RUM JUNGLE REHABILITATION - STAGE 2A DETAILED ENGINEERING DESIGN

Main Pit Backfill
Construction Methodology
Issued for Client and External Peer Review

Prepared for:

Northern Territory Government
Rum Jungle Stage 2A, Mines Division
Department of Primary Industry and Resources
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Northern Territory Government (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
680.10421.90030-R01-v2.0 Issued for Peer Review	16 June 2020	Ben Tarrant / Phil Davies	Danielle O'Toole / Dominic Trani	Danielle O'Toole
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GLOSSARY

Abbreviation/Acronym	Full form
AHD	Australian Height Datum
AMD	Acid and Metalliferous Drainage
AS (/NZS)	Australian Standard (and New Zealand Standard)
bgs	Below Ground Surface
DPIR, the Proponent	NT Department of Primary Industry and Resources
EBFR	East Branch of the Finniss River
EFDC	East Finniss Diversion Channel
FRALT	Finniss River Aboriginal Land Trust
LDWQO (s)	Locally Derived Water Quality Objective (s)
Mt	Mount
NAF	Non Acid Forming
NLC	Northern Land Council
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NTG	Northern Territory Government
PAF	Potentially Acid Forming
Project	Rum Jungle Stage 3 Rehabilitation Project
QA/QC	Quality Assurance/Quality Control
RJ	Rum Jungle
TARP	Trigger Action Response Plan
TO	Traditional Aboriginal Owners
Qld	Queensland
WRD	Waste Rock Dump (existing)
WSF	Waste Storage Facility (planned)
WTP	Water Treatment Plant

DISCLAIMER

The following Main Pit Backfill Strategy Construction Methodology has been based on limited available data at the time of design. A reference backfill strategy design involving barge subaqueous backfilling has been prepared. A suitably qualified Contractor will be required to backfill the Main Pit with waste rock materials and cap to the satisfaction of Rum Jungle remediation objectives.

1 Introduction

1.1 Project Background

The Northern Territory Government (NTG), represented by the Department of Primary Industry and Resources (DPIR), proposes the rehabilitation of the former Rum Jungle Mine site (the Project), located 6 km north of Batchelor, Northern Territory (NT). The project location and regional setting are shown on Figure 1-1.

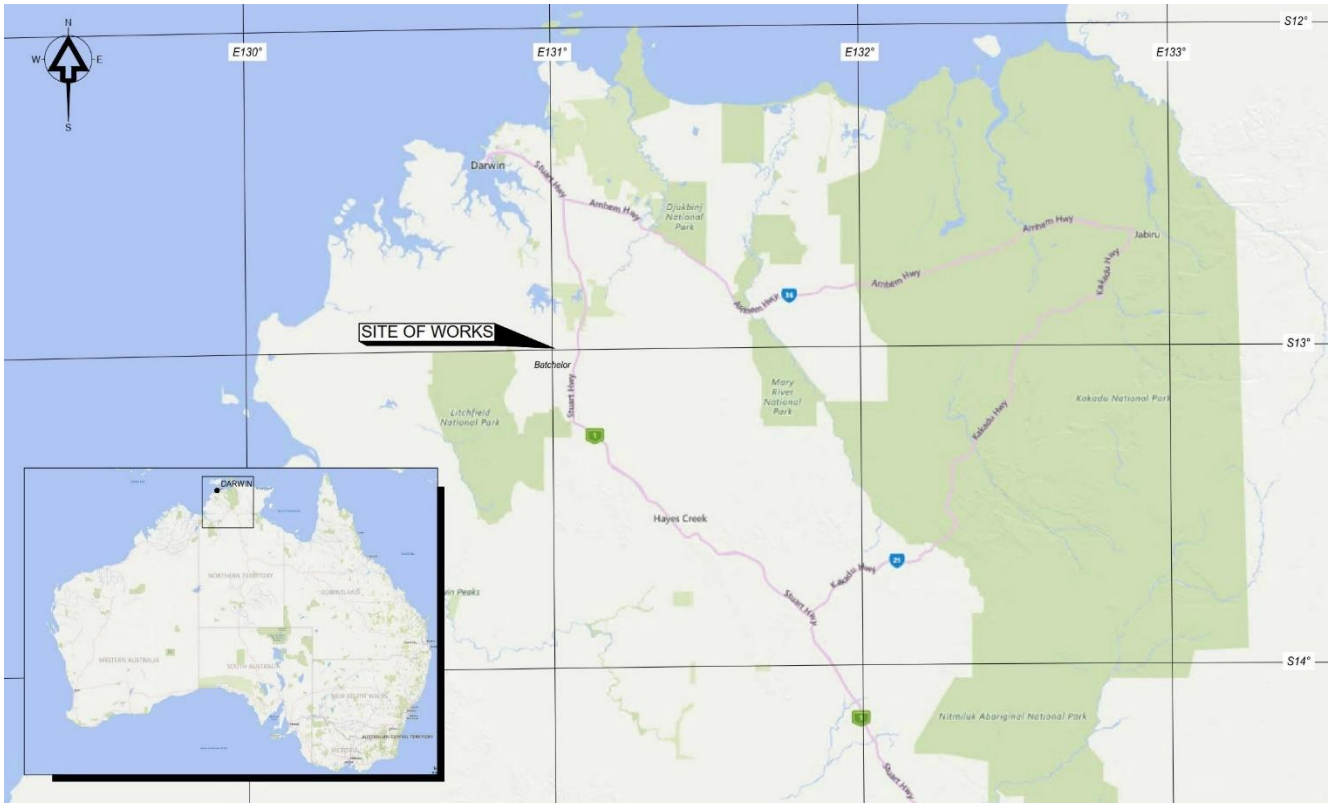

Figure 1-1 Project Location

The former Rum Jungle mine was rehabiliated in the 1980s, however recent studies indicate that not only has the site deteriorated and needs further rehabilitation, but that the traditional Aboriginal owners (TO) cultural requirements have not been met. Since 2009, the NTG and the Australian Government have been working under a National Partnership arrangement to complete investigative work to inform a rehabilitation plan, deliver site maintenance and continue environmental monitoring. The results of these programs have been used to develop an improved rehabilitation strategy that is consistent with the views and interests of traditional Aboriginal owners and that meets contemporary environmental and mined land rehabilitation standards.

The Project's high-level objectives are two-fold and focus on environmental remediation and restoration of cultural values of the site as described below:

- Improve the environmental condition onsite and downstream of site within the East Branch Finniss River (EBFR). This includes the following key outcomes:

  - Improved surface water quality conditions within EBFR in accordance with locally derived water quality objectives (LDWQOs).
  - Achieve chemically and physically stable landforms.
  - Support self-sustaining vegetation systems within rehabilitated landforms.
  - Develop physical environmental conditions supportive of the proposed Land Use Plan.
- Improve site conditions to restore cultural values. This includes the following key outcomes:
  - Restoration of the flow of the EBFR to original course as far as possible.
  - Remove culturally insensitive landforms from adjacent to sacred sites and relocate ensuring a culturally safe distance from the sacred sites.
  - Return living systems including endemic species to the remaining landforms.
  - Preserve Aboriginal cultural heritage artefacts and places.
  - Isolate sources of pollution including radiological hazards.
  - Maximise opportunities for Traditional Owners to work onsite to aid reconnection to country.

1.2 Rehabilitation Strategy

The rehabilitation strategy has been developed from an understanding of current site conditions, contamination processes and a Land Use Plan goals as established with Traditional Owners. There are several key elements that have been incorporated in the strategy in order to satisfy the cultural needs of sacred site Custodians. Full details of the rehabilitation strategy can be found in the Draft Environmental Impact Statement (NT-DPIR, December 2019).

1.2.1 Remediation Action Plan

The actions planned to address contamination processes and improve prospects of future land use are:

- Slow down or halt the acid and metalliferous drainage (AMD) production reactions from waste rock onsite by consolidating waste rock into one of three new facilities based on potentially acid forming (PAF) characteristics. These facilities are:
  - Main Pit backfill zone: ~1.9 Mm^3 stored volume
  - Eastern Waste Storage Facility (WSF): ~3.8 Mm^3 stored volume
  - Western WSF: ~3.2 Mm^3 stored volume
- Slow down or halt the future generation and transportation mechanisms for copper and other metals in the new WSFs by adopting leading practice methodology for storage of PAF waste rock.
- Treat existing groundwater sources (i.e. the Main and Intermediate Waste Rock Dumps (WRDs)) that contaminate the EBFR by pumping and treating these impacted waters.
- Treat other AMD-impacted groundwater that does not contribute to the EBFR copper load (i.e. old ore stockpile area) by pumping and treating these impacted waters.
- Isolate radiological and AMD affected soils at the Rum Jungle site and Mt Burton from environmental and human receptors by relocating these soils to the new WSFs on site.

- Isolate asbestos materials at the Rum Jungle site from environmental and human receptors by removing from surface soils and relocating to the new WSFs or by another approved means offsite.

Detail on these actions are described within this Design Report.

1.2.2 Reestablishment of Cultural Values

The actions that are planned to address the compromised environmental and cultural values that are not related to contamination processes are:

- Return the EBFR to its original course as far as possible.
- Restore land parcels that are poorly vegetated such as the Old Tailings Dam area and vine thicket stand.
- Revegetate new landforms to stabilise the surface and restore ecological function as far as practicable.

1.3 Objectives and Scope of Works for Main Pit Backfilling

This report has been prepared to support the Technical Specifications and Bill of Quantities associated with the Main Pit Backfilling works.

The primary purpose of the Main Pit Backfilling is to backfill the highest grade potentially acid forming (PAF) from various Waste Rock Dumps (WRD) across the Rum Jungle Project Site in order to encapsulate sub-aqueously. The materials identified with the highest PAF grade are located in:

- Intermediate WRD; and
- Dysons Overburden.

To minimise the likelihood of AMD from the Main Pit, the waste rock materials are to be placed and treated in line with strict geotechnical and geochemical quality requirements.

Full details regarding the background of the works can be found in SLRs Detailed Engineering Report (still under development) (SLR, 2020a).

The following outlines the minimum construction methodology to be adopted to meet these quality requirements.

2 Quality Requirements

2.1 Geochemical

This section outlines the chemical stabilisation of the waste rock for long term storage. The pore solution formed within the placed waste rock should have a circum-neutral pH at placement. This will avoid the loss of long-term neutralising capacity. This requires operating the pit lake at a pH ≥7 during backfilling and lime dosing backfill materials as outlined below. Lime dosing and mixing to be performed prior to sub-aqueous placement.

Lime supply will be performed by Backfill Operations. The efficiency of the lime will be tested every 3,000 tonnes of lime supplied. The efficiency of the lime will be provided in the reporting as detailed in **Section 2.2.1.**

Table 1 Sand Bedding Layers Liming Rates

Material to Treat	Placement Location	Hydrated Lime Treatment	Total Lime Quantity
Sand Bedding Layers	Main Pit	1.7% by weight of Bedding Layer Material Backfilled	3,105 tonnes

Table 2 Main Pit Liming Rates

Material to Treat	Placement Location	Granulated Lime Treatment	Total Lime Quantity
Intermediate WRD	Main Pit	24 kg $CaCO_3$ per tonne of WRD	44,652 tonnes
Dyson's Overburden WRD	Main Pit	24 kg $CaCO_3$ per tonne of WRD	26,940 tonnes
Main WRD	Main Pit	15 kg $CaCO_3$ per tonne of WRD	11,168 tonnes

The impacted water quality at the Main Pit lake must not be allowed to enter the East Branch Finniss River. Only water meeting the quality limits (Locally Derived Water Quality Objectives, LDWQO) can be released from site and only under certain conditions to be established by the NT EPA.

No water quality testing is required of the backfill operators for the purpose of payment or construction specification as this is within the scope of the Water Management operators. The backfill operators are expected to assist the Water Management operators with access to continual monitoring equipment and pumping equipment installed within the Main Pit.

2.2 Geochemical Conformance Testing Required

2.2.1 Lime Mixing

Volumetric (m^3) and weight (tonnes) recording of lime dosing (rates and total) against waste rock source or Sand Bedding will be measured in real-time with data provided to the Superintendent on a weekly basis.

2.2.2 Lime Dosage Validation

To confirm that material backfilled has been adequately dosed in accordance with applicable liming rates, weight and volume of lime dosed shall be measured and recorded against waste rock source on a per tonne of waste rock backfilled basis. Records shall be auditable and the measurement and recording methodology demonstrable to the satisfaction of the Superintendent. The lime dosage will be measured at a point in the material processing chain that ensures lime dosed is not lost in material processing and reflects the dosage rate of backfilled material. The liming rate applicable to waste rock source will remain fixed, however, the Principal reserves the right to amend liming rates if required.

Measured and recorded lime dosage rates shall be in real-time and continually monitored with compiled data sets provided to the Superintendent on a weekly basis. Minimum data to be presented in the record shall include the following:

- Time and Date of backfill;
- Main Pit floor Reduced Level (m AHD) at time of backfill;
- Lime volume (m^3) and Weight (kg) that has been applied to backfilled material;
- Type of lime applied and lime efficiency rate (as provided by Supplier and/or tested by Contractor);

- Waste Rock Source, Volume (m^3) and Weight (Tonnes) that has been dosed and backfilled; and
- Applied dose rate (kg of lime/per tonne backfill material).
- Applicable calibration certificates of mass/weight/volume measuring equipment

2.2.3 Water Quality Testing

Control testing for water quality within the Main Pit at the point of material placement shall be the responsibility of the Backfill Operations conducted and continuously from backfill material delivery system (barge/conveyor or similar) at multiple depths to understand vertical and horizontal mixing of the chemocline and changes to the pit lake water quality from waste rock placement at the point of placement. This data will be used to inform the feed water for the WTP for operational purposes as well as instruct backfilling operations. The water quality monitoring is shown in **Table 3**.

Water quality monitoring instrumentation must use telemetry, be robust, able to withstand backfilling operations and collected data accessible by key operators (WTP and Main Pit Backfill) in real time.

It is noted, the probe parameter requirements of Electrical Conductivity and Oxidation Reduction Potential may not be used in the QA/QC, however they will be monitored to enable characterisation of the pit water not captured by pH measurement.

Table 3 Main Pit Water Quality In-situ Multi-Probe (within Main Pit) Testing Frequency

Backfilling Stage	Locations	Depth (m below pit lake surface)	Probe Parameter Requirements	Frequency
Sand Bedding Layer	Off Backfill Material Delivery System.	10, 20, 30 & within 3.0m of Main Pit floor.	pH, Electrical Conductivity, Depth of Probe, Oxidation Reduction Potential, Time & Date of test	Continuous
Waste Rock < 27m AHD	Off Backfill Material Delivery System.	10, 20 & within 3.0m of Main Pit Floor	pH, Electrical Conductivity, Depth of Probe, Oxidation Reduction Potential, Time & Date of test	Continuous
Waste Rock < 35m AHD	Off Backfill Material Delivery System.	5, 10 & within 2.0m of Main Pit Floor	pH, Electrical Conductivity, Depth of Probe, Oxidation Reduction Potential, Time & Date of test	Continuous
Waste Rock < 56m AHD	Off Backfill Material Delivery System.	Within 2.0m of Main Pit Floor	pH, Electrical Conductivity, Depth of Probe, Oxidation Reduction Potential, Time & Date of test	Continuous
Inert Capping Layer < 58m AHD	Off Backfill Material Delivery System.	Within 2.0m of Main Pit Floor	pH, Electrical Conductivity, Depth of Probe, Oxidation Reduction Potential, Time & Date of test	Continuous

Should the pit lake water quality at the elevation of waste rock layer placement alter below a pH of 7, backfilling operations are to be conducted in accordance with the Tigger Action Response Plan (TARP) (**Section 2.2.5**), the water quality is to be adjusted until the pH is achieved. At this time, operations can recommence.

2.2.4 Hydrated Lime Delivery

A hydrated lime slurry delivery system shall be installed to deliver hydrated lime as a slurry directly to the existing Main Pit floor via submerged pipeline, with the outlet able to be positioned within 4.0 m radius of affected location. Slurry delivery via pipeline will be necessary to prevent the dissolution of the hydrated lime into the water column prior to reaching the affected zone.

The intention of the lime delivery system is to neutralise a drop in pH that may be trigger by backfill material placement and ensure entrained pore water within the backfill materials is pH ≥7. The lime required herein this section is intended to serve the TARP (**Section 2.2.5**) and is in addition to quantities provided in **Table 1** and **Table 2**.

The pipeline shall deliver the lime to the main pit floor (or within 4.0 m) at the location of backfill placement (within 4.0 m radius) as dictated by Trigger Action Response Plan (ref: **Section 2.2.5**).

The lime delivery system shall be setup such that delivery can occur within 15 minutes of requirement. The pipeline system is recommended to be able to retract as the backfill materials are placed and the depth of the Main Pit water column decreases. Furthermore, due to the nature of materials being placed, it is recommended the delivery system be retractable to mitigate against the risk of damage during backfilling.

2.2.5 Main Pit Backfilling Water Quality Trigger Action Response Plan (TARP)

A Trigger Action Response Plan (TARP) will be dictated by the Off Backfill Material Delivery System (Barge/Conveyor or alternative) Water Quality Monitoring Probe (Drawing Ref: 680.10421.MPS.D05). The TARP will be applicable to all probes at depth.

- pH ≥ 7 = green – continue backfilling as normal
- 6.5 < pH < 7 for 10 consecutive minutes or for more than 30 total minutes in a 60 min period = amber – report to superintendent, alert water treatment plant, increase monitoring frequency and slow backfill rate until pH stabilises above amber trigger. Begin hydrated lime delivery if pH does increase to green trigger level after 30 minutes. Monitor until pH stabilises to pH ≥ 7 for 10 consecutive minutes at which time revert to green level controls.
- pH ≤ 6.5 for 10 consecutive minutes or 20 total minutes in a 60-minute period = red – Notify superintendent and water treatment plant, cease all backfill operations and begin hydrated lime delivery. Monitor until pH stabilise to pH ≥ 7 for 10 consecutive minutes at which time revert to green level controls.

2.3 Geotechnical

2.3.1 Bedding Layers

Bedding layers are required to support and facilitate the placement of Waste Rock materials over the soft tailings deposits as well as mitigate the risk of remobilisation of highly concentrated contaminated water (chemocline) within the basal layers.

2.3.2 Sand Bedding Layer -1mm (SBL-1)

Table 4 Sand Bedding Layer (SBL-1) Material Specifications

Parameter	Specification
Material Source	Borrow Area B (FRALT)
Particle Size Distribution	100% Passing 2.36 mm sieve
	≥ 85% Passing 1.18 mm sieve
	≤ 25% Passing 0.075 mm sieve
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 80
	Plasticity Index ≤ 55
Minimum Layer Thickness*	1.00 m

Notes: [*]: Within the area defined by the RL 19m AHD contour and not exceeding 20m AHD (above the RL 19m AHD pit wall contour)

2.3.3 Sand Bedding Layer Unscreened (SBL-U/S)

Table 5 Sand Bedding Layer Unscreened (SBL-U/S) Material Specifications

Parameter	Specification
Material Source	Borrow Area B (FRALT)
Particle Size Distribution	100% Passing 53.00 mm sieve
	≤ 25% Passing 0.075 mm sieve
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 80
	Plasticity Index ≤ 55
Minimum Layer Thickness*	1.00 m

Notes: [*]: To a level not exceeding RL 21m AHD (above the RL19m AHD pit wall contour)

2.3.4 Sand Bedding Layer +1mm (SBL+1)

Table 6 Sand Bedding Layer (+1mm) Material Specifications

Parameter	Specification
Material Source	Borrow Area B (FRALT) (stockpile from -1mm screening)
Particle Size Distribution	100% Passing 75.00 mm sieve
	< 15% Passing 1.18 mm sieve
Minimum Layer Thickness*	1.00 m

Notes: [*]: To a level not exceeding RL 22m AHD (above the RL 19m AHD pit wall contour)

2.3.5 Waste Rock

Waste rock layers are divided into a lens layer, envisioned to fill the ‘bowl’ created by the sand bedding layer placement and waste rock placed above the lens.

2.3.5.1 Waste Rock Lens: Up to RL 22m AHD

The waste rock lens layer requires control on maximum particle size due to the low strength and chemically sensitive environment anticipated at lower depths.

Table 7 Waste Rock Lens Material Specifications

Parameter	Specification
Material Source	Waste Rock Dumps
Particle Size Distribution	100% Passing 100 mm sieve
	≤ 30% Passing 0.075 mm sieve
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 80
	Plasticity Index ≤ 55
Layer Maximum Elevation	+22m AHD

2.3.5.2 Waste Rock: RL 22m AHD to RL 27m AHD

The waste rock RL 22 m AHD to RL 27 m AHD layer requires control on maximum particle size due to the low strength and chemically sensitive environment anticipated at lower depths.

Table 8 Waste Rock RL 22m AHD to RL 27m AHD Specifications

Parameter	Specification
Material Source	Waste Rock Dumps
Particle Size Distribution	100% Passing 200 mm sieve
	≤ 30% Passing 0.075 mm sieve
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 80
	Plasticity Index ≤ 55
Layer Maximum Elevation	+27m AHD

2.3.5.3 Waste Rock: RL 27m AHD to RL 56m AHD

Table 9 Waste Rock RL 27m AHD to RL 56m AHD Material Specifications

Parameter	Specification
Material Source	Waste Rock Dumps
Particle Size Distribution	Maximum Particle Size 1,000 mm
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 80
	Plasticity Index ≤ 55
Layer Minimum Elevation	+27m AHD
Layer Maximum Elevation	+56m AHD

2.3.6 Inert Capping Layer

Placement of an inert (non-potentially acid forming) capping layer overlaying waste rock materials.

Table 10 Inert Capping Material Specifications

Parameter	Specification
Material Source	Borrow Area B (FRALT)
Particle Size Distribution	N/A
Atterberg Limits (for particles passing 0.075 mm sieve)	Liquid Limit ≤ 60
	Plasticity Index ≤ 12
	% Passing 0.425 sieve x Plasticity Index ≤ 300
Emerson Class	Non-dispersive (≥ Class 4)
Layer Minimum Thickness	2.00m
Layer Maximum Elevation	+58m AHD

2.4 Geotechnical Conformance Testing

2.4.1 Material Specifications

Table 11 SBL-1 Sand Bedding Layer Assurance / Quality Control (Prior to Placement)

Test	Standard	Rationale	Frequency
Particle Size Distribution	AS1289 3.6.1	measure percentage by mass passing design particle sizing	10 tests per 5,000 tonnes

Table 12 SBL U/S Sand Bedding Layer Assurance / Quality Control (Prior to Placement)

Test	Standard	Rationale	Frequency
Particle Size Distribution	AS1289 3.6.1	measure percentage by mass passing design particle sizing	10 tests per 5,000 tonnes

Table 13 SBL+1 Sand Bedding Layer Assurance / Quality Control (Prior to Placement)

Test	Standard	Rationale	Frequency
Particle Size Distribution	AS1289 3.6.1	measure percentage by mass passing design particle sizing	10 tests per 5,000 tonnes

Table 14 Waste Rock Assurance / Quality Control (Prior to Placement) WR Lens to RL 27 m AHD

Test	Standard	Rationale	Frequency
Particle Size Distribution	AS1289 3.6.1	measure percentage by mass passing design particle sizing	5 tests per 5,000 tonnes

Table 15 Waste Rock Assurance / Quality Control (Prior to Placement) Above RL 27 m AHD

Test	Standard	Rationale	Frequency
Particle Size Distribution	AS1289 3.6.1	measure percentage by mass passing design particle sizing	2 tests per 5,000 tonnes

Table 16 Inert Capping Assurance / Quality Control (Prior to Placement)

Test	Standard	Rationale	Frequency
Emerson Class	AS1289 3.8.1	Measure dispersion potential	5 tests per 5,000 tonnes

2.4.2 Placement Controls

The rate of placement shall not cause significant impact or disturbance of the chemocline such that the water treatment or surface water quality is affected.

Sand Bedding Layers

To manage the potential for instability or failure within the tailings temporary slopes formed within the Bedding Layer materials, geometries shall not exceed:

- a maximum overall gradient of 1V:10H within any 20 m x 20 m area (using a 2m survey grid); and
- a maximum height difference of 2.0 m within any 100 m x 100 m area (using a 2m survey grid) between the lowest and highest elevation of the placed sand bedding backfill.

Sand bedding placement shall commence from the Main Pit centre outwards towards the RL 19 m AHD contour. Continued placement shall proceed from low elevation to high elevation zones to buttress slopes, minimise slope angles and minimise height differentials in accordance with the abovementioned dot point geometric placement controls.

Where changes to the water quality and/or tailings instability or failure occur the method and rate of deposition shall be reassessed.

To provide confirmation that placement is being conducted in accordance with the Specifications, control testing via over water Cone Penetration Testing (CPT) for Bedding Layer distribution shall be conducted in order to confirm the extent and thickness of Bedding Layer material. CPTs will extend into the tailings to record changes in strength properties.

To provide confirmation that placement is being conducted in accordance with the Specifications, control surveying (such as multibeam surveys) for changes in the tailings and backfill material surface level shall be conducted in real-time during Bedding Layer placement.

Where the tailings surface exhibits change or disturbance from the placement of material, the method and rate of placement may require revision.

Where exceedances in the maximum temporary slope gradient and height occur placement must focus on rectification and filling in lower elevations to maintain stability.

CPTs will involve in-situ testing under the supervision of an appropriately qualified and experienced geotechnical engineer. CPTs are to be arranged by the Contractor as per test locations stipulated by the CQA Consultant at the following frequencies:

- 10 tests inside the 19 m AHD baseline contour on a 50m grid after completion of the SBL-1 to RL 12m; and
- 10 tests inside the 19 m AHD baseline contour on a 50m grid after completion of the SBL+1 to RL 12m.

Waste Rock

- No waste rock filling prior to completion and approval by the Superintendent of all Sand Bedding Layers to within a minimum horizontal distance of 100m from the nearest location of proposed waste rock filling;
- Waste Rock below RL 22m AHD shall be placed as follows:
    - maximum overall gradient of 1V:10H within any 20m x 20m area (using a 2m survey grid); and
    - maximum height difference of 2m within any 100m x 100m area (using a 2m survey grid) between the lowest and highest elevation of the placed sand bedding backfill.
- Waste Rock placed between RL 22m and 27m AHD shall be placed in as follows:
    - maximum overall gradient of 1V:4H within any 20m x 20m area (using a 2m survey grid); and
    - maximum relative height difference rock backfill of 4m within any 100m x 100m area (using a 2m survey grid) between the lowest and highest elevation of the placed waste.
- Waste Rock placed between RL 27m and 35m AHD shall be placed as follows:
    - maximum overall gradient of 1V:3H within any 20m x 20m area (using a 2m survey grid); and
    - maximum relative height difference of 8m within any 100m x 100m area (using a 2m survey grid) between the lowest and highest elevation of the placed waste rock backfill.
- Waste Rock placed above RL 35 m AHD contour shall be placed with temporary slopes limited to their angle of repose and not exceeding:
    - maximum relative height difference of 8m within any 100m x 100m area (using a 2m survey grid) between the lowest and highest elevation of the placed waste rock backfill.
- For backfilling above RL 27m AHD, placement of predominantly clay material (> 30 % passing 0.075mm) must be avoided. Assessment of clay content is to be performed visually, with predominantly clay material to be remixed with granular materials prior to sub-aqueous placement.
- Waste Rock placement shall commence from the Main Pit centre outwards. Continued placement shall proceed from low elevation to high elevation zones to buttress slopes, minimise slope angles and minimise height differentials in accordance with the abovementioned dot point geometric placement controls.

2.5 Placement Rates

The Bedding Layers shall be deposited over water using the Contractor's chosen method(s) which achieve a controlled and accurate placement to meet the geometric requirements specified herein.

The Rate of placement of all backfill materials shall not exceed the limits set by the maximum rate of water treatment from the Main Pit.

Where unacceptable changes to the water quality and/or tailings instability or failure occur the method and rate of deposition shall be halted and reassessed.

The rate of placement shall not cause significant impact or disturbance of the chemocline such that the water treatment or surface water quality is affected.

The rate of placement should be such that Main Pit Backfilling works are completed prior to the end of construction period.

The following are estimated placement rates for Main Pit backfilling works.

Table 17 Estimated Placement Rates

Layer	Placement Rate per Hour (m³ / hr)	Contingency	Placement Rate Per Day (m³ / day)*
Sand Bedding Layer -1mm (SBL-1)	60	40 %	306
Sand Bedding Layer Unscreened (SBL U/S)	60	20 %	714
Sand Bedding Layer +1mm (SBL+1)	120	20 %	714
Waste Rock Lens to RL 22m AHD	300	10 %	1,948
Waste Rock to RL 27m AHD	300	10 %	1,948
Waste Rock to RL 56m AHD	600	10 %	3,896
Inert Capping Layer	600	10 %	3,896

Notes: [*] Placement Rate per Day has been determined for a 5-day work week, 10 hr shift normalised over 7-day calendar week and adjusted for contingency. Rate Per Day = Rate Per Hour * (1-Contingency) * 5-day Work Week * 10 hrs / 7-day calendar week.

2.6 Water Level Monitoring

The Main Pit and Intermediate Pit water levels are to be maintained throughout backfilling as specified:

- Main Pit: RL 58 to 59 m AHD; and
- Intermediate Pit: RL 49 to 50 m AHD.

Tolerance for the Intermediate Pit can be relaxed during the dry season July to September at the discretion of the Superintendent.

Water Level monitoring is to be continuous with alarm to the Pit Backfill operators to stop operations should these limits be breached. Once the water level conformance is achieved, operations can re-commence.

1. Main Pit Backfilling Water Level Trigger Action Response Plan (TARP)

A Trigger Action Response Plan (TARP) will be dictated by the Off Backfill Material Delivery System (Barge/Conveyor or alternative) Water Quality Monitoring Probe (Drawing Ref: 680.10421.MPS.D05). The TARP will be applicable to all probes at depth.

- Main Pit Water Level RL 58 to 59 m AHD = green – continue backfilling as normal
- Main Pit Water Level < RL 58 or > 59 m AHD for 10 consecutive minutes or for more than 30 total minutes in a 60 min period = amber – report to superintendent, alert water treatment plant, increase monitoring frequency and slow backfill rate until level stabilises above amber trigger.
- Main Pit Water Level < RL 57 or > 59.50 m AHD for any time = red – Notify superintendent and water treatment plant, cease all backfill operations. Monitor until water level stabilise to green trigger levels at which time revert to green level controls.

3 Landform

- Base of Main Pit (backfilled tailings surface): 16m AHD
- Diameter of Main Pit at crest: ~350 m
- Diameter of Main Pit at base: ~125 m
- Maximum Wet Season Main Pit Water Level: 61 m AHD
- Minimum Dry Season Water Main Pit Level: 59 m AHD
- Maximum Waste Rock Backfill Level: 56 m AHD
- Maximum Backfilled Level: 58 m AHD
- Total Volume Available for Storage in Main Pit: 2,173,228 m^3
- Main Pit Crest final landform re-contoured batter: 1V:6H
- Volume of material to cut Main Pit access ramp: 6,350 m^3
- Volume material required for landform re-contour batters (inclusive of Main Pit access ramp backfill): 14,400m^3
- Volume of contaminated/waste rock material to be removed from within the Main Pit exclusion zone = 2,805m^3

4 Construction Methodology

4.1 Overview

- Superintendent to perform Main Pit Slope Risk Assessment (SRA) and general site suitability assessment prior to establishment.
- Superintendent to install exclusion zone demarcation and assess proposed locations for Main Pit backfill operations (Offices, Laydown Yard, Stockpile Area, Material Processing Area, Crane outrigger locations, Conveyor locations/foundation (if applicable), etc).
- Site clearance, including de-vegetation where required, and setting out Works area (performed under Earthworks Work Package).
- Construction of diversion bunding around Main Pit to prevent surface water run-off entering Main Pit (performed under Earthworks Work Package).
- Construction Main Pit inlet flow exclusion and Diversion Channel Modifications (performed under Earthworks Work Package).
- Construct and Commission Main Pit dewatering system (performed under Water Treatment Plant Work Package).
- Construction of access ramp to Main Pit (Provisional) (Earthworks Contractor under instruction of Main Pit Backfill Contractor).
- Construction of site compounds and platforms for lay-down and stockpile areas, vehicle parking, amenities, site accommodation (Earthworks to be performed under Earthworks Work Package under instruction from Main Pit Backfill Contractor).

Establishment

- Construct, commission and lime treat Main Pit Water body to pH ≥ 7 (Water Treatment Plant Works Package) prior to backfill works commence.
- Bathymetric survey of the Main Pit to establish a baseline survey for backfill design.
- Establish offices, processing area, stockpiling, lime batching, storage and laydown yard.
- Install Pontoon.
- Mobilise barge and punt(s).
- Perform pre-works bathymetry survey and Main Pit water profile characterisation.
- Screen and stockpile sand bedding layer materials at Main Pit Stockpile area.

Materials haulage, processing and stockpile management

The works for material processing and stockpile management includes the following:

- Construction of facilities for housing screening, mixing and materials testing plant for inspection and acceptance of site-won, imported backfill materials and lime on to the Works area.
- Supply of hydrated and granulated lime.
- Operation of segregating, stockpiling, screening, testing, lime dosing/mixing and managing stockpiles of various materials.
- Measurable and auditable lime dosing and mixing appropriate to the backfill material prior to sub-aqueous placement.
- Haulage of sand bedding materials and waste rock materials will be performed under the Earthworks Work Package.

Backfilling

Throughout backfilling works, Main Pit water body operating pH will have a pH ≥ 7 (to be managed by Water Treatment Plant Operations and Backfill Operations (Ref: **Section 2.2.3 & 2.2.4**)).

- No sand bedding layer to be placed until Main Pit water body confirmed to be pH ≥ 7 (Responsibility of Water Treatment Plant Works Package).
- Mix with hydrated lime at 1.7% w/w rate and sub-aqueously place Sand Bedding Layer -1mm (SBL-1) to minimum RL 17m AHD.
- CPT QA/QC testing.
- Mix with hydrated lime at 1.7% w/w rate sub-aqueously place Sand Bedding Layer Unscreened (SBL U/S) to minimum RL 18m AHD.
- Mix with hydrated lime at 1.7% w/w rate sub-aqueously place Sand Bedding Layer +1mm (SBL+1mm) to minimum RL 19m AHD.
- CPT QA/QC Testing.
- Screen, crush and mix with granulated lime at WRD source specific rate and sub-aqueously place Waste Rock Lens with lime to minimum RL 22m AHD.

- Screen, crush and mix with granulated lime at WRD source specific rate and sub-aqueously place Waste Rock with lime to minimum RL 27m AHD.
- Screen, crush and mix with granulated lime at WRD source specific rate and sub-aqueously place Waste Rock with lime to maximum RL 56m AHD.
- Screen, crush and mix with granulated lime at WRD source specific rate and sub-aqueously place inert capping layer to RL 58m AHD.
- No placement of this layer until the pit lake water quality meets the Zone 2 Locally Derived Water Quality Objectives (Table 4-4 Hydrobiology, Rum Jungle Impact Assessment - Final Report, June 2016).
- Regular multibeam/bathymetry or similar surveying with 3rd party auditing throughout all backfilling.
- Continual monitoring and reporting of lime rates and volumes placed.

Landform Contouring (Performed under Earthworks Work Package)

- Backfill Main Pit access ramp with inert, non-dispersive materials.
- Backfill from Main Pit crest to surface of inert capping layer (RL 58m AHD) at 1V:6H batter with clean inert material.
- Remove contaminated soils and waste rock materials from within the Main Pit Backfilling exclusion zone.
- Install erosion protection to the re-profiled side slopes consisting of coarse granular borrow material.
- Removal of Main Pit bunding (Earthworks Work Package).
- Re-alignment of EBFR (Earthworks Work Package).

Demobilisation

- Final bathymetry survey of final surface (upon completion of capping and following landform contouring).
- Removal of Barge.
- Removal of Barge anchor points and pontoon.
- Removal of surplus stockpiles.
- Removal of office and backfill infrastructure/equipment and rehabilitation of area.

4.2 Construction Erosion and Sediment and Control Plan

This is to be prepared by Contractor.

5 Quantities

Table 18 Main Pit Backfill Breakdown

Layer	Source	Volume in Main Pit (m^3)									
		Year 1		Year 2		Year 3		Year 4		Year 5	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Sand Bedding Layer SBL-1	Borrow Area B (Hydrated Lime)[1]			28,481 (1,102)							
Sand Bedding Layer U/S				26,834 (1,039)							
Sand Bedding Layer SBL+1	Screened Stockpile from SBL-1 (Hydrated Lime)[1]			15,340 (595)	9,541 (369)						
Waste Rock Lens Up to RL 22m AHD	Dyson's Overburden WRD (Granulated Lime)[2]				55,825 (2,174)						
Waste Rock Up to RL 27m AHD	Dyson's Overburden WRD (Granulated Lime)[2]				89,048 (3,468)	75,324 (2,933)					
Waste Rock Up to RL 56m AHD	Dyson's Overburden WRD (Granulated Lime)[2]					356,256 (13,875)					
Waste Rock Up to RL 56m AHD	Intermediate WRD (Granulated Lime)[2]					85,846 (3,343)	339,509 (13,223)	530,016 (20,643)			
Waste Rock Up to RL 56m AHD	Main WRD (Granulated Lime)[2]							62,733 (1,526)	321,785 (7,781)		
Inert Capping Up to RL 58m AHD	Borrow Area B (FRALT)									176,692	

Notes:

[1] Volume of Hydrated lime = sand bedding volume * 1.8 tonne/m^3 bulk density * 1.7% w/w application rate / (1.0 tonne/m^3 lime bulk factor * 79% lime efficiency)

[2] Volume of granulated lime = Volume of Waste Rock in Main Pit / 1.3 (bulking factor from Backfill to Waste Rock Dump (WRD) Source) * 2 tonne/m^3 waste rock density * Lime Dose Rate (kg /tonne of WRD) / (79% Lime Efficiency * 1.2 tonne/m^3 lime bulk density)

6 References

NT-DPIR. (December 2019). *Northern Territory Government, Department of Primary Industry and Resources - Draft Envirionmental Impact Statement.*

SLR. (2020a). *Rum Jungle Rehabilitation - Stage 2A Detailed Engineering Design - Design Report.*

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