maintenance, operation and decommissioning of the RSF will be to ANCOLD guidelines as recommended in the Assessment Report 84.

An ANCOLD risk assessment was undertaken by Knight Piésold (2019) and is contained in Appendix D. It concluded that the consequence category for the Revised Project RSF is High C. The design criteria based on High C consequence category facility is shown in Table 4-2.

Table 4-2 ANCOLD design criteria based on high C classification (Knight Piésold, 2019)

ANCOLD Guideline Requirement	Description of requirements	Guideline Reference
Extreme storm storage	1 in 100 year AEP 72 hour duration storm with no release, evaporation or decant	ANCOLD 2012 Table 4
Contingency freeboard	Wave run-up associated with a 1:10 AEP wind velocity and an additional freeboard of 0.5 m	ANCOLD 2012 Table 5
Spillway capacity	1 in 100,000 year Annual Exceedance Probability (AEP) design flood with freeboard allowance to suit wave run-up for 1:10 AEP wind velocity	ANCOLD 2012 Table 6
Design earthquake loading	OBE 1 in 1,000 year MDE 1 in 10,000 year Post Closure MCE	ANCOLD 2012 Table 7
Stability minimum factor of safety	Long term drained 1.5 Short term undrained Potential loss of containment 1.5 No potential loss of containment 1.3 Post seismic 1.0 – 1.2	ANCOLD 2012 Table 8
Dam safety/ inspection frequency	Inspection by Dam Designer or equivalent qualified Engineer - Annual inspections. Routine inspections – daily to 3 times per week	ANCOLD 2012 Tables 9 and 10

Design controls for the RSF as documented by Knight Piésold (2019) are as follows:

The combined tailings and gypsum residue cells will contain the following design features to mitigate leaching of contaminants into groundwater or surface water:

- A soil-lined basin with a full underdrainage network to provide seepage control and reduce losses
- Embankments will have a low permeability soil upstream fill zone (10^{-8} m/s) and will be built using modified centreline construction techniques
- A cut-off trench will be located beneath the entire length of the embankment and will be excavated into a competent foundation layer.

The WLR cells will comprise the following design controls for seepage management:

- A soil and HDPE lined basin with a full underdrainage network as well as a leakage control and recovery system, to provide more stringent seepage control
- Geosynthetic primary basin liner
- Embankments will have a low permeable upstream fill zone (10^{-8} m/s) as well as a HDPE geomembrane liner
- A cut-off trench will be located beneath the entire length of the embankment and will be excavated into a competent foundation layer. To allow for continuous lining of the embankments, raises will be constructed using downstream construction techniques.

Each cell is sized to contain the rainfall runoff due to a longer duration 1% Average Exceedance Period (AEP) rainfall event or due to a short term extreme storm (1% AEP, 72 hour storm) in addition to the maximum average climate operation pond.

An emergency spillway, sized to pass the Probable Maximum Precipitation (PMP) rainfall event, will be installed at each cell to prevent overtopping of the embankment in an uncontrolled manner if the design rainfall event is exceeded.

Performance monitoring of the facilities to assess overall performance and provide early warnings indicating potential operational or environmental issues will be implemented through the following monitoring and inspection programs:

- Instrumentation:
  - Embankment Survey Monuments – deformation monitoring
  - Piezometers – vibrating wire and standpipes
  - Monitoring bores – primarily water quality but designed to be upgraded to additional deep seepage control if required.
- Regular inspection and maintenance programme detailed in RSF operating manual. Records will be provided to the Engineer of Record for review to ensure the facility is being operated in accordance with the design intent.
- Annual technical audits by the Engineer of Record and peer review by a suitably qualified geotechnical engineer experienced in tailings management.

Additional details relating to the Revised Project RSF site inspection, ANCOLD assessment and design parameters is contained in Appendix D.

4.7.2 Overflow or catastrophic failure of RSF

Changes to flooding scenarios could be caused by a dam break at the RSF prior to it being covered for closure.

Contaminants (including radionuclides) could enter surface waters from an overflow or dam-break of the RSF at the processing site during the operational life and prior to final closure. The failure of the RSF and resultant spread of contaminants could potentially impact the environment downstream of the RSF.

A dam break inundation assessment has been conducted for the RSF as part of the Revised Project (Knight Piésold, 2019). The assessment is based on a failure occurring when the facility has reached the ultimate capacity / immediately before closure.

The modelled inundation area (Figure 1.1 and Figure 1.2 in Appendix D) informs the estimate of potentially affected, in the unlikely event that a dam break were to occur. The dam break assessment is contained in Appendix D.

Arafura has committed, in the Assessed Project, to implement measures to lower the risk of dam failures. These include designing the facilities to accommodate a 100 year ARI event and constructing the dams according to ANCOLD guidelines, and applying the recommendations in the Assessment Report 84 that relate to inspection of the dams by an independent certifying engineer.

The RSF will be designed in compliance with the NT EPA Assessment Report 84. Prior to construction, an Independent Certifying Engineer will provide:

- Objective and independent expert review to the relevant regulator on the suitability of the site selection, including review of alternative sites and assessment of comparative risks.
- Objective and independent expert review to the relevant regulator on the adequacy of the residue storage facility design, including details of the sub-surface drainage and type of low-permeability liners to ensure long-term containment of tailings/residues or leachate from waste rock dumps.
- Regular inspections, auditing and reporting to the relevant regulator during construction of the residue storage facilities and waste rock dumps to ensure construction and operation is in accordance with the endorsed design and design objectives.
- Objective and independent expert review of the proposed performance monitoring program for the waste storages including potential seepage and leachates from the storage facilities.
- Objective and independent expert review of the decommissioning and final rehabilitation to minimise long-term risks to the environment, community, future land use and visual amenity from the waste storages.
- An independent assessment of the Project's management of tailings and residues, including performance monitoring results in an annual report to the relevant regulator and the Arafura or Operator.

4.8 Radiation

Theme	Factor	Objective	Potential impact from proposed alteration
People and communities	Human health	Ensure that the risks to human health are identified, understood and adequately avoided and/or mitigated	Infiltration or leachate from RSF seeping into the groundwater
			dispersion of particulate matter, gas or dust, which may contain radioactive material, which can reduce air quality at nearby receptors

4.8.1 Human health - dispersion of particulate matter, gas or dust

The proposed new configuration for the storage of tailings, gypsum, process plant and water leach residues both optimises and reduces the footprint for waste storage resulting in smaller, discrete disposal cells. As a cell reaches capacity, a new cell will be constructed nearby and once full, the existing cell will be decommissioned and rehabilitated. This acts to reduce the exposed disturbed areas.

Arafura has previously reported the radionuclide content of a number of process streams and a summary is provided in Table 4-3 (GHD 2016, Appendix P). Note that the units are Bq/g for solids and Bq/l for liquids and there is a 1,000 fold difference between the mass and volume units. Note also that the concentrations provided in Table 4-3 do not represent all process streams.

Since then, additional work has been conducted and summarised in Table 4-4.

Table 4-3 Radionuclide concentration in various process streams

Radionuclide	Ore (Bq/g)	Beneficiation Tailings		Beneficiation Concentrate	Residue Facility Tailings	
		Solids (Bq/g)	Liquids (Bq/l)	Solids (Bq/g)	Solids (Bq/g)	Liquids (Bq/l)
Th232	9.6	5.0	0	19.0	8.3	92.4
Ra228	9.6	5.5	0	18.0	10.1	145.4
Th228	9.6	5.0	0	19.0	9.5	93.5
U238	2.1	1.0	0	4.5	2.8	17.3
U234	2.1	0.9	0	4.6	3.0	16.3
Th230	2.1	0.5	0	5.5	4.7	34.7
Ra226	2.1	0.8	0	4.8	2.2	12.9
Pb210	2.1	0.7	0	5.1	2.6	0.2
Po210	2.1	1.0	0	4.5	2.0	0.3
Ac227	0.0	0.0	0	0.0	0.0	0.0

Table 4-4 Estimated radionuclide concentration for material to be disposed in beneficiation tailings

Material	Natural Uranium1,2	Natural Thorium1,2	Approximate Mass Flow3	Source
	Solids (Bq/g)		ktpa	
Gypsum	0.1	0.5	815	Knight Piésold 2017a
Flotation Tailings	1.9	7.3	875	Knight Piésold 2017b
Calculated combined beneficiation tailings	1.0	4.0	1,690	See Note 4

Note 1: The waste streams are considered to be in secular equilibrium.

Note 2: The activity concentrations in liquids are negligible,- <0.12Bq/l for natural uranium and <0.04Bq/l for natural thorium.

Note 3: Exact mass flows vary and depend upon the mining and processing schedule, and are provided here for indication purposes only.

Note 4: The calculated natural uranium and thorium concentrations of the combined waste stream are based on the gypsum and flotation tailings figures. Note that the activity concentration of the combined tailings reduces due to the inclusion of the gypsum, which has very low activity concentrations, in the beneficiation tailings.

For the purposes of waste characterisation, it has been assumed that the majority of radionuclides in the flotation concentrate will be removed in the processing and separation plant. These will report to the processing plant and separation plant waste streams along with other impurities and waste. Table 4-3 shows the radionuclide content of the flotation concentrate.

For the characterisation of radionuclides in the final combined waste stream, it has been assumed that all radionuclides in the processing plant concentrate are solubilised and report to the final waste stream in solution. This is a worst case situation.

Table 4-5 shows the estimated changes in radionuclide concentration in the Processing Plant residues due to the addition of the radionuclides in solution. As can be seen, the impact of changing the tailings design on radionuclide concentrations is minimal. This is because the quantity of additional radionuclide entering the processing plant waste stream is small compared to the quantity that already exists there.

Table 4-5 Estimated radionuclide concentrations in the final processing plant residues

Radionuclide	RSF Wastes [Arafura 2016]		RSF Wastes 2019 Revised Estimates	
	Solids (Bq/g)	Liquids (Bq/l)	Solids (Bq/g)	Liquids (Bq/l)
Th232	**8.3**	**92.4**	**8.3**	**96.1**
Ra228	10.5	20.1	10.5	28.4
Th228	9.5	73.0	9.5	77.2
U238	**2.8**	**17.3**	**2.8**	**17.8**
U234	3.0	16.3	3.0	17.0
Th230	4.7	34.7	4.7	36.7
Ra226	2.3	1.5	2.3	2.6
Pb210	2.6	0.2	2.6	0.9
Po210	2.0	0.3	2.0	0.5
Ac227	0.0	0.0	0.0	5.8

Th232 and U 238 are the head of chain isotopes. Arafura has undertaken an additional radionuclide assessment of the proposed RSF wastes in 2019. There are slight increases in the predicted individual radionuclide concentrations in solids. However, these changes are all less than 5% which is within analytical error.

The classification of the waste material (low level radioactive material) is not affected by the slight revision in estimates.

The 2019 assessment has included the activity concentration for Ac227, because Actinium and Lanthanum have similar chemical properties, and under the revised program, Lanthanum is now being disposed on site into the RSF.

The combined beneficiation tailings and gypsum does not result in an increase in radiological risks to workers or the environment above that contemplated under the EIS. The primary reason for this is that the radionuclide concentrations are very similar to the original concentrations.

The combined processing and separation residues have slightly higher radionuclides concentrations. The RSF will be classed as a radioactive waste disposal facility for “Very Low Level Waste” in accordance with the relevant Australian regulations, similar to numerous other facilities in operation in Australia. The main design features associated with this classification are seepage control measures, dust control and closure capping requirements.

The controls and management measures for occupational and environmental radiation protection as outlined in the original EIS are therefore considered to be relevant and adequate for the Revised Project design.

5. References

GHD, 2016, Nolans Project Environmental Impact Statement. A report for Arafura Resources Limited.

GHD, 2017, Nolans Project Environmental Impact Statement – Supplementary Report. A report for Arafura Resources Limited.

GHD, 2018, Impact of Proposed Operational Changes to EIS.

Knight Piésold, 2018a, Nolans – Mining Area Surface Water Management – Design Summary. A memorandum for Arafura Resources Limited.

Knight Piésold, 2018c, Arafura Resources Ltd, Nolans Project – Surface Water Management Definitive Feasibility Study, Design Report, prepared by Knight Piésold Pty Limited, November 2018

Knight Piésold, 2019, Nolans Project – Residue Storage Facility, Definitive Feasibility Study Design Report. A report for Arafura Resources Limited, March 2019.

Knight Piésold 2017a, Tailings Testing Report, Gypsum Tailings, Knight Piésold Consulting December 2017.

Knight Piésold 2017b, Tailings testing report, Beneficiation tailings, November 2017.

Appendices

Appendix A Nolans Project - Mining Area - General Arrangement - Stage 1 and Stage 2 (as prepared by Knight Piésold Consulting)

Appendix B Nolans Project - Mining Area Surface Water Management - Design Summary (Knight Piésold Consulting, 2018a)

Appendix C Traffic Assessment – Impact of Proposed Alterations to the Assessed Project (GHD, 2018)

Appendix D Nolans Project – Residue Storage Facility, Definitive Feasibility Study, Design Report (Knight Piésold Consulting, 2019)

Appendix E Nolans Project - Update to Air Quality Assessment, March 2019

Appendix F Nolans Project – Greenhouse Gas Assessment – March 2019

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4322795-18451/https://projects.ghd.com/oc/NorthernTerritory/nolansprojectrefiner/Delivery/Documents/4322795-REP-2_NolansProjectSection14ANotification.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	D Welch L Kneen	B Webster	On file	N Conroy	On file	03/12/2018
1	L Kneen	N Conroy	On file	N Conroy	On file	09/05/2019
2	L Kneen	N Conroy		N Conroy		23/05/2019
3	L Kneen	N Conroy		N Conroy		19/06/2019

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