ARAFURA RESOURCES LIMITED

RESIDUE STORAGE FACILITY MANAGEMENT PLAN

Document No:	ARMS-0000-H-PLN-N-0006 Rev 1
Project Name:	Nolans Rare Earth Project

NdPr

REVISION HISTORY

Date	Description	Prepared	Reviewed	Approved	3rd Party Approval
July 2020	Rev 1 Issued to DITT	Michael Robinson, ESG Manager	Michael Robinson, ESG Manager	Stewart Watkins, GM Projects	
23/07/2021	Rev 0	Michael Robinson, ESG Manager	Brian Fowler, GM NT & Sustainability	Stewart Watkins, GM Projects	

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1.0 INTRODUCTION

The Nolans Project (the Project) is a rare earth mine 100% owned by Arafura Resources Limited (Arafura) located approximately 135 kilometres northwest of Alice Springs. The Project will process ore from the rare earths-phosphate-uranium-thorium (REE-P-U-Th) deposit to produce neodymium and praseodymium (NdPr) oxide. The process plant will generate two waste streams that will be pumped as slurry to a Residue Storage Facility (RSF).

The RSF Management Plan (the Plan) should be read in conjunction with the RSF supporting documentation. A detailed description of the design and operational requirements, including monitoring, are provided within the Design Report and RSF Operating, and Monitoring Manual compiled by engineering consultants Knight Piesold (KP).

- Knight Piesold, Residue Storage Facility, Definitive Feasibility Study – Design Report, prepared for Arafura Resources Pty Ltd, March 2019, Document Reference PE801-00140/12.
- Knight Piesold, Residue Storage Facility Operating and Monitoring Manual, prepared for Arafura Resources Pty Ltd, November 2018, Document Reference PE801-00140/18.

1.1 Purpose

The purpose of the Plan is to provide a framework that will assist with the identification and management of the key environmental risks associated with the RSF. In addition, the Plan provides guidance on the RSF monitoring and reporting requirements and assigns actions when performance thresholds are exceeded.

1.2 Objectives

The objective of the Plan is to ensure that the RSF operates in a manner that causes no adverse impacts to people or the environment.

1.3 Roles and Responsibilities

Table 1-1 provides the roles and responsibilities required to implement and maintain the Plan.

Table 1-1: Roles and Responsibilities

Position	Responsibility
General Manager	To approve the Plan and to ensure that there are adequate resources available so the outcomes stipulated within the Plan can be achieved.
Environmental Manager	To ensure that the Plan is reviewed and updated to reflect changes in the RSF design, associated environmental and social risks and statutory requirement. To coordinate the environmental monitoring and reporting requirements stipulated within the Plan.
Process Manager	To operate the RSF within the parameters of the engineered design and operating procedure.

1.4 Guidelines and Standards

The Project is obliged to comply with all relevant environmental legislation. A summary of the industry guidelines and guidelines are provided in Table 1-2

Table 1-2 Guidelines and Standards

Agency	Guidelines
ANCOLD	Australian National Committee on Large Dams: "Guidelines on the Consequence Categories for Dams"
ANCOLD	Australian National Committee on Large Dams: "Guidelines on Tailings Dams, Planning, Design, Construction, Operation and Closure"
Northern Territory Environmental Protection Authority	Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory
Department of Mines, Industry Regulation and Safety's	Code of Practice for Tailings storage facilities in Western Australia
Department of Mines, Industry Regulation and Safety	Guide to the preparation of a design report for tailings storage facilities (RSFs)

1.5 Implementation of the Plan

Supporting documents are required to be finalised before the RSF Environmental Management Plan becomes fully implemented. Table 1-3 provides a list of these documents. This plan is a dynamic document that requires regular updates as the Project is optimised over the coming years.

The Plan has primarily been developed from the Detailed Feasibility Study (DFS) which has a RSF design capacity of 23 years. The Section 14A project update notification increased the project LOM to 38 years. In this case the RSF will be duplicated (mirrored to the south) to allow for the additional LOM storage requirements.

Table 1-3: Implementation of supporting documents required to complete the RSF Environmental Management Plan

Document	Description	Status
RSF DFS Design Report	A detailed description on the DFS design for the RSF. The report includes facility hazard ratings, site baseline data, engineering analysis and detailed plans describing the key features of the facility.	Complete
RSF DSF Operating and Monitoring Manual	A detailed description of the operation, monitoring, maintenance, ongoing construction, closure, rehabilitation, and post-rehabilitation requirements of the RSF at the level of DFS level.	Complete
RSF Environmental Management Plan (this plan)	An assessment of the environmental risks associated with the RSF. The plan identifies suitable management controls, monitoring requirements and response plans to mitigate potential environmental impacts that may result from the facility operation. The Plan will be reviewed and updated as changes are made to the Design Reports and Operating/Monitoring Manuals or at the same time as the mine management plan.	Complete
RSF Final Design Report.	The design will be updated to include the optimised design for Stage 1. Additional reviews will be conducted prior to additional lifts being constructed.	Scheduled 2022
RSF Operating and Monitoring Manual	A revision of the operating and monitoring manual to include additional details for the optimised stage 1 design. Additional reviews will be conducted prior to additional lifts being constructed.	Scheduled 2022
RSF Environmental Monitoring Procedure	A detailed procedure to accurately identify and describe the steps required to meet the environmental monitoring requirements.	Scheduled 2022

2.0 RSF DESIGN AND EXPECTED PERFORMANCE

2.1 Site Setting

The RSF is located at the southeast toe of the Reynolds Range on surface deposits identified by geological maps to comprise Quaternary alluvium becoming red soil sedimentary deposits moving southward. The RSF will occupy an area of approximately 1 km by 1.7 km at the end of the LOM and the embankments will be approximately 10 m high at Stage 1 and 15 m at final stage. The ground falls in a southward direction at an incline of approximately 1V:160H with steeper contours at the northern end at the foot of the hills.

2.2 Design Overview

The Project will produce three residue wastes delivered to the RSF as two different streams: a combined Beneficiation (BF) and Gypsum (GYP) Residue stream and a Water Leach (WL) Residue stream. Deriving from the process plant immediately northeast of the RSF, the wastes will be received via bunded pipelines at the RSF as a slurry (Figure 2-1). The RSF is designed to operate the two Residue Facilities (RF) concurrently, one to receive BF and GYP Residue and the other to receive WL Residue. The two RFs will share an adjoining embankment and are considered one cell.

Each cell (consisting of BF/GYP and WL residue facilities) will be lifted 4 times in two-year construction cycles before the next cell becomes operational. To limit the operational area, as well as the final height, each cell will operate for approximately 7-9 years and then will be decommissioned and covered in preparation for rehabilitation. This construction methodology will ensure that the area of residue is kept to a minimum for mitigating dust and erosion potential. The original DFS LOM of 23-years stated that a total of three cells would be constructed sequentially over that LOM. Following that initial 23-year DFS LOM, the LOM was increased to 38 years in the Section 14A project update notification. To accommodate this longer LOM, three additional RSF cells will be constructed sequentially over the second half of the 38-year LOM in a new RSF that will mirror the initial RSF along its southern boundary.

The BF/GYP RF will be approximately 50 ha each whilst the WL RF will be approximately 16 ha each. The entire construction footprint of the RSF (3 x BF/GYP and 3 x WL) will be approximately 240 ha in the first 23 years of LOM, and an additional 240 ha during the remainder of the 38-year LOM. These areas will allow for vehicle access and a reduced embankment profile at closure. The configuration of the RSF after the first 23 years is illustrated in Figure 2-2.

Each cell is predicted to operate for 7 to 9 years. In total 47.6 Mt of waste will be stored in the RSF consisting of 27.8 Mt BF Residue, 13.4 Mt GYP Residue and 6.4 Mt of WL Residue.

The two residue facility types (BF/GYP and WL) have been designed with consideration to the geochemical properties of the waste streams being deposited. To provide seepage control and to reduce seepage losses, engineered basin liners and underdrainage features have been integrated.

The BF/GYP RF will incorporate a reworked soil lined basin with a full piped underdrainage network. The embankments will have a low permeability soil upstream fill zone and will be built using modified centre line 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 WL RF will include additional seepage measures comprising of two basin liners, a primary HDPE geomembrane overlying a secondary engineered soil liner. The WL RF will incorporate an underdrain network above the HDPE liner with an additional leakage control and recovery system below the HDPE liner providing stringent seepage management. The embankments will have a low permeable upstream fill zone as well as a HDPE geomembrane liner and, like the BF/GYP RF, include a cut-off trench beneath the entire length of the embankment, excavated into a competent foundation layer. To allow for continuous lining of the embankments, embankment lifts will be constructed using downstream construction techniques.

Figure 2-1 : Location of the Residue Storage Facility in Relation to the Site Infrastructure

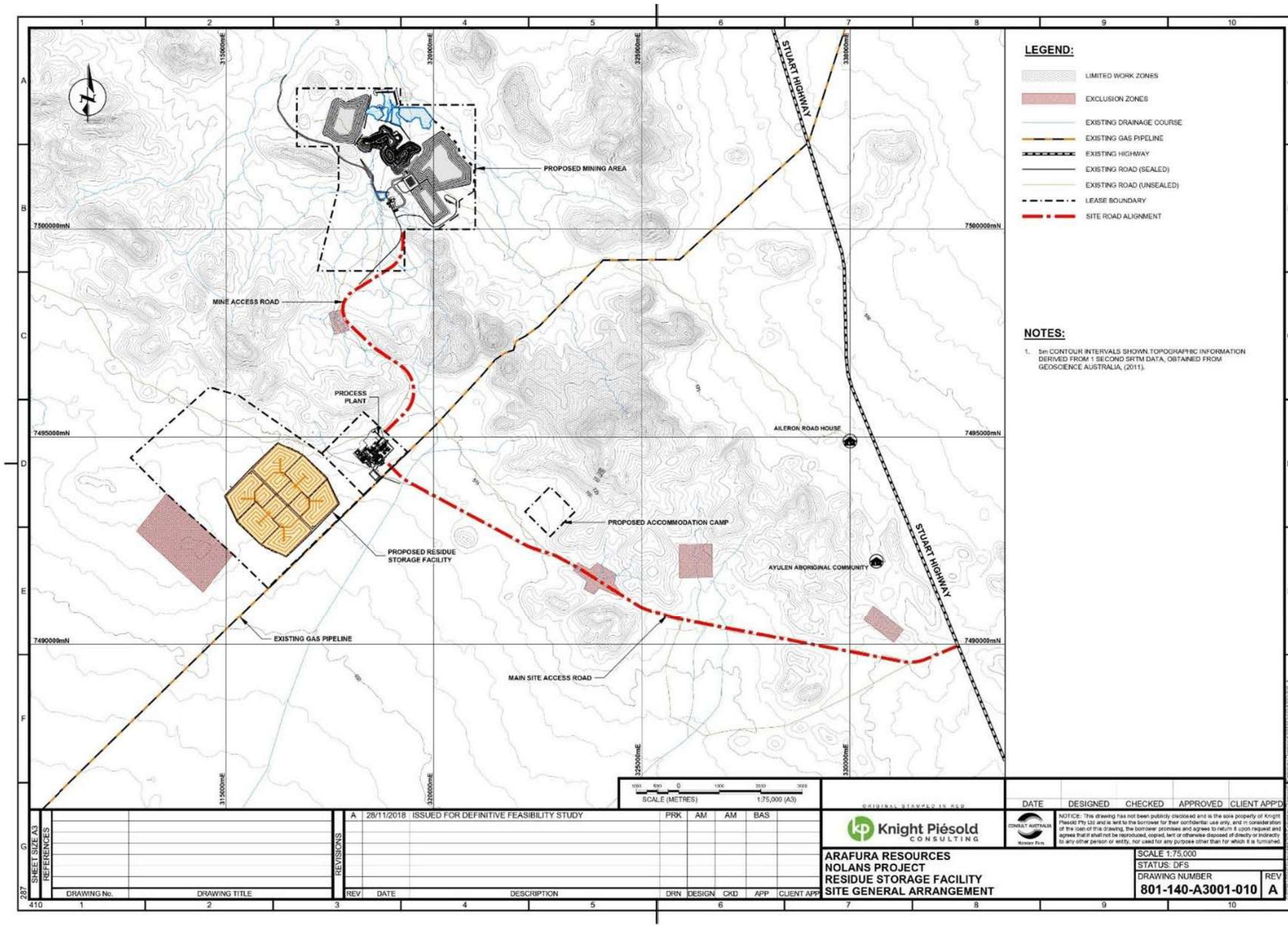
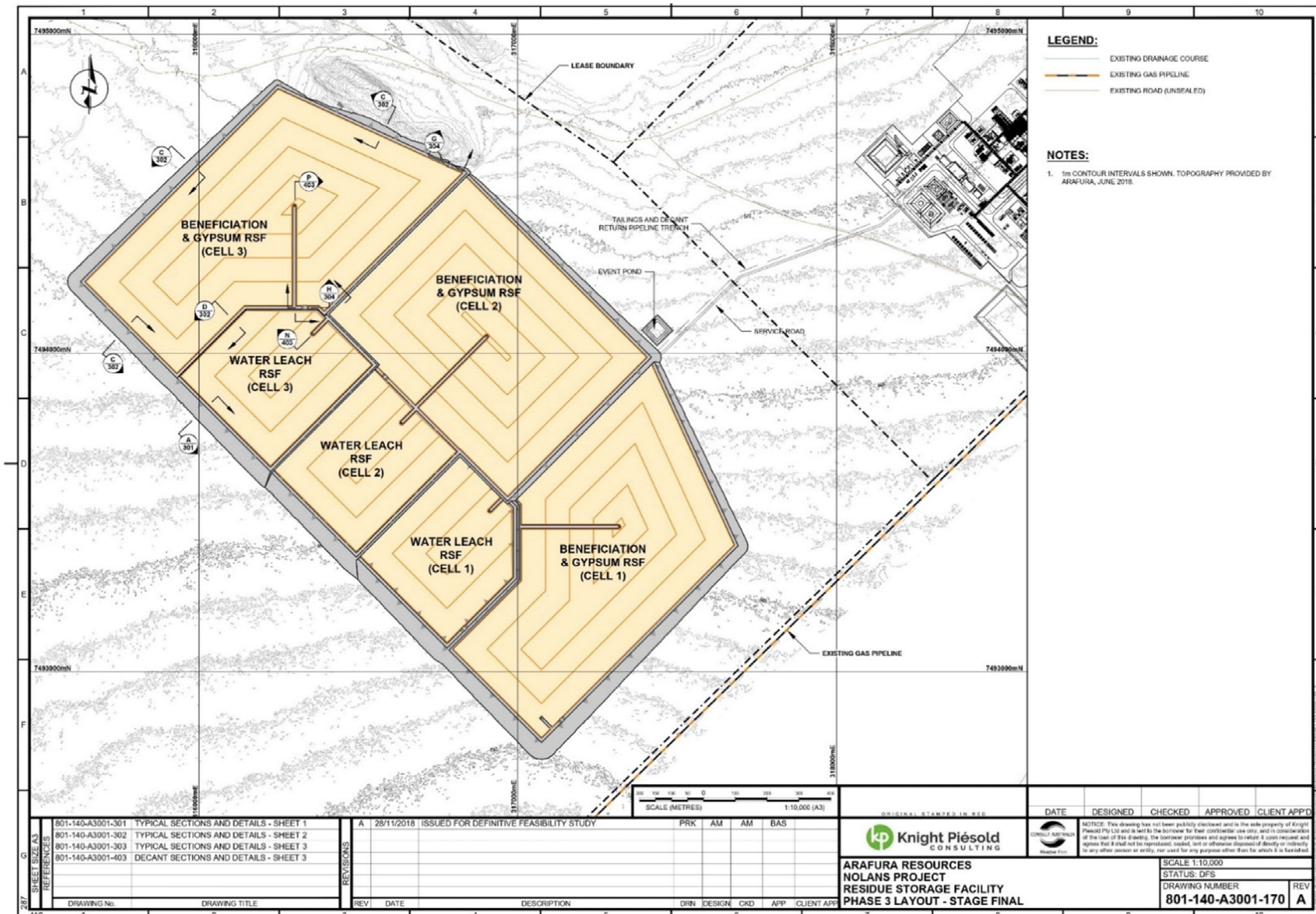


Figure 2-2 : Residue Storage Facility Cell Layout, First 23 years of LOM



2.3 Staged Construction

As an example of the staged construction of the RSF, Table 2-2 and Table 2-1 outline the staging schedule for the BF/GYP and WL residue facilities respectively, as presented in the DFS design. These tables present indicative values taken from the DFS to show how the cell construction will be staged. These values will change somewhat when the final engineering design for the RSF occurs.

Currently it is planned that most of the construction materials can be sourced from within future cells as well as a hill to the north-west of the facility. If it is found that insufficient material can be excavated from these locations, then additional borrow areas located externally are planned. In addition, it is likely that clean mine waste from the open pit mine will also be used for future RSF wall lifts. Details of construction materials will be outlined within the Arafura Borrow Material Management Plan that will be prepared during project engineering.

Table 2-2: Estimated LOM Disposal Staging Schedule for Beneficiation/Gypsum Residue Facilities

Cell		Stage	Construction Year	Crest Elevation (mRL)	Storage Capacity		Cumulative storage (Mt)		Density	Cumulative Storage in Cell (Mm^3)
					(month)	(Mt)	in Cell	in Facility	(t/m^3)	
Beneficiation & Gypsum Residue Cells	1	1	-1	663.4	30	1.58	1.58	1.58	1.03	1.53
		2	3	666.0	30	2.22	3.80	3.80	1.18	3.22
		3	5	668.1	24	1.45	5.25	5.25	1.23	4.27
		4	7	670.4	24	1.60	6.85	6.85	1.29	5.31
	2	1	9	666.8	12	0.94	0.94	7.79	0.75	10.39
		2	10	669.9	24	1.99	2.93	9.78	1.06	9.23
		3	12	672.1	24	2.05	4.98	11.83	1.18	10.03
		4	14	674.2	24	1.92	6.89	13.75	1.24	11.09
	3	1	16	668.2	12	0.99	0.99	14.74	0.76	19.39
		2	17	671.6	24	2.06	3.05	16.80	1.08	15.56
		3	19	674.4	24	1.96	5.01	18.76	1.16	16.17
		4	21	676.4	24	1.05	6.06	19.81	1.23	16.11

Table 2-1: Estimated LOM Disposal Staging Schedule for Water Leach Residue Facilities

Cell		Stage	Construction Year	Crest Elevation (mRL)	Storage Capacity		Cumulative storage (Mt)		Density	Cumulative Storage in Cell (Mm^3)
					(month)	(Mt)	in Cell	in Facility	(t/m^3)	
Water Leach Residue Cells	1	1	-1	662.9	36	0.30	0.30	0.30	0.89	0.35
		2	3	665.4	24	0.28	0.59	0.59	0.91	0.67
		3	5	667.6	24	0.28	0.87	0.87	0.92	0.99
		4	7	669.7	24	0.29	1.15	1.15	0.93	1.30
	2	1	9	663.5	12	0.15	0.15	1.30	0.66	0.23
		2	10	666.6	24	0.27	0.41	1.57	0.82	0.55
		3	12	669.0	24	0.29	0.70	1.86	0.87	0.86
		4	14	671.2	24	0.29	0.99	2.15	0.89	1.18
	3	1	16	665.2	12	0.14	0.14	2.29	0.66	0.23
		2	17	668.1	24	0.29	0.43	2.58	0.82	0.55
		3	19	670.4	24	0.29	0.73	2.87	0.87	0.85
		4	21	672.0	24	0.20	0.92	3.07	0.89	1.08

2.4 Key Design Parameters

A failure consequence assessment and determination of the hazard categories for the RSF has been completed in accordance with WA Department of Mines, Industry Regulation and Safety's (DMIRS) Code of Practice for "Tailings storage facilities in Western Australia" and the ANCOLD "Guidelines on the Consequence Categories for Dams".

Based on the assessment, the RSF is rated as a "High C" consequence category facility. The design criteria applicable to this category are summarise in Table 2-3 adopted design parameter for the site conditions have been provided in Table 2-4

Table 2-3: ANCOLD Minimum Design Criteria drawn from ANCOLD Guidelines on Tailings Dams, Planning, Design, Construction, Operation and Closure.

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

Table 2-4 RSF Key Climatic Design Parameters

RSF DESIGN CRITERIA		Source
Design Climatic Conditions	Annual Rainfall: Average: 291 mm ▪ 1 in 100-year AEP Dry: 30 mm ▪ 1 in 100-year AEP Wet: 847 mm Design Storm Depth: ▪ 1 in 100-year AEP 24-hour storm: 196 mm 298 mm ▪ 1 in 100-year 72-hour storm: 670 mm ▪ PMP 24-hour storm: 1,090 mm ▪ PMP 72-hour storm: 1,982 mm Annual Penmen Lake Evaporation: SEE to NWW Dominant Wind Direction:	KP Climate Assessment
Embankment Freeboard	The critical elevation out of: ▪ Minimum of 0.5 m to maximum tailings. ▪ Minimum of 1.0 m to maximum design pond. ▪ Minimum of 0.1 m for maximum emergency spillway flow (PMP)	KP Design
Spillway capacity	Sized to safely discharge any excess water due to a PMP rainfall event after attenuation in the facility.	KP Design
Design earthquake loading	OBE 1 in 1,000 year: 0.024g MDE 1 in 10,000 year: 0.045g Post Closure MCE: 0.053g	KP Design and Seismic Assessment
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	KP Design

2.5 Residue Characteristics

2.5.1 Studies

- Knight Piésold Pty Ltd "*Nolans Project, Tailings Testing Report, Beneficiation Tailings*", Ref. PE801-000140/09 Rev. 0, November 2017.
- Knight Piésold Pty Ltd "*Nolans Project, Tailings Testing Report, Gypsum Tailings*", Ref. PE801-000140/10 Rev. A, December 2017.
- Knight Piésold Pty Ltd "*Nolans Project, Tailings Testing Report, Water Leach*", Ref. PE801-000140/16 Rev. A, November 2018.
- Knight Piésold Pty Ltd "*Nolans Project, Tailings Testing Report, Blend Tailings*", Ref. PE801-000140/17 Rev. A, November 2018.

2.5.2 Physical Characteristics

Residue testing has been used to predict physical behaviour of the residue, including water release and settlement density. A summary of the findings is available in the RFS DFS Design Report.

2.5.3 Geochemical Characteristics

2.5.3.1 Multi-Element and Radionuclide Concentrations

Tailings test samples had a moderate number of element enrichments, with the level of enrichment varying from slight to high. Bismuth, sulfur and thorium were highly enriched, with phosphorous and uranium significantly enriched and lead and selenium slightly enriched.

Based on the waste characterisation testing conducted by KP, the RSF is classed as a nuclear waste disposal facility in accordance with Australian Radiation Protection and Nuclear Safety Agency regulations (Australian Government 2005; Australian Government 2017) for "Very Low-Level Waste" with the radioactivity of the head-of-decay chain elements within the residue and the liquor in both BF/GYP and WL Facilities in the range of 1 to 10 Bq/g or 1 to 10 Bq/L. The RSF lining system design accounts for these elevated radiation levels, specifically relating to seepage, dust control and capping requirements. The management of radiation and limiting exposure will be managed under the Radiation Management Plan.

2.5.3.2 Acid Potential

Acid base accounting conducted during the waste characterisation testing indicated that both BF/GYP Residue and WL Residue are likely Non-Acid Forming and therefore very low risks of acid generation are calculated within the Facilities.

2.6 Water Management

2.6.1 Residue Water Management

The RSF supernatant pond will be located at the decant tower in the centre of the BF/GPY facility or against the northern perimeter embankment of the WL facility (but still in the centre of the RSF).

Supernatant water will be removed from each RSF cell via an, automatically operated, submersible pump located within a decant tower.

Supernatant recovered from the decant system will be pumped back to the processing plant for reuse in the process circuit.

2.6.2 Surface Water Management

Adequate controls are designed-in to the proposed RSF structures to ensure overflow is extremely unlikely even under the most severe events. Each RSF cell will be able to contain, in addition to tailings and supernatant, adequate freeboard for a 1 in 100-year ARI 72 hour storm event.

2.6.3 Water Balance:

The TSF water balance was modelled using specially developed computer software. Findings from the water balance model include:

- The water balance for the project indicates all cells highly operate water negative for the whole life of the project. The supernatant pond stays at the minimum operating size or close to minimum size all the time, and consequently ponding of water against the external embankments is unlikely to occur even under storm events.
- Process make-up water will be required throughout the operation although the quantity required will vary between the wet and dry seasons. Under all considered climatic conditions, available water from the RSF is less than the required plant make-up.
- Decant return water flows for the Beneficiation and Gypsum Cells range from 0 to 57,000 m^3/month for average climatic conditions and from 0 to 68,000 m^3/month for extreme wet/dry climatic conditions. Approximately 8 to 12% of the water in slurry can be recovered from the cells as an annual average.
- Decant return water flows for the Water Cells range from 0 to 12,000 m^3/month for all climatic conditions considered. Approximately 5 to 8% of the water in slurry can be recovered from the cells as an annual average.
- This results in a maximum make up requirement of 145,000 m^3/month (1.73 Mm^3 annually) to prevent shortfalls in the operation of both RSF Cells. Under average climatic conditions 135,000 m^3/month (1.61 Mm^3 annually) are required to prevent shortfalls.

2.7 Geotechnical Assessment

2.7.1 Studies

Several geotechnical site investigations were conducted for the Nolans project these include:

- Knight Piésold, report PE801-00140/02, “Nolans Project, Plant Site and Haul Road, Geotechnical Report”, Rev. A, October 2010.
- Knight Piésold, report PE801-00140/06, “Nolans Project, Geotechnical Site Investigation Report”, Rev. B, October 2011.

- Knight Piésold Pty Ltd Report Ref. PE801-00140/14, "Nolans Project – Definitive Feasibility Study - Geotechnical Interpretative Report", Rev 2 March 2020.

2.7.2 Embankment Foundations

A site-specific geotechnical investigation for the RSF location was completed in August 2018 with the following main points noted:

- Boreholes and test pits indicate that the near surface medium dense clayey sand (and some calcrete) is continuous across the RSF and overlies highly weathered, very low to low strength rock from between 4 m and 7 m depth.
- Laboratory testing has confirmed clayey sands prevalent across the entire RSF basin area exhibit a low permeability and will provide sufficient seepage control within the BF/ GYP cells and act as a suitable secondary soil liner in the WL cells.

2.7.3 Embankment Construction

The embankments will have a low permeability soil upstream fill zone and will be built using both modified centreline and downstream 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.

General construction material will include:

- Low permeability Zone A material from local borrow.
- Zone B (transition fill) and Zone C (structural fill) material from local borrow.
- Erosion Protection (Zone E) from local borrow or supply from mining operation.
- Drain/filter Material (Zone F) imported from off site or processed on site and supplied to local stockpile.
- Coarse rockfill (decant Zone G) processed on site or supplied from the mining operation.

Typical perimeter and divider embankment cross sections have been provided for the BF/GYP and WL RSF in Figure 2-3 and Figure 2-4 respectively. The source of the various fill materials will be further defined in the project Borrow Management Plan that will be written as part of the final engineering designs for the project

Figure 2-3: Typical Gypsum and Beneficiation RSF Perimeter and Divider Embankments Cross Sections

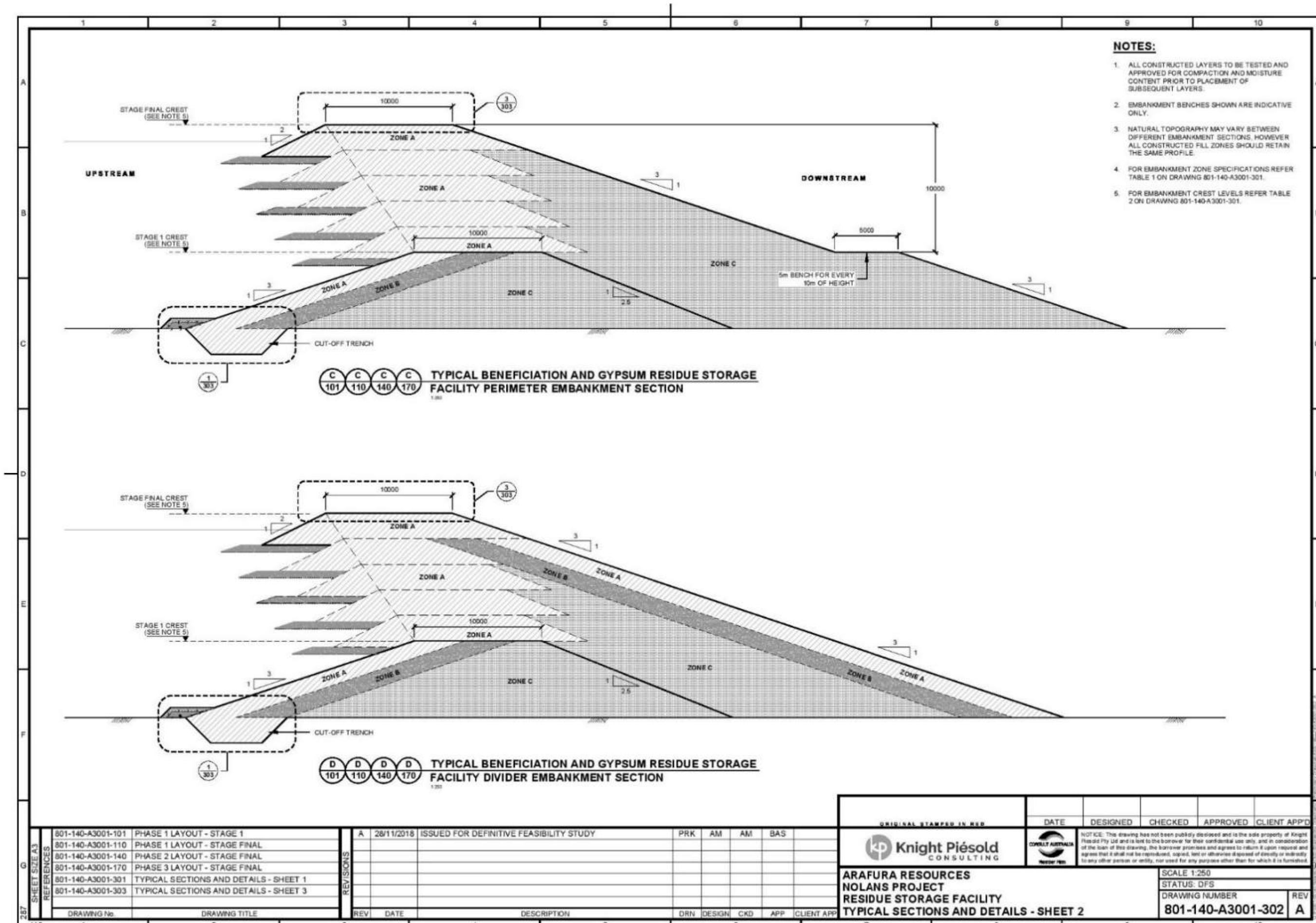


Figure 2-4 Typical Water Leach RSF Perimeter and Divider Embankments Cross Sections

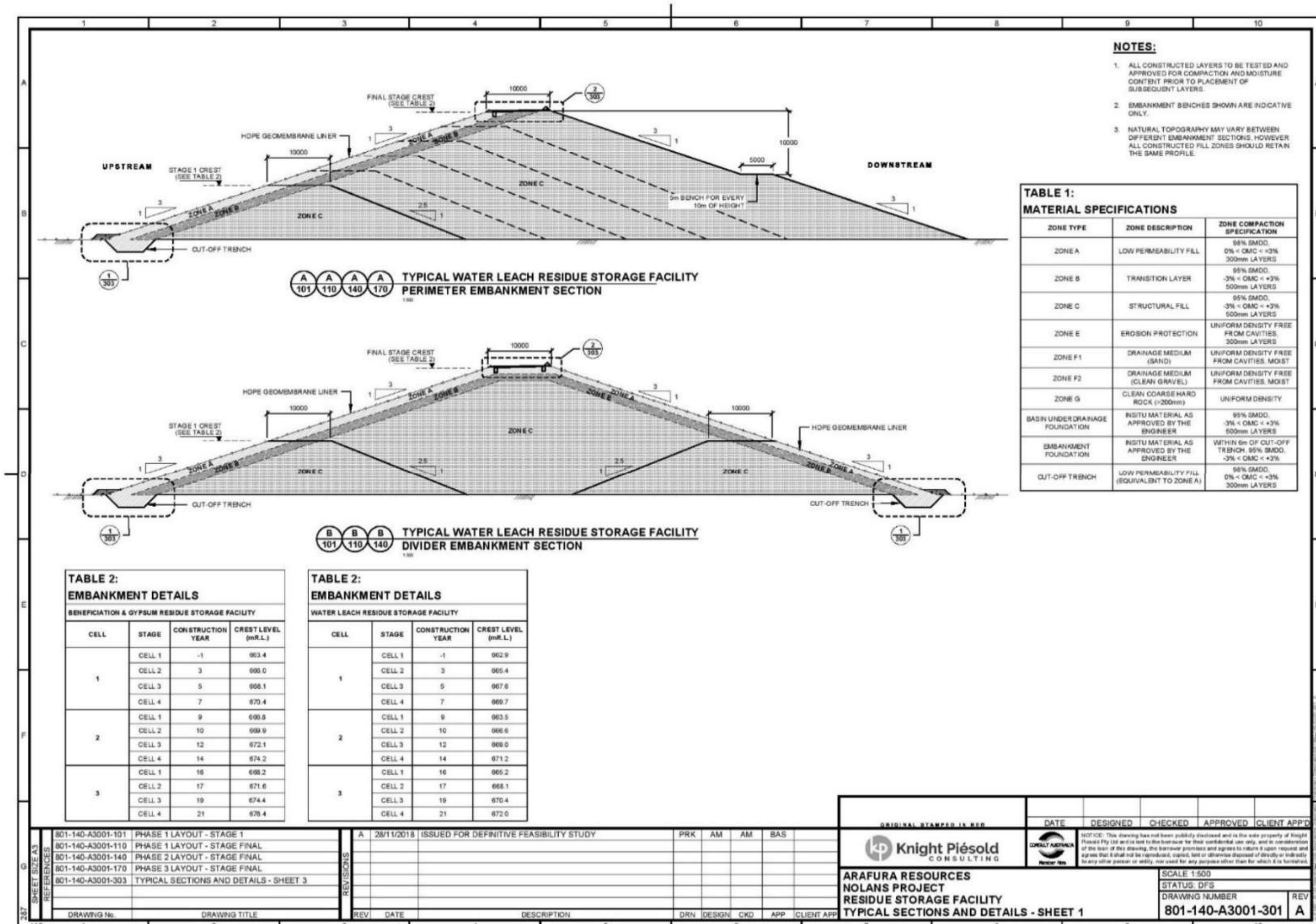


TABLE 1: MATERIAL SPECIFICATIONS

ZONE TYPE	ZONE DESCRIPTION	ZONE COMPACTION SPECIFICATION
ZONE A	LOW PERMEABILITY FILL	98% SMDD, 0% < OMC < +3% 300mm LAYERS
ZONE B	TRANSITION LAYER	95% SMDD, -3% < OMC < +3% 500mm LAYERS
ZONE C	STRUCTURAL FILL	95% SMDD, -3% < OMC < +3% 500mm LAYERS
ZONE E	EROSION PROTECTION	UNIFORM DENSITY FREE FROM CAVITIES, 300mm LAYERS
ZONE F1	DRAINAGE MEDIUM (SAND)	UNIFORM DENSITY FREE FROM CAVITIES, MOIST
ZONE F2	DRAINAGE MEDIUM (CLEAN GRAVEL)	UNIFORM DENSITY FREE FROM CAVITIES, MOIST
ZONE G	CLEAN COARSE HARD ROCK (>200mm)	UNIFORM DENSITY
BASIN UNDERDRAINAGE FOUNDATION	INSITU MATERIAL AS APPROVED BY THE ENGINEER	95% SMDD, -3% < OMC < +3% 500mm LAYERS
EMBANKMENT FOUNDATION	INSITU MATERIAL AS APPROVED BY THE ENGINEER	WITHIN 6m OF CUT-OFF TRENCH, 95% SMDD, -3% < OMC < +3%
CUT-OFF TRENCH	LOW PERMEABILITY FILL (EQUIVALENT TO ZONE A)	98% SMDD, 0% < OMC < +3% 300mm LAYERS

TABLE 2: EMBANKMENT DETAILS

BENEFICIATION & GYPSUM RESIDUE STORAGE FACILITY

CELL	STAGE	CONSTRUCTION YEAR	CREST LEVEL (mR.L.)
1	CELL 1	-1	663.4
	CELL 2	3	666.0
	CELL 3	5	668.1
	CELL 4	7	670.4
2	CELL 1	9	666.8
	CELL 2	10	669.9
	CELL 3	12	672.1
	CELL 4	14	674.2
3	CELL 1	16	668.2
	CELL 2	17	671.6
	CELL 3	19	674.4
	CELL 4	21	676.4

TABLE 2: EMBANKMENT DETAILS

WATER LEACH RESIDUE STORAGE FACILITY

CELL	STAGE	CONSTRUCTION YEAR	CREST LEVEL (mR.L.)
1	CELL 1	-1	662.9
	CELL 2	3	665.4
	CELL 3	5	667.6
	CELL 4	7	669.7
2	CELL 1	9	663.5
	CELL 2	10	666.6
	CELL 3	12	669.0
	CELL 4	14	671.2
3	CELL 1	16	665.2
	CELL 2	17	668.1
	CELL 3	19	670.4
	CELL 4	21	672.0

2.8 Seepage Analysis

A seepage analysis was undertaken as part of the RSF Design Report. The analysis was designed specifically to evaluate the following aspects of the design:

- The total seepage losses from the RSF. It is possible to estimate the maximum seepage loss (based on conservative assumptions) which provides some indication of the potential environmental impact from operation of the RSF.
- The volume of water collected in the basin underdrainage systems.

The analyses indicated that seepage losses from the BF/GYP facilities are low to very low when a full underdrainage network (and, in the case of the WL Facility, HDPE liner) have been installed from for all stage of the RSF. The analysis concluded the following:

- The seepage loss is considered small (<0.4 kL/ha/day)
  - BF/GYP Facility – 0.4 kL/ha/day.
  - WL Facility – 0.1 to 0.2 kL/ha/day.
- Toe drains as well as the proposed lining are effective in maintaining a low phreatic surface in the embankments and the foundation areas, and therefore will have a positive impact on the stability of the embankments.
- The seepage return pump should be sized to allow for a minimum flow rate of 4 L/sec in the WL Facility and 12 L/sec in the B/G Facility. A static pump head of 25 m should be allowed for as part of the pump selection.

3.0 RISK AND IMPACT IDENTIFICATION

The Project risks have been assessed within the Environmental Impact Statement and supplementary reports as submitted to the Northern Territory Environment Protection Authority (GHD 2016; GHD 2017).

For the RSF, key environmental risks and control measures have been consolidated within the RSF environmental impact summary (Table 3-1). The impact summary includes performance indicators and reporting evidence to measure the effectives of the management controls in meeting the desired outcomes.

3.1 RSF Environmental Impact Summary

Table 3-1 identifies the key environmental risks associated with the RSF and the control measures that will be implemented to ensure the desired outcomes are achieved. Performance indicators have been included to ensure that the control measures are implemented effectively.

Table 3-1: Environmental Impact Summary

Potential Risk Pathway	Control Measures	Performance Indicators	Reporting / evidence	Timing	Related Documents
Outcome 1: Surface water does not overflow the RSF in an event Less than 1:100 ARI.					
RSF surface water overflows embankments due to high rainfall event.	Operational freeboard to be maintained so that surface water does not overflow in an event less than 1 in 100 ARI.	Operational freeboard does not exceed 500mm.	Daily RSF Inspections Monthly RSF Report Annual RSF Audit.	Daily Monthly Annual	RSF - Operating and Monitoring Manual.
	Spill ways to be maintained to enable controlled relief in a PMP event.	Spillways to be constructed and maintained as per RSF Design, including a minimum of 100mm freeboard for maximum emergency spillway flow in a PMP event.	Annual RSF Audit	Annual	RSF - Operating and Monitoring Manual.
Outcomes 2: The RSF embankments are structurally stable					
Compromised embankment stability	The RSF will be operated within the	The RSF embankments are maintained to a level that	RSF audit by qualified engineer which includes	Annual	RSF - Design Report.

due to changes in foundation conditions.	design and operating parameters to ensure stability is not compromised.	achieves the minimum ANCOLD design parameters.	an analysis of survey pin movement and changes to phreatic water.		RSF - Operating and Monitoring Manual. RSF Environmental Monitoring Procedure
Outcome 3: No Seepage in Excess of the Design Parameters					
Compromised basin/embankment liners cause seepage.	The RSF will be operated within the design and operating parameters to ensure natural groundwater quality and levels are maintained.	Groundwater quality does not exceed the ANZECC & ARMCANZ (2000) guidance for livestock drinking water.	Water quality monitoring.	Quarterly	RSF - Operating and Monitoring Manual. RSF Environmental Monitoring Procedure
		Phreatic water does not exceed the height of the piezometer wire.	Piezometer readings	Monthly	RSF - Operating and Monitoring Manual. RSF Environmental Monitoring Procedure
		Groundwater quality does not exceed background levels.	Environmental monitoring bore groundwater levels	Quarterly	RSF - Operating and Monitoring Manual. RSF Environmental Monitoring Procedure
Outcome 4: Dust generation from the RSF does Not Impact the Environment.					
Dust generated from exposed residue.	Dust generation is not predicted within design RSF operation but manual dust	Depositional dust will not exceed 50% of baseline at the allocated dust monitoring stations.	Annual Environmental Report to include dust monitoring data and vegetation assessment.	Annually	RSF Environmental Monitoring Procedure

	monitoring stations will be monitored.				
Outcome 5: Radiation Exposure will not Exceed Levels Identified within the Radiation management Plan.					
	Implement the Arafura Radiation Management Plan.	As per Radiation Management Plan	As per Radiation Management Plan	As per Radiation Management Plan	Radiation Management Plan RSF Environmental Monitoring Procedure

4.0 ENVIRONMENTAL CONTROL MEASURES

4.1 Embankment Construction

The RSF will be constructed in line with the RSF Design Report. To ensure that the RSF meets minimum design parameters, all earthworks will be supervised by a qualified engineer on behalf of the Engineer of Record with full QA/QC testing during construction. Records will be compiled in a formal construction report for sign off at the end of each construction phase.

4.2 Residue Delivery and Deposition Method

Design details are incorporated into the RSF to construct effective basal lining and tailings seal to reduce seepage potential. Tailings deposition is carried out sub-aerially from the perimeter to promote beach formation that optimises drying, draining and water removal. As solids settle, water is released and flows to the supernatant pond for pump decant removal. A thin film is left to form on residue beaches to minimise dust generation. Evaporation mainly completes the dewatering process with some drainage into the underdrainage system.

Normal tailings deposition is cycled from a bank of six off-take spigots to maximise evaporation drying and further reduce seepage. Continuous slurry deposition occurs to approximately 100mm depth and then delivery moves to the next bank. Rotations are expected to occur at least daily. Higher deposition rates that regularly exceed 100mm in one day require more frequent change in offtake banks or discharge from a greater number of spigots.

Implementation of the designed deposition strategy optimises net available storage capacity and reduces the volume of water stored on the facility at any time. This approach also promotes effective supernatant pond management and maintenance of freeboard against the upstream embankment face to the crest.

4.3 Pond Control and Water Management

4.3.1 Supernatant Pond Control

The supernatant pond location and geometry will be controlled by managed spigotting from the perimeter embankments. Should adverse supernatant pond location, geometry or operating levels develop, the following should be considered as corrective measures:

- Forming a steeper beach across embankments by the adjustment of the deposition methodology.
- Controlled and managed spigotting from selected positions around the perimeter.

4.3.2 Decant Return

The supernatant pond volume and water management will be controlled by a decant system that will operate throughout the life of mine. The RSF will have two decant towers, one located in the centre of the BF/GYP facility and one on the perimeter embankment of the WL facility. Both decant facilities will be accessible by structural fill causeways. Both the causeways and decant towers will be raised during each embankment lift.

The decant towers will operate automatically returning water to the processing plant once optimal supernatant pond levels are reached.

4.3.3 Operational Freeboard

Operational Freeboard is the vertical height between the lowest elevation of the perimeter embankment and the Residue beach immediately inside the embankment.
A minimum of 500 mm Operational Freeboard is specified for the Nolans RSF, which will therefore provide a Total Freeboard always greater than 500 mm.

4.4 Seepage Control

While some seepage into the underlying foundation is acceptable (EPA, 2006), the proposed design ensures control and minimisation of seepage. Underdrainage collection features have been incorporated into the facility to maximise settled density and recover any seepage loss. Components of the seepage control system are outlined below.

4.4.1 Cut-off trench.

A cut off trench will be excavated into foundation soils to competent foundation material and backfilled with low permeability (Zone A) fill during the Stage 1 construction. The cut off trench varies in depth to extend through to competent foundation material. The cut off trench will be constructed directly below the upstream Zone A of the embankment, and excavated for the entire embankment length, to reduce near surface seepage.

4.4.2 Basin underdrainage collection system.

The RSF basin areas will be cleared and grubbed as part of the Stage 1 construction. Part of the basin will be used as the borrow area for the embankment construction materials during Stage 1. Sufficient low permeable material will be left in place to scarify, moisture condition and compact the basin to form a low permeable soil liner. In areas where no suitable material is encountered it will be sourced from a borrow area.
A HDPE liner will be installed over the compacted soil liner within the Water Leach Cells to further reduce seepage losses. The HDPE liner will be extended to the crest of the embankment and be extended during each construction stage.

4.4.3 Underdrainage System

The RSF underdrainage system consists of a collector drain through the centre of the basin and finger drains at regular spacing within the whole basin. The pond underdrainage will gravity drain to the underdrainage sump at the RSF embankment via the branch drains in the natural drainage alignments.

Toe drains will be constructed at the upstream embankment toe. The toe drains will feed directly into the underdrainage collection sump.

The underdrainage system is designed to reduce the phreatic surface within the residue mass and near the RSF embankments. The system has several benefits, as follows:

- Reduces seepage through the basin and under/through the embankment. This is beneficial to the environment and promotes increased embankment stability.

- Drains the residue mass, thus increasing the density of the residue and providing a more efficient facility in terms of constructed storage capacity.
- Increases the strength of the residue mass immediately adjacent to the embankment.
- Reduces the phreatic surface in the residue mass and RSF embankments.

The system takes advantage of the natural fall of the ground to reduce re-shaping of the basin. Any borrowing of construction materials within the basin will also be planned so it assists with the basin shaping.

4.4.4 Underdrainage collection tower

An underdrainage collection tower was positioned at the low point within the BF&GYP RSF cell basin, adjacent to the embankment upstream toe. The underdrainage sump will collect solution from the upstream toe drains and basin underdrainage system. The collected solution will be pumped on to the residue surface via a submersible pump situated at the base of the underdrainage tower. The underdrainage sump consists of the following components:

- An approximately 3.5 m deep excavation below the basin borrow pit floor in which the underdrainage tower base is situated. The basin liner will extend beneath the sump.
- A 900 mm diameter vertical reinforced concrete tower pipe, running from the base of the sump to the embankment crest elevation and accessed via an underdrainage tower causeway.
- The sump will be backfilled with coarse drainage medium and sealed against ingress of residue.
- A submersible pump will be situated at the base of the collection sump. The pump will operate with a level control.
- Underdrainage system pumps, pipelines and associated infrastructure will be designed by others.

4.4.5 Embankment upstream toe drain

Like the underdrainage recovery tower, a sump will be excavated within the WL RSF cells and a bottom slotted inclined HDPE pipe installed which acts as a sleeve for a submersible pump installed within. The pipe will extend to the embankment crest to allow access to remove the submersible pump for maintenance. The sump will be backfilled with coarse drainage rock and sealed with appropriate filters to prevent ingress of residue.

4.4.6 Leakage Control and Recovery System

In addition to the underdrainage system, a Leakage Collection and Recovery System (LCRS) will be installed beneath the basin liner of the WL RSF cells. The system consists of collector pipes along the embankment upstream toe alignment as well as through the centre of the cell. A sump will be built similar in layout to the underdrainage sump with the exception that the main basin liner extends above the sump. Only the LCRS collector pipes will be extended into this sump.

This sump will act as a monitoring point to confirm the performance and integrity of the basin liner system. In case the basin liner develops a significant leak, a recovery pump can be installed to return any leakage back into the RSF.

4.5 Spillways

Emergency spillways will be accessible for an unlikely rainfall event that exceeds design storms. During each stage, an emergency spillway will be constructed for each cell to allow emergency discharge and prevent uncontrolled embankment overtopping.

The emergency spillway will allow for the safe management of rainfall events up to the Probable Maximum Precipitation (PMP) event.

Ancillary closure spillways will be built at cell decommissioning and sized to discharge PMP events without significant attenuation in the RSF.

4.6 Containment trench and pipelines

A containment trench is provided for both the delivery and decant pipelines transporting tailings and water between the RSF and Plant Site. The containment trench is lined with HDPE to reduce spillage risk and discharge to the environment in the event of pipeline bursts.

To allow for safe release of tailings contained within the pipelines in an emergency, an event pond will be constructed. Located at the toe of the RSF, the event pond will provide adequate storage capacity for the whole volume of slurry contained in the pipeline, plus a pumping allowance.

4.7 Dust Management

The RSF is not expected to generate dust if it is operated within the design parameters. The active beach will move continuously maintaining damp conditions across the entire surface of the RSF to prevent dust generation. It is possible that additional dust will be generated during construction activities and from newly filled embankments. Water trucks will be utilised during these activities to suppress excessive dust.

Manual dust monitoring stations will be installed and monitored as discussed further in 5.2.3, Dust.

If dust generation exceeds the TARP trigger levels, decreasing the timing between spigot rotations will be considered to increase the moisture in the beaches. In addition, recycling of the pond decant water through the RSF spigots will be considered if needed.

4.8 Radiation Management

As per the Australian Radiation Protection and Nuclear Safety Agency regulations, the facility has been classified as a nuclear waste disposal facility for “Very Low-Level Waste”. The specifics about managing radiation and limiting exposure have been included in a separate radiation management plan.

5.0 MONITORING

All environmental monitoring will be conducted in accordance with the relevant Environmental Monitoring Procedures. The procedure will provide instructions required to monitor embankment stability, groundwater levels and quality, dust emissions and radiation levels. A schedule for the monitoring requirements has been provided in Table 5-1 and an overview of the monitoring requirements have been described in Section 5.2. A plan of the monitoring instrument layout has been provided in Figure 5-1 and monitoring instrument details are shown in Figure 5-2

5.1 Monitoring Schedule

Table 5-1: RSF Compliance Monitoring Summary

Monitoring Aspect	Monitoring Requirement	Frequency
Embankment Stability	Survey pins	Monthly
	Water volume and level	Weekly
	Residue level	Weekly
	Piezometer Phreatic Phase	Monthly
Groundwater	Water level	Monthly
	Water quality – TDS, pH	Monthly
	Water quality – major component analysis	Quarterly
Dust	Dust generation	Weekly
	Dust composition – major component analysis	Quarterly
Radiation	Continuous Gamma Radiation Monitoring Station	Continuous *
	Radon Monitoring	Weekly *

*As per the Radiation Management Plan.

Figure 5-1: Monitoring Instrument Layout for the Residue Storage Facility

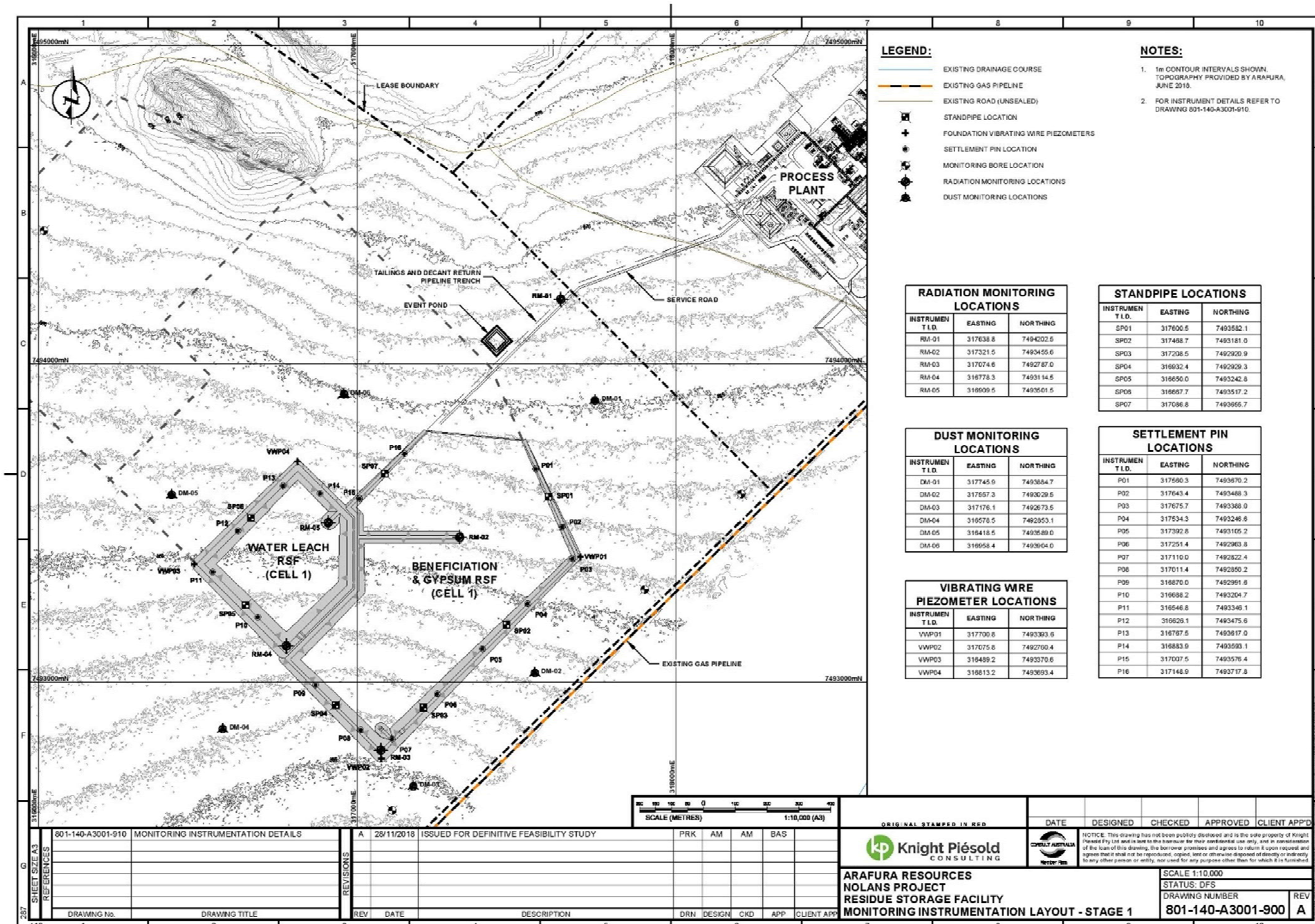
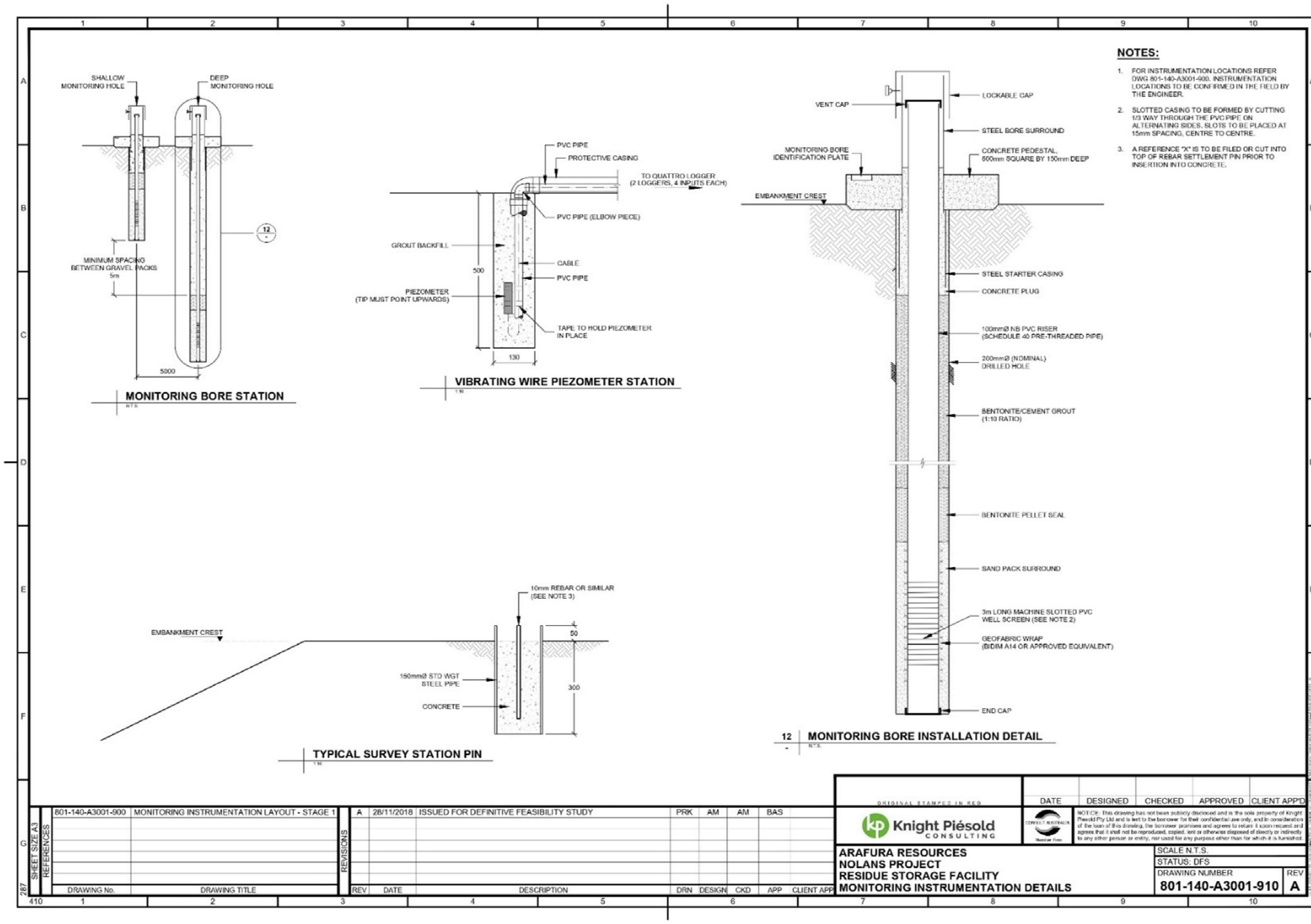


Figure 5-2: Monitoring Instrument Details for the Residue Storage Facility



5.2 Monitoring Requirements

5.2.1 Embankment Stability

5.2.1.1 Survey Pins

To regularly monitor and assess embankment movement, survey pins will be installed at regular intervals along the downstream side of the RSF embankment crest. The date of installation, survey pin ID, Northing, Easting and RL, will be recorded on installation as a reference point to monitor embankment movement overtime. Any displacement of the survey pins will be observed during routine monitoring (Table 5-1) and investigation by a qualified geotechnical engineer as per the TARP provided in Table 6-1.

5.2.1.2 Piezometers

Piezometers will be used to measure porewater pressure (phreatic phase) as an indication of changing conditions within the embankments that could lead to compromised stability. Standpipe piezometers as well as Vibrating Wire Piezometers (VWP) will be installed during the construction works. It is anticipated that the VWPs will be maintained during construction works whilst the standpipe piezometers will be backfilled and re-drilled after each lift. Specific installation details for the standpipe piezometers and VWPs are included within the RSF Operating and Monitoring Manual.

The piezometers will be monitored periodically (refer to Table 5-1) by collecting data using a handheld reader or by retrieving data from a data logger. Data will be analysed to ensure that the piezometers remain dry and that increase in water level of more than 10% of the embankment height between readings is investigated. Investigatory requirements have been included within the TARP, Table 6-1.

5.2.2 Groundwater Levels and Quality

Groundwater monitoring stations will be installed downstream of the RSF perimeter embankment to facilitate early detection of changes in groundwater level and/or groundwater quality both during operation and at closure. Each monitoring station will consist of two monitoring bores. This will include a shallow bore (10 m) to monitor seepage from the facility flowing within the sediment and a deep bore (40-60 m) to monitor the chemical composition of the groundwater. Each bore will be constructed from a 100 mm diameter casing so that they can be converted to a dewatering bore if required. Groundwater monitoring will be conducted in accordance with the monitoring scheduled outlined in the overall groundwater sampling procedure, which has been prepared for the MMP.

5.2.3 Dust

When operated within the design parameters, the RSF is not expected to generate dust as discussed in section 4.7, Dust Management. Manual dust monitoring stations will be installed and read in accordance with the monitoring schedule outlined in Table 5-1. Recommended trigger levels and response plans have been made by KP and included in the TARP (Table 6-1).

6.0 TRIGGER ACTION RESPONSE PLAN

Table 6-1: TARP for to avoid environmental impacts associated with the RSF.

Monitoring Instrument	Trigger	Action	Response
Survey Pins	A change of greater than 10 mm (in one direction) between readings or 20 mm between three readings (in one direction)	Conduct additional survey to increase data collection.	If confirmed, qualified geotechnical engineer notified and informed of each reading and for further assessment.
	Settlement continues	Additional survey pins are to be installed and full detailed embankment survey pickup conducted.	Frequency of survey pin readings to increase to daily. Implement further remedial action recommended by geotechnical engineer to be implemented, such as additional monitoring equipment, removing surcharge, reducing supernatant pond volume.
Groundwater Bores - Levels	A change in level of greater than 1 m between readings or 2 m between three readings.	Immediate re-measure. Cross checked against typical seasonal fluctuations for the region by a qualified hydrogeologist	A qualified geotechnical engineer notified and informed of regular updates
	Increase continues to within 5 m of natural ground level	Investigate further with a hydrologist.	Detailed assessment of the source and extent to be determined by hydrogeologist. Implement action recommended by the geotechnical engineer.

Monitoring Instrument	Trigger	Action	Response
Groundwater Bores - Quality	Water quality readings recorded exceed baseline readings or the values stipulated within the license conditions.	Resample bores.	Report the findings to the licensing authority as per licence conditions.
	Elevated readings continue and samples indicate higher than typical constituent levels.	Engage qualified geotechnical engineer and hydrologist.	Implement recommendation made by qualified geotechnical engineer and update licensing authority on outcomes.
Piezometers	A change from reading dry to a reading of standing water or a water level greater than 10% of the embankment height.	Immediate remeasure	A qualified geotechnical engineer should be notified and informed of each reading.
	Levels increase to greater than 20% of the embankment height	Monitoring frequency must be increased too weekly	Remedial action recommended by the geotechnical engineer is to be implemented. A stability analysis should be undertaken to check the factor of safety (FOS) of the RSF embankment with the raised phreatic surface.

Monitoring Instrument	Trigger	Action	Response
Dust	An increase of dust collected in the downwind station of greater than 50% of the baseline from the upwind/reference station	Increase of monitoring frequency. dust composition of the downwind station should be geochemically assessed to confirm the residue beach as origin	RSF operating procedures should be reviewed and the beach rotation increased. Undertake an options assessment to reduce dust, potentially with the installation of water sprays over the beach to maintain a higher moisture content.

* The above monitoring frequencies have been suggested in the initial design, and will be further refined during the final design process.

7.0 PERFORMANCE REVIEW

Monitoring the performance of the TSF is an important component of demonstrating that the design assumptions and mitigation measures are effective in controlling the potential environmental impacts from the TSF, both during operations and after closure. Monitoring data will be compiled and assessed at regular intervals and reported as part of the mine's annual environmental monitoring report, which is submitted as part of Arafura's obligations under its Mining Management Plan.

7.1 Maintenance Inspections

Maintenance inspections are conducted by the facility operators to identify potential problems, allowing an opportunity to remediate them before they become a significant risk. Details regarding the maintenance inspections are included within the RSF Operating and Monitoring Manual and include:

- Production shift inspections – every 12 hours
- TSF infrastructure inspections - monthly or after 50 mm rainfall events

7.2 Performance Monitoring

Performance monitoring requirements are outlined in detail within the RSF Operating and Monitoring Manual and are the responsibility of the facility operator. The manual provides provisions to conduct daily observations of the following:

- Moisture content of ore.
- Solids tonnage to the RSF.
- Percent solids of Residue slurry.
- Any additional water inputs to the RSF.
- Rainfall and evaporation at the RSF.
- Water return from the RSF to Plant Site.
- Collection efficiency of the underdrainage system based on underdrainage sump pump monitoring.

All observations will be consolidated within the TSF monthly operating report.

7.3 Annual Audits

The ANCOLD "Guidelines on Residue Dam Design, Construction and Closure", require annual audits to be conducted by a suitability qualified geotechnical engineer to ensure the RSF is operating in a safe and efficient manner. The audit will be conducted by a suitably qualified geotechnical engineer and will include the following:

- Residue beach survey.
- Reconciliation of stored residue volume and densities

- Assessment of in situ residue properties
- Water balance
- Validation of storage design
- Presentation and interpretation of monitoring results
- General description and review of the RSF water management and operations.
- Complete description and review of previous embankment raises.

A copy of the audit will be included within the Arafura Annual Environmental Report.

8.0 ABBREVIATIONS AND DEFINITIONS

8.1 Abbreviations

Abbreviation	Meaning
Arafura / ARU	Arafura Resources Limited
BF	Beneficiation
DFS	Detailed Feasibility Study
DMIRS	Department of Mines, Industry Regulation and Safety's
GYP	Gypsum
KP	Knight Piesold
LCRS	Leakage Collection and Recovery System
LOM	Life of Mine
MMP	Mine Management Plan
NdPr	Neodymium and praseodymium
PMP	Probable Maximum Precipitation
RF	Residue Facility
VMP	Vibrating Wire Piezometers
WL	Water Leach