

Paraburdoo Closure Plan

2019

Mineral Field 47 – West Pilbara

FDMS No RTIO-HSE-0071355

Version 2.0

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Executive Summary

Overview

The Paraburdoo mine is located in the Pilbara region of Western Australia, approximately 5 km south-west of the Paraburdoo town in the Shire of Ashburton. The mine is located within the traditional lands of the Yinhawangka People. The Paraburdoo mine, in combination with Eastern Range mine and the Western Range deposits, are known as the Greater Paraburdoo Iron Ore Hub. The Paraburdoo mine is operated by Rio Tinto and is 100% owned by Hamersley Iron Pty Limited.

Paraburdoo uses traditional open cut, conventional drill-and-blast and load-and-haul mining methods to mine iron ore deposits positioned above and below the groundwater table. Ore is processed on-site before being transported via rail to either Dampier or Cape Lambert ports for shipping. Completion of mining at Paraburdoo is currently scheduled for 2039, although additional deposits may be proposed in the future, and subject to relevant approvals, may extend mining post this date.

Purpose

This closure plan has been developed to support the Greater Paraburdoo Iron Ore Hub Proposal (The Proposal) referred to the Environmental Protection Authority (**EPA**) under the Section 38 (s38) of the *Environmental Protection Act 1986 (EP Act)* and the Department of Agriculture, Water and the Environment (**DAWE**) (Cwth) under the *Environmental Protection and Biodiversity Act 1999 (EPBC Act)*. Within the Paraburdoo mine, pits and deposits included in The Proposal comprise 27 West, 20 West, 14 West -16 West and 4 East Extension (4EE); the deposition of tailings into the 4 West pit is also included. The remainder of the operating areas at the Paraburdoo mine are excluded from The Proposal. The development of the Western Range and 4 East Extension deposits is presently under pre-feasibility study (**PFS**) by Rio Tinto. Existing and project baseline information have been used to develop closure strategies, and these will be refined as further information becomes available.

The purpose of this closure plan is to also address closure of the existing Paraburdoo operations. This closure plan has been developed to meet the requirements of the joint Department of Mines and Petroleum and Environmental Protection Authority *Guidelines for Preparing Mine Closure Plans* (2015).

Scope

This document, titled 'Paraburdoo Closure Plan September 2019', represents the updated closure plan for the Paraburdoo operations and supersedes the previous 2018 Paraburdoo Closure Plan. It is applicable to existing operations and addresses the proposed development of Paraburdoo deposits and associated infrastructure. This closure plan does not include the nearby Channar and Eastern Range mine sites or development of the proposed Western Range deposits. The Paraburdoo town is outside the scope of this closure plan.

Post-mining land use

Post-mining land use options in the Pilbara are generally limited due to the remote location. As a result of the nature of the mining activity undertaken, the final landform will include large voids and waste dumps, and will therefore be unlikely to support pastoral activities in the immediate disturbed areas. However, it is recognised that surrounding areas are likely to return to pastoral activity.

The proposed post-mining land use assumes that the site will be rehabilitated to create a safe, stable and non-polluting landscape vegetated with native vegetation of local provenance, to maximise environmental and cultural heritage outcomes and ensure the site minimises adverse impacts on the current surrounding land use. The post-mining land use will be confirmed prior to closure, during final planning phases and in consultation with relevant stakeholders.

Closure objectives

The following closure objectives have been developed for Paraburdoo:

- cultural heritage values have been preserved where possible;
- public health and safety hazards have been appropriately managed;
- contamination risks have been appropriately managed;
- the final landform is stable and considers hydrological factors;

- vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use;
- surface water flows of the Seven Mile and Pirraburdu Creeks have been maintained;
- pit lakes do not result in a significant ecological impact, and
- infrastructure has been appropriately managed.

Indicative completion criteria have been proposed for each of these objectives; ongoing consultation is planned with stakeholders to ensure these criteria remain suitable.

Anticipated closure outcome

The Seven Mile and Pirraburdu Creek lines will continue to flow through the area. One pit lake is predicted to form as groundwater levels recover; preliminary modelling suggests the pit lake will act as a groundwater sink, remain circum-neutral with increasing Total Dissolved Solids (**TDS**) over time. Groundwater is not predicted to recover to pre-mining levels in all areas. Potentially acid forming (**PAF**) mineral waste within waste landforms will be encapsulated. Waste landforms will be reshaped to be stable based on their material characteristics. It is assumed that all infrastructure will be removed, but this will be subject to negotiation with the Western Australian State Government as per State Agreement Act obligations. All accessible disturbed areas outside of the pit voids will be rehabilitated. Rehabilitation practices include application of topsoil or an alternative growth medium where available, and spreading native seed of local provenance with the aim of creating self-sustaining ecosystems.

The area around pit voids may be unstable as pit walls are expected to collapse over time, and inadvertent public access will be restricted by the use of physical barriers (e.g. abandonment bunds). Strategies for managing safety risks will be developed as the site approaches closure, but will need to consider the potential for ongoing public access resulting from a portion of the mining area being underlain by pastoral stations and the access requirements of the local Traditional Owner groups.

Closure Plan Checklist

The following table provides cross reference to the requirements of the Department of Mines and Petroleum / Environmental Protection Authority *Guidelines for Preparing Mine Closure Plans* (2015).

	Mine closure plan (MCP) checklist	Y/N/NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
1	Has the Checklist been endorsed by a senior representative within the operating company?	Y	viii				
Public Availability							
2	Are you aware that from 2015 all MCPs will be made publically available?	Y	NA				
3	Is there any information in this MCP that should not be publicly available?	N	NA				
4	If "Yes" to Q3, has confidential information been submitted in a separate document / section?	NA	Appendix C				
Cover page, table of contents							
5	Does the MCP cover page include: Project Title, Company Name, Contact Details (including telephone numbers and email address) Document ID and version number, Date of submission (needs to match the date of this checklist)	Y					
Scope and purpose							
6	State why the MCP is submitted (e.g. as part of a Mining Proposal, a reviewed MCP or to fulfil other legal requirement)	Y	1	To support the GPdo Hub environmental approval	Y		Inclusion of 4EE pit, 4W TSF and general updates
Project overview							
7	Does the project summary include land ownership details, location of the project, comprehensive site plans and background information on the history and status of the project?	Y	5-69		Y		Inclusion of 4EE pit, 4W TSF and general updates

Mine closure plan (MCP) checklist		Y/N/NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
Legal obligations and commitments							
8	Does the MCP include a consolidated summary or register of closure obligations and commitments been included?	Y	Appendix A		N		No new obligations
Stakeholder engagement							
9	Have all stakeholders involved in closure been identified?	Y	14		N		No new stakeholders
10	Does the MCP included a summary or register of historic stakeholder engagement been provided, with details on who has been consulted and the outcomes?	Y	Appendix B		Y		New entries
11	Does the MCP include a stakeholder consultation strategy to be implemented in the future?	Y	14		N		No change to strategy or process
Post mining land use(s) and closure objectives							
12	Does the MCP include agreed post-mining land use, closure objectives and conceptual landform design diagram?	Y	16, 17; 96; Appendix F		Y		Updated mine plan, new objective (pit lakes)
13	Does the MCP identify all potential (or pre-existing) environmental legacies which may restrict the post mining land use (including contaminated sites)?	Y	63		N		No new contaminated sites
14	Has any soil or groundwater contamination that occurred, or is suspected to have occurred, during the operation of the mine, been reported to DER as required under the <i>Contaminated Sites Act 2003</i> ?	Y	63		N		No new contaminated sites
Development of completion criteria							
15	Does the MCP include an appropriate set of specific completion criteria and closure performance indicators?	Y	18		Y		New objective (pit lakes)

Mine closure plan (MCP) checklist				Y/N/NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
Collection and analysis of closure data									
16	Does the MCP include baseline data (including pre-mining studies and environmental data)	Y	22 - 74 and Appendix C			Y			Inclusion of 4EE pit, 4W TSF and general updates
17	Has materials characterisation been carried out consistent with applicable standards and guidelines (e.g. GARD Guide)?	Y	31			N			No new characterisation completed
18	Does the MCP identify applicable closure learnings from benchmarking against other comparable mine sites?	Y	Appendix C			Y			New entries
19	Does the MCP identify all key issues impacting mine closure objectives and outcomes (including potential contamination impacts)?	Y	71			Y			Inclusion of 4EE pit, 4W TSF and general updates
20	Does the MCP include information relevant to mine closure for each domain or feature?	Y	92			Y			Updated domains and new TSF
Identification and management of closure issues									
21	Does the MCP include a gap analysis / risk assessment to determine if further information is required in relation to closure of each domain or feature?	Y	70 and Appendix D			Y			Updated risk assessment
22	Does the MCP include the process, methodology and has the rationale been provided to justify identification and management of the issues?	Y	70 and Appendix D			Y			Updated risk assessment

	Mine closure plan (MCP) checklist	Y/N/NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
Closure implementation							
23	Does the MCP include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	92		Y		Inclusion of 4EE pit, 4W TSF and general updates
24	Does the MCP include a closure work program for each domain or feature?	Y	92	To be refined prior to closure	Y		Inclusion of 4EE pit, 4W TSF and general updates
25	Does the MCP contain site layout plans to clearly show each type of disturbance as defined in Schedule 1 of the MRF Regulations?	Y	92	State agreement site not subject to MRF	Y		Inclusion of 4EE pit, 4W TSF and general updates
26	Does the MCP contain a schedule of research and trial activities?	Y	Appendix E		Y		New entries
27	Does the MCP contain a schedule of progressive rehabilitation activities?	Y	5	Indicative closure schedule provided in Table 1 and Table 2. Opportunities for rehabilitation assessed annually Other areas proposed for end of mine life.	Y		Inclusion of 4EE pit, 4W TSF and general updates
28	Does the MCP include details of how unexpected closure and care and maintenance will be handled?	Y	99		N		No change to strategy or process
29	Does the MCP contain a schedule of decommissioning activities?	N		To be refined prior to closure	N		No change to strategy or process
30	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	100	To be refined prior to closure	N		No change to strategy or process

	Mine closure plan (MCP) checklist	Y/N/NA	Page No.	Comments	Change from previous version (Y/N)	Page No.	Comments
Closure monitoring and maintenance							
31	Does the MCP contain a framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance?	Y	100	To be refined prior to closure	N		No change to strategy or process
Financial provisioning for closure							
32	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	102		N		No change to strategy or process
33	Does the MCP include a process for regular review of the financial provision?	Y	102		N		No change to strategy or process
Management of information and data							
34	Does the MCP contain a description of management strategies including systems and processes for the retention of mine records?	Y	103		N		No change to strategy or process

Corporate endorsement:

I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan is true and correct and addresses the relevant requirements of the *Guidelines for Preparing Mine Closure Plans* approved by the Director General of Mines, Industry Regulation and Safety.



James Davison

General Manager – Studies & Technology

Date: 19th September 2019

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Abbreviations

4EE	4 East Extension
ABA	Acid Base Accounting
AMD	Acid and/or Metalliferous Mine Drainage
ANC	Acid Neutralising Capacity
ANZECC	Australian and New Zealand Environment Conservation Council
AWT	Above Water Table
AEP	Annual Exceedance Probability
BIF	Banded Iron Formation
BOM	Bureau of Meteorology
BS	Black Shale
BWT	Below Water Table
CHMP	Cultural Heritage Management Plan
CPP	Central Processing Plant
DAWE	Department of Agriculture, Water and the Environment (Federal)
DBCA	Department of Biodiversity, Conservation and Attractions
DG	Dales Gorge
DER	Department of Environmental Regulation (Part of DWER)
DET	Detritals
DIR	Department of Industry and Resources
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines and Petroleum (now DMIRS)
DOR	Dolerite
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Lands and Heritage
DSI	Detailed Site Investigation
DWER	Department of Water and Environmental Regulation
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Authority (Part of DWER)
EP Act	Environmental Protection Act 1986 (WA)
ESP	Exchangeable Sodium Percentage
FFPP	Further Fines Processing Plant
FIFO	Fly-in Fly-out
FWZ	Footwall zone
GAI	Global Abundance Index
Ha	Hectares
HPB	High Phosphorous Brockman
HYD	Hydrated Zone

IBRA	Interim Biogeographic Regionalisation for Australia
ILUA	Indigenous Land Use Agreements
IOD	Indian Ocean Dipole
IODMS	Iron Ore Document Management System
JOF	Joffe
JTSI	Department of Jobs, Tourism, Science and Innovation
LoM	Life of Mine
LPB	Low Phosphorous Brockman
m ³	Meters cubed
mbgl	Meters below ground level
MCA	Minerals Council of Australia
MCS	Mount McRae Shale
MME	Marra Mamba East
MPA	Maximum Potential Acidity
Mg	Milligram
ML	Million litre
Mm ³	Million meters cubed
mRL	Metres above Relevant Level (Sea Level)
MS	Ministerial Statement
MTS	Mt Sylvia Formation
NAF	Non-acid forming
NLC	North Lobe Creek
NPR	Neutralisation Potential Ratio
NVCP	Native Vegetation Clearing Permits
OEPA	Office of the Environmental Protection Authority
OoM	Order of Magnitude
PA	Participation Agreement
PAF	Potentially Acid Forming
PCO	Present Closure Obligation
PEC	Priority Ecological Community
PFS	Pre-feasibility study
PMP	Probable Maximum Precipitation
PMP-F	Probable Maximum Precipitation - Flood
PSI	Preliminary Site Investigation
RL	Relative Level
RQA	Rehabilitation Quality Assessments
SCARD	Spontaneous Combustion and Acid Rock Drainage
TEC	Threatened Ecological Community

TPC	Total Projected Closure
TSF	Tailings storage facility
WD	Wittenoom Formation-Dolomite
WF	Wittenoom Formation
WG	Wyloo Group
WS	Whaleback Shale
WW	Weeli Wolli
YAC	Yinhawangka Aboriginal Corporation
YS	Yandicoogina Shale
ZOI	Zone of Instability

PURPOSE AND SCOPE

1 Purpose

Planning for closure of a site is a critical business process that demonstrates Rio Tinto's commitment to sustainable development. This closure plan has been prepared in accordance with the Department of Mines, Industry, Regulation and Safety (**DMIRS**) / Environmental Protection Authority (**EPA**) *Guidelines for Preparing Mine Closure Plans* (2015).

This closure plan encompasses all mining activities within the Paraburdoo mining operation and has been updated to achieve the following goals:

- to support an application under Part IV of the *Environmental Protection Act 1986 (WA)* (**EP Act**) for the Greater Paraburdoo Iron Ore Hub, the scope of which includes the expansion of existing operations and the development of new pits at Paraburdoo;
- to meet the internal requirements of the Rio Tinto Closure Standard (2015) mandated for all Rio Tinto businesses;
- to reflect the current knowledge and requirements for closure of the Paraburdoo mine, and identify future requirements to continue to progress towards a planned and managed closure of the site; and
- to ensure that the closure provisions for the site remain current.

2 Scope

This plan covers closure of the Paraburdoo deposits and has been delineated by the following tenure and other boundaries:

- Mining Lease 246SA (AML70/00246) granted under the *Iron Ore (Hamersley Range) Agreement Act 1968 (Paraburdoo)* (**Paraburdoo State Agreement**);
- *Mining Act 1978 (WA)* (**Mining Act**) tenure issued pursuant to the Paraburdoo State Agreement:
 - G4SA (AG70/00004) issued for further fines;
 - G5SA (AG70/00005) issued for Kurra Kulli camp;
 - G14SA (AG70/00014) issued for Paraburdoo tailings;
 - G47/01254 issued for Paraburdoo waste dump extension;
 - Miscellaneous licence L47/00326 issued for Paraburdoo landfill;
 - Miscellaneous licence L47/00130 issued for the Paraburdoo gas pipeline;
- *Land Administration Act 1997 (WA)* (**Land Administration Act**):
 - Lease N104722 issued for the industrial area;
 - Lease N104723 issued for the plant area;
 - Lease N104470 issued for the Paraburdoo construction camp;
 - Lease N104474 (portion to mine site only) issued for Paraburdoo water main;
 - Lease N104193 issued for Paraburdoo borefield;
 - Easement L478326 issued for Turee Creek and Channar borefields (production and monitoring bores) which are located to the south of Channar mine and supply water to Channar, Eastern Range and Paraburdoo mine sites;
 - Two communication towers located on the Channar and Eastern Range mine sites which operate the borefields; and
 - Lease I206646 Tom Price to Paraburdoo railway.

The plan excludes the following:

- other nearby mining areas and deposits including Eastern Range, Channar and Western Range, which are subject to separate closure plans;
- potential future deposits within the Paraburdoo area that are not included in the Part IV application currently under assessment;
- exploration areas and exploration infrastructure as these will be rehabilitated as part of exploration activities;
- Lease I213357 Paraburdoo town and related infrastructure required by the town;
- Lease L215248 Mt Misery Communications infrastructure;
- Lease N104471 Town Sewerage Treatment Plant;
- Lease N104721 Paraburdoo Airport;
- Lease N104473 Paraburdoo Water Tanks;
- Lease I123646 Paraburdoo Powerline;
- Lease N104474 (portion to town site only) issued for Paraburdoo water main;
- Lease I163654 overland conveyor (which is included in the Channar and Eastern Range closure plans);
- Lease N104472 the Paraburdoo Greenbelt;
- the mainline rail;
- the proposed Western Range overland conveyor that transports ore from Western Range to Paraburdoo mine. This aspect is currently under evaluation and may or may not be built;
- proposed haul roads and other service corridors that may be built for Western Range; and
- the access road located to the east of the mine and dividing Eastern Range and Paraburdoo as this road is subject to the Eastern Range closure plan.

This method of assigning scope and footprint varies from the process normally adopted for closure plans, which is aligned more neatly to tenure boundaries and has been adopted to better align closure aspects to the future use or timing of the mining area that utilises the asset. This needs to be considered for future closure planning processes and a review of the footprint in future closure plan iterations undertaken to confirm it remains appropriate. The footprint boundary and associated tenure is depicted in Figure 1.

In terms of considerations, community impacts are not within the scope of this closure plan. A Pilbara town strategy is currently under development. Once finalised, the strategy will inform the future town planning strategies.

This closure plan supersedes all previous closure, and decommissioning and rehabilitation plans for the Paraburdoo mine.

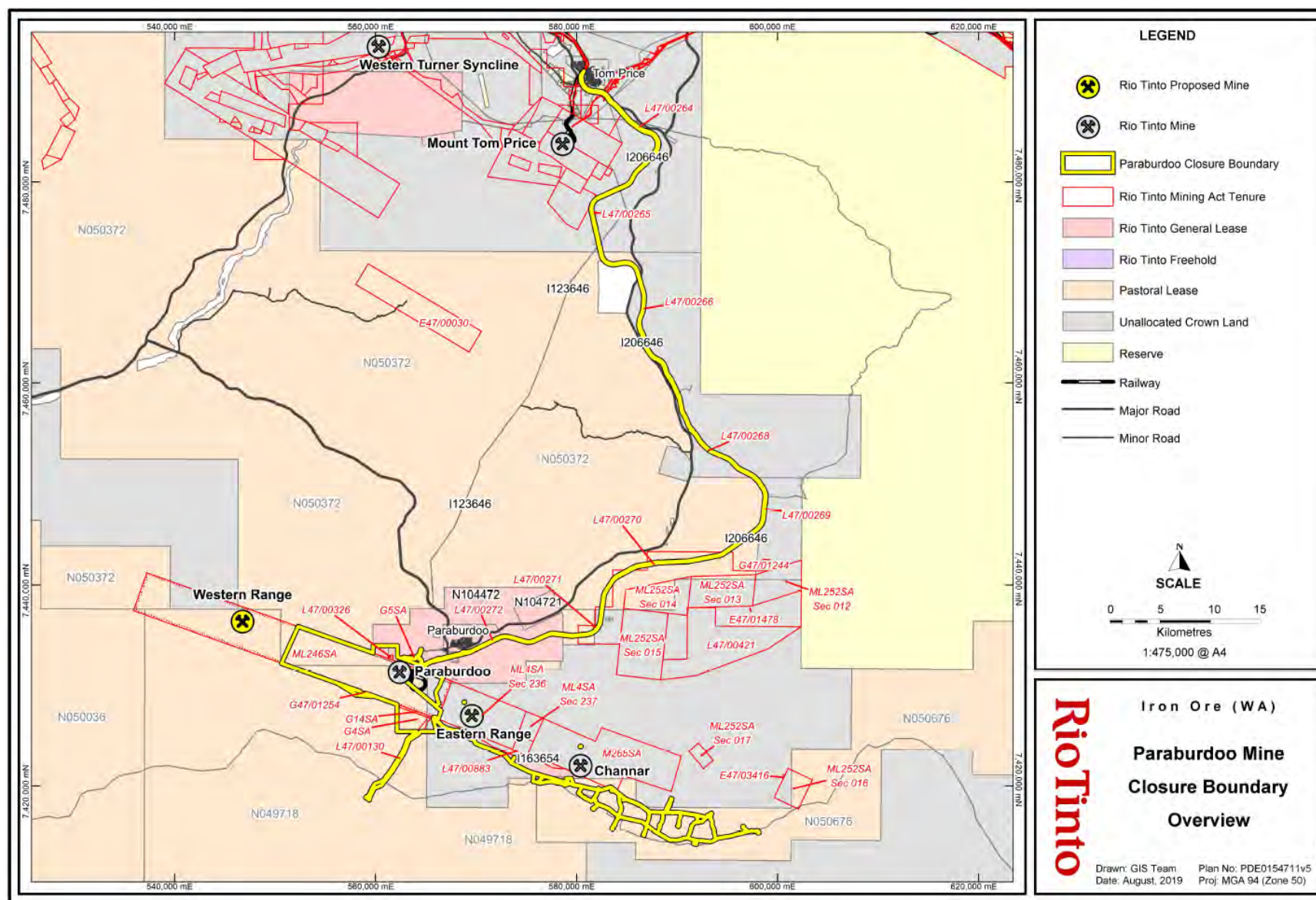


Figure 1: Paraburdoo closure plan scope area (yellow outline)

2.1 Closure planning process

Closure planning is an iterative process that commences during the planning phase of mine development and is regularly updated and refined during the operational phase (Figure 2). Closure plans are updated to account for changes resulting from:

- amendments to the mine plan;
- improvements of the site closure knowledge base (e.g. through daily activities, technical studies and research actions, progressive rehabilitation);
- new or amended regulation;
- changes to surrounding land uses; and
- evolving stakeholder expectations.

The review brings specialists together to discuss current performance, proposed mine changes and opportunities to improve closure outcomes. At the end of the review, improvement actions are assigned and the closure plan is updated.

A key output of closure planning is the development of a closure cost estimate. Closure provisions are subsequently integrated into our business planning processes to ensure funds will be available to close the site effectively.

The detail of each closure plan increases as the knowledge base develops. When the site approaches scheduled closure, studies will be completed to define how infrastructure, decontamination, rehabilitation, the workforce and communications will be managed throughout the mine closure period (and beyond). Stakeholder engagement and endorsement of completion criteria is conducted at this time.

In the final closure plan, location specific management plans are provided for each closure domain. These detailed plans cover the physical closure, dismantling and subsequent rehabilitation implementation requirements. The supporting technical reports that have been used to predict the post-closure outcomes are appended to the final closure plan.

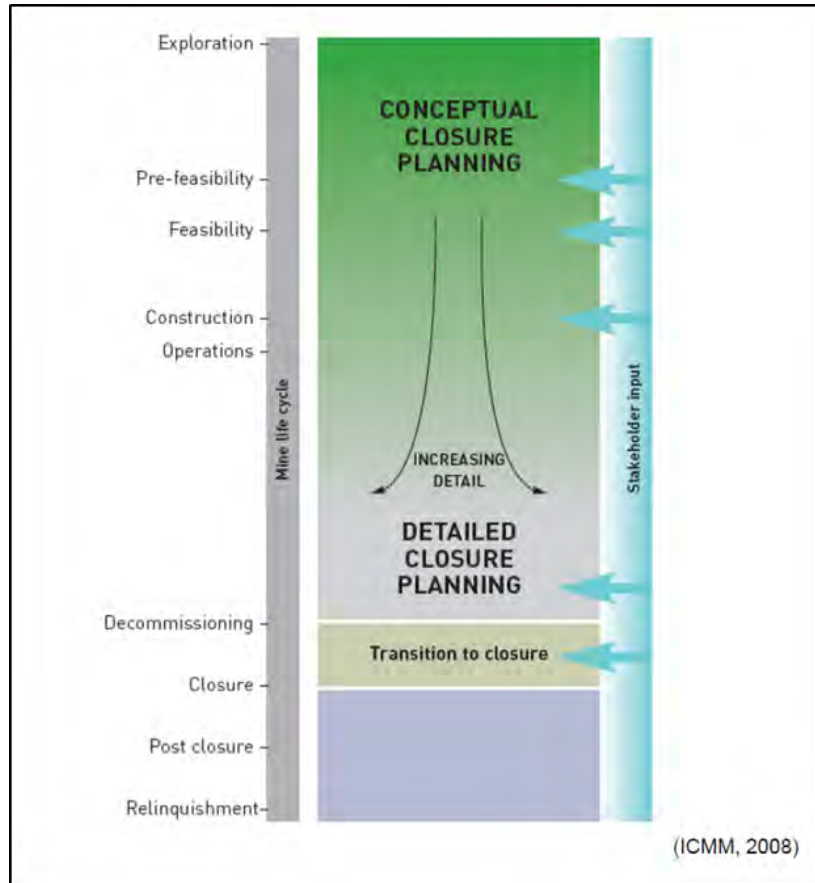


Figure 2: Progression of closure planning

PROJECT OVERVIEW

3 Description of the operation

3.1 Ownership

The Paraburdoo mine is operated by the Rio Tinto Iron Ore group (hereafter referred to as Rio Tinto) and is 100% owned by Hamersley Iron Pty Ltd, which is wholly owned by Rio Tinto Limited. The site is not subject to any Joint Venture arrangements.

3.2 Location

The Paraburdoo mine is located in the Pilbara region of Western Australia, approximately 5 km south west of Paraburdoo town, and 55 km south-southwest of the town of Tom Price (Figure 3). The mine falls within the local authority of the Shire of Ashburton. It is in a relatively remote region of the State with the nearest town being Paraburdoo. The mine is located within the traditional lands of the Yinhawangka People (Figure 4) and the nearest Aboriginal community is located at Bellary Springs which is approximately 30km from the town of Paraburdoo.

As described in the Greater Paraburdoo Iron Ore Hub Proposal, the Paraburdoo mine in combination with two other mine sites (Eastern Range and Western Range (proposed)) are referred to as the Greater Paraburdoo Iron Ore Hub. The Channar mine is also located nearby but is not part of the Part IV proposal. The Paraburdoo mine is the ore processing hub for the Paraburdoo, Eastern Range and Channar mine sites. Eastern Range mine site lies approximately 6 km to the east and Channar mine is situated approximately 20 km east of the Paraburdoo Central Processing Plant (**CPP**). The Western Range deposits are located to the west of the CPP at a distance of approximately 12 km.

Tenure associated with the Paraburdoo operational area is shown in Figure 5 and detailed in Section 2. The mining area is located on State Agreement Mining Lease 246SA and is underlain predominantly by the pastoral leases Mininer Pastoral Station (N049718) and Rocklea Pastoral Station (N050372) as presented in Figure 6. Turee Pastoral Creek Station (N050676) underlies the Turee Creek production borefield. Rocklea Station is currently leased and managed by Hamersley Iron (a subsidiary of Rio Tinto) and is used for cattle grazing activities. Mininer and Turee Creek Pastoral Stations are leased and operated by third parties external to Rio Tinto. A small portion of the mining area located to the east is underlain by vacant crown land.

Aside from the operating Rio Tinto mine sites of Eastern Range and Channar, several live exploration tenements are located adjacent to the Paraburdoo mining lease, however development of these leases is not considered within this closure plan.

3.3 Mine operations

The mine commenced operations in 1972 in the 4 West pit (4W). It is an open cut operation utilising conventional drill-and-blast and load-and-haul mining methods. Ore is processed on site before being transported from Paraburdoo via the rail line to the Cape Lambert and Dampier Ports for shipping. The existing pits at Paraburdoo consist of 11 West (11W), 5 West (5W), 4 West (4W), North Lobe Creek (NLC), 4 East (4E) and 18 East (18E). For the purpose of simplicity, existing pit stages 4EMX, 4EX3 and 4E have been collectively grouped and called 4E pit. Included in the scope of the Part IV proposal are new pits; 27 West (27W), 20 West (20W), 14-16 West (14-16W) and the cut-back extension of the existing 4E pit, known as 4 East Extension (4EE). This layout is presented in Figure 7.

This Closure Plan has been developed to support the Greater Paraburdoo Hub Proposal referred under Section 38 (s38) of the *Environmental Protection Act 1986 (EP Act)* that includes the development of a new mine at Western Range and the extension of existing operations at Paraburdoo (27W, 20W, 14-16W and 4EE) and Eastern Range (42EE and 47E). This closure plan considers the entire Paraburdoo mine, hence a significant proportion of the plan covers operational areas that are not within the scope of the Proposal subject to assessment under Part IV of the EP Act.

The current central case mining schedule is presented in Table 1. The scheduled completion of ex-pit mining is in 2039, but should be considered indicative only, particularly regarding completion years.

The mine schedules and plans are subject to regular review to ensure optimised performance of the operations and are therefore subject to change.

It is also important to consider the other nearby mining operations and deposits of Channar, Eastern Range and Western Range as they rely on the same infrastructure network as the Paraburdoo processing plant. With this in mind it is possible that mining in the Paraburdoo pits may be complete whilst the processing facilities and tailings systems remain in operation. Western Range is in the pre-feasibility stage and subject to Rio Tinto and Regulatory approval.

Table 1: Indicative mining schedule

Pit	Commencement	Completion	Description	PAF or Inert	Status
4W	1972	2021	BWT	PAF	Active
5W	2012	2015	AWT	Inert	Inactive
11W	1997	2023	AWT	Inert	Active
14-16W	2021	2023	AWT	Inert	Proposed
20W	unknown	unknown	AWT	Inert	Conceptual
27W	unknown	unknown	AWT	Inert	Conceptual
NLC	2014	2021	BWT	Inert	Active
4E	1972	2023	BWT	PAF	Active
4EE	2021	2039	BWT	PAF	Proposed
18E	1997	2007	AWT	Inert	Inactive

Note: Above Water Table (**AWT**), Below Water Table (**BWT**) and Potentially Acid Forming (**PAF**)

Significant waste rock volumes will be permanently stored in waste dumps. Low grade ore is stockpiled on site and for the purposes of this plan it has been assumed these stockpiles will remain on closure and be rehabilitated. The key waste landforms associated with the mine are shown in Table 2. The proposed construction and rehabilitation design criteria for these landforms are included in Appendix F.

Iron ore from Paraburdoo, Channar and Eastern Range is crushed and processed through the Paraburdoo processing plant. Iron ore from the proposed Western Range deposits will also be crushed and processed through the Paraburdoo processing plant.

Inert waste fines generated from processing are sent to the Tailings Storage Facility (**TSF**) which is located approximately 3 km to the south east of the processing plant. Furthermore, storage of tailings within the 4W pit is currently proposed and under Rio Tinto evaluation. This aspect is described in more detail in Section 18.

Table 2: Waste landform inventory

Landform	Type	Description	Status
4E_WD	Waste Dump	PAF	Rehabilitated*
4E_North_WD	Low Grade Stockpile	Inert	Active
4EX_WD	Waste Dump (In-pit)	PAF	Inactive
4EMX_WD	Waste Dump	Inert	Active*
4EE_WD	Waste Dump	PAF	Proposed
4EX3_South_WD	Waste Dump	PAF	Inactive*
18E_WD	Waste Dump	Inert	Inactive
4W_Main_WD	Waste Dump	Inert	Inactive
4W_WD01	Waste Dump	PAF	Active
4W_WD02	Waste Dump	Inert	Rehabilitated
4W_WD03	Waste Dump (In-pit)	Inert	Active
5W_WD01	Waste Dump	Inert	Partially Rehabilitated
5W_WD02	Waste Dump	Inert	Inactive
11W_WD	Waste Dump	Inert	Active
11W_BF	Waste Dump (In-pit)	Inert	Proposed
27W_WD	Waste dump	Inert	Proposed
NLC_WD01	Waste Dump	Inert	Active
NLC_WD02	Waste Dump (In-pit)	Inert	Proposed
TSF	Tailings Storage Facility	Inert	Active
4W In-pit TSF	Tailings Storage Facility (In-pit)	Inert	Proposed
4W_LB	Landbridge	Inert	Active
NLC_LB	Landbridge	Inert	Active
20W-27W_LB	Landbridge	Inert	Proposed
18E_LB	Landbridge	Inert	Active
4E_West_LB	Landbridge	Inert	Active
4E_East_LB	Landbridge	Inert	Active

Note: * existing waste dumps 4E_WD, 4EMX_WD and 4EX3_South_WD will be covered/partially covered in waste from 4EE pit and create a new waste dump called 4EE_WD.

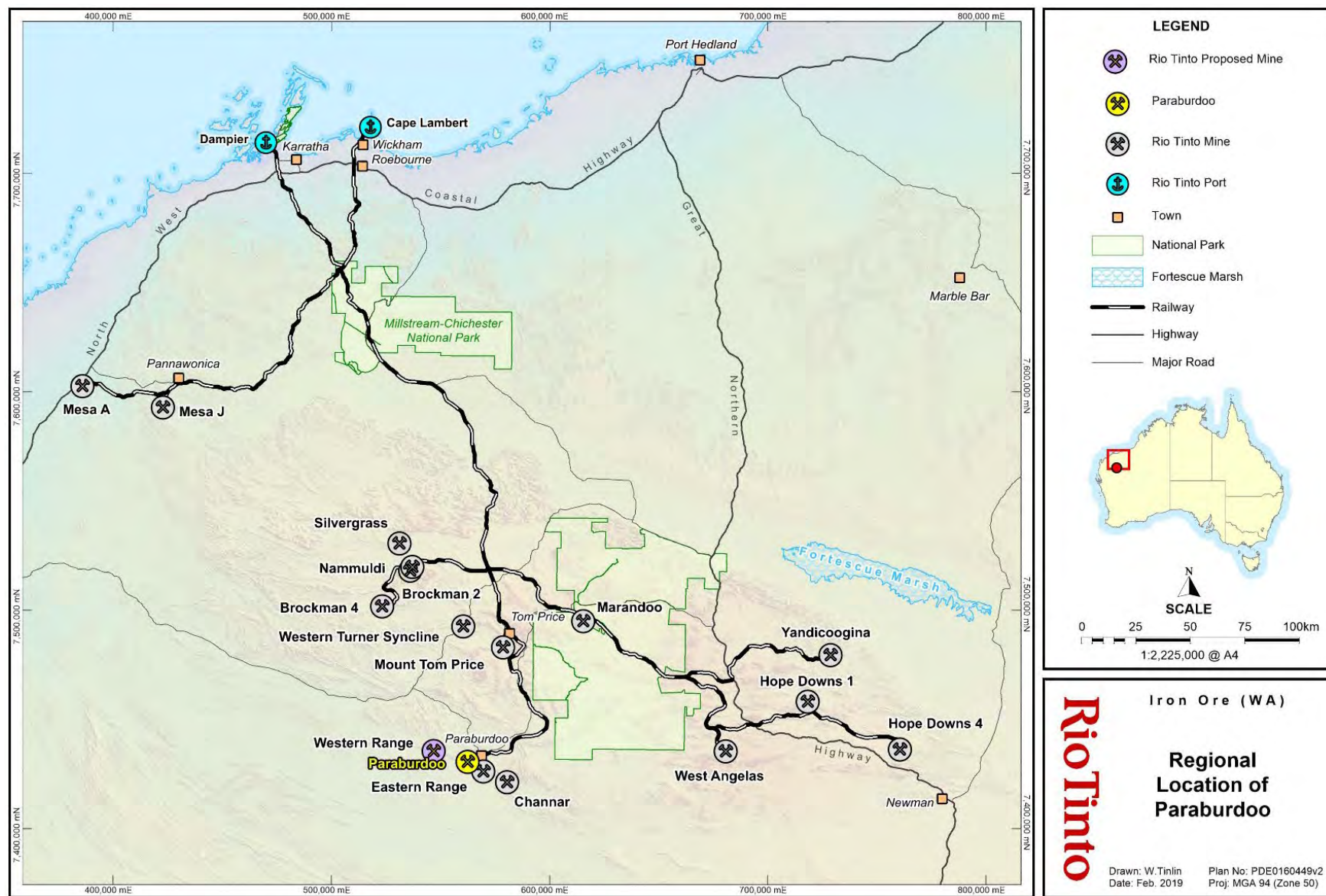


Figure 3: Regional location of the Paraburdoo mine

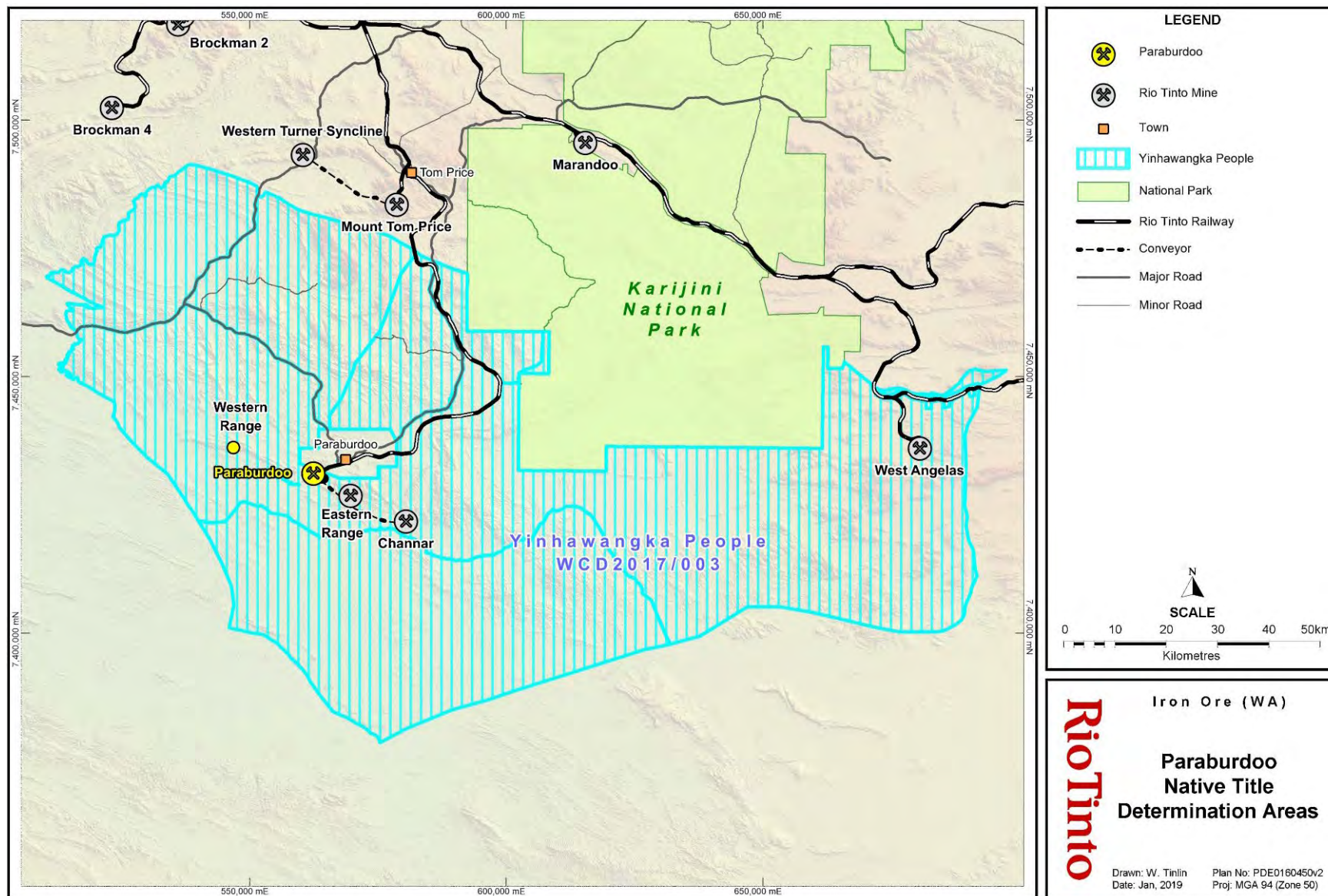
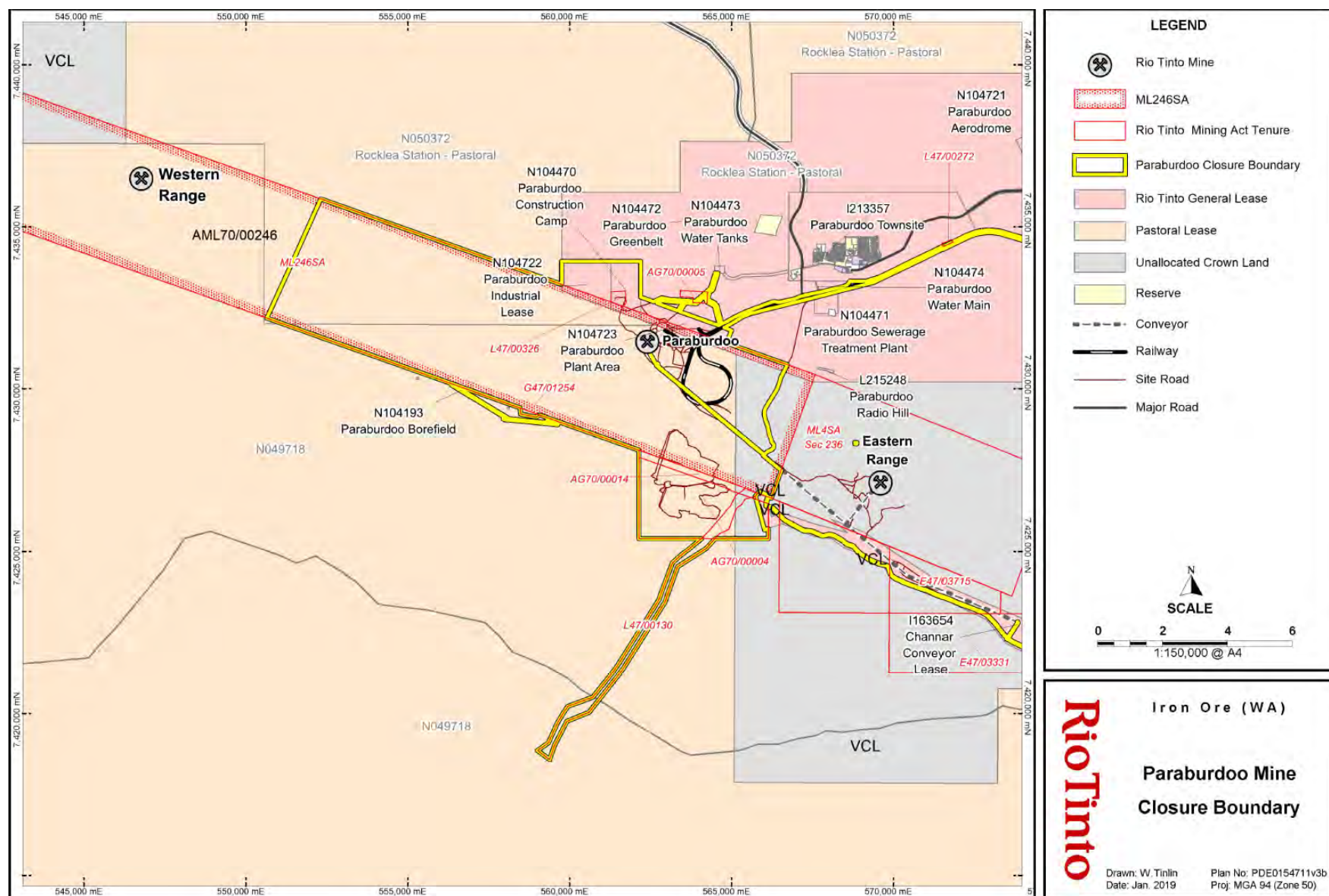


Figure 4: Paraburdoo Native Title determination areas



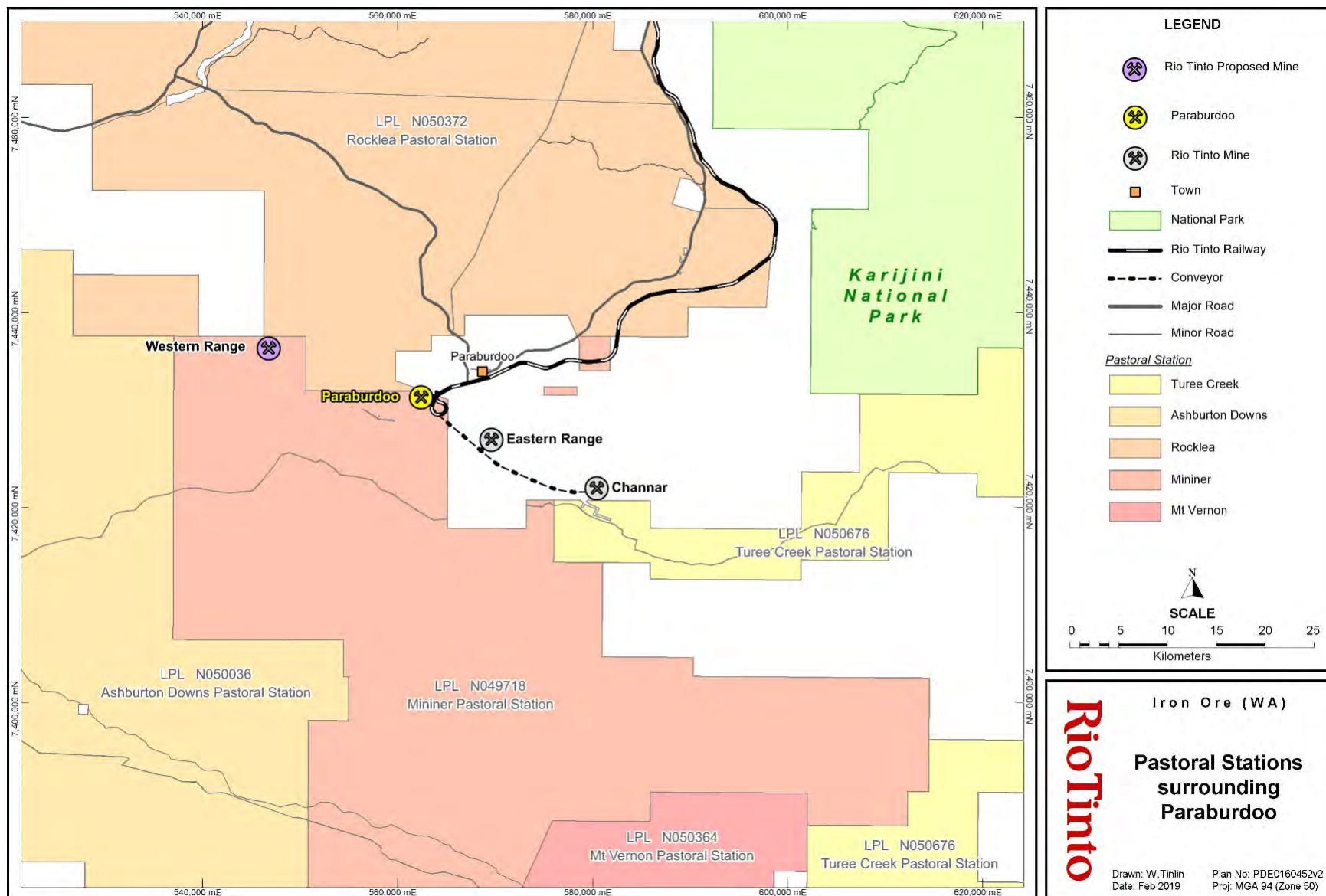


Figure 6: Pastoral stations surrounding Paraburdoo

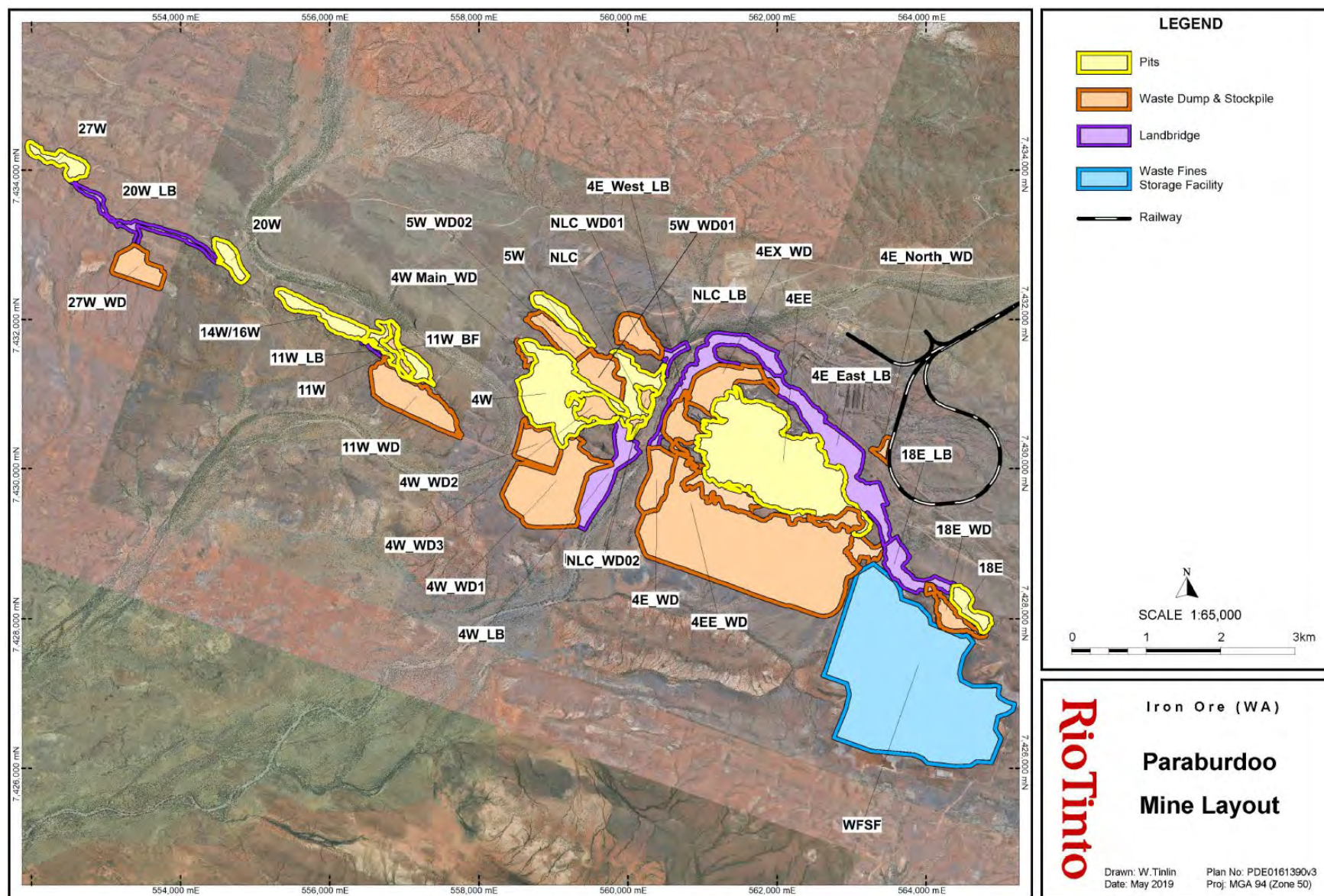


Figure 7: Paraburdoo indicative mine layout

IDENTIFICATION OF CLOSURE OBLIGATIONS AND COMMITMENTS

4 Legal obligations

A closure obligations register for Paraburdoo is presented as Appendix A. The register contains details of legal obligations and commitments from the following instruments:

- Iron Ore (Hamersley Range) Agreement Act 1963;
- Iron Ore (Hamersley Range) Agreement Act 1968 (Paraburdoo) , which is the Third Schedule of the *Iron Ore (Hamersley Range) Agreement Act 1963*;
- mineral leases and general purpose leases issued under the *Mining Act 1978* pursuant to the *Iron Ore (Hamersley Range) Agreement Act 1963* and *Mining Act 1978* miscellaneous licences;
- Land Administration Act 1997 special leases;
- Part V of the *Environmental Protection Act 1986* licence L5275/1972/12;
- relevant Native Vegetation Clearing Permits (**NVCP**) issued under Section 51 of the *Environmental Protection Act, 1986*; and
- Easement L478326 Turee Creek Borefield.

The register also identifies legislation, standards and guidelines that may not apply to Paraburdoo specifically, but that may be relevant to closure of mine sites generally.

It is assumed that the Health, Safety, Environmental and Quality Management System process utilised during operations will continue to be employed to govern closure implementation and the post-closure monitoring period prior to relinquishment.

This closure plan has been prepared in support of a referral under s38 of the EP Act. It is expected a Ministerial Statement will be issued for the Project (as part of the Greater Paraburdoo Iron Ore Hub Proposal), which will contain conditions relevant to the closure of Paraburdoo. These will be documented in the next iteration of the Paraburdoo Closure Plan.

At this stage it is assumed that the Health, Safety, Environmental and Quality Management System process utilised during operations will continue to be employed to govern closure implementation and the post-closure monitoring period prior to relinquishment.

STAKEHOLDER ENGAGEMENT

5 Stakeholder engagement

5.1 Engagement process

Stakeholder engagement is a key part of mine closure planning as it ensures that the expectations of stakeholders are understood by the mine operator and enables them to be considered and managed during the planning and implementation phase of closure. Rio Tinto has established processes for consultation with stakeholders, and these are imbedded in both the Rio Tinto *Closure Standard* (2015) and *Community and Social Performance Standard* (2015). These standards are aligned with principles from the Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia (ANZMEC/MCA, 2000). Consultation commences at appropriate times during the early stages of exploration planning and will continue until the final relinquishment of the site.

As part of this process all potentially impacted stakeholders are identified and recorded in a register, a summary of which is shown in Table 3. This register is used to ensure relevant and timely communications are held with stakeholders across a broad range of topics relevant to the mining operations, including closure. This register is regularly reviewed and updated to maintain currency. Regular consultation is conducted with a wide range of stakeholders via a variety of forums, for example various State and Local Government agency briefing meetings and Traditional Owner consultation forums established under Indigenous Land Use Agreements. Discussions regarding closure and related activities are included in these meetings as appropriate. The level of closure specific content and detail will increase as closure approaches.

A communications register specifically for closure of Paraburdoo is maintained and a copy as at the time of writing is included in Appendix B. This register is used to ensure stakeholder feedback is tracked and monitored to ensure that appropriate actions are taken to address these issues in a timely manner. Stakeholder engagement has been undertaken for the Channar and Eastern Range Order of Magnitude (**OoM**) closure studies and other Rio Tinto Pilbara mines, aspects from this engagement that are relevant to closure at Paraburdoo have been included in this register.

Table 3: Paraburdoo key stakeholder list

Category	Stakeholder
Commonwealth	<ul style="list-style-type: none"> • Department of Agriculture, Water and the Environment (DAWE); • Civil Aviation Safety Authority
State	<ul style="list-style-type: none"> • Department of Water and Environmental Regulation (DWER) • Department of Mines, Industry Regulation and Safety (DMIRS) • Department of Jobs, Tourism, Science and Innovation (JTSI) • Department of Biodiversity Conservation and Attractions (DBCA) • Department of Planning, Lands and Heritage (DPLH) • Department of Primary Industries and Regional Development • Department of Health
Local	<ul style="list-style-type: none"> • Shire of Ashburton • WA Police – Pilbara • Main Roads • Western Power/Horizon • Pilbara Development Commission • WA Country Health Services
Community	<ul style="list-style-type: none"> • Yinhawangka group • Yinhawangka Aboriginal Corporation (YAC) • Mininer and Rocklea Pastoral Stations owners/managers • Paraburdoo residents • Bellary Springs residents
Internal	<ul style="list-style-type: none"> • Rio Tinto Iron Ore employees and contractors

POST-MINING LAND USE AND CLOSURE OBJECTIVES

6 Land use

6.1 Historical land use

The lands surrounding the mine are the traditional lands recognised as belonging to the Yinhawangka People. Determination of native title for the Yinhawangka People occurred on 18 July 2017 when they were formally recognised as native title holders by the Federal Court of Australia. Since European settlement, land uses in the region have included cattle grazing, exploration, mining and conservation. Aside from mining activity and associated infrastructure, the Paraburdoo area is largely undeveloped. Pastoral activity in the region has historically been limited to grazing of cattle. The Paraburdoo mine footprint is generally on areas of rugged terrain of low pastoral land value and as such, cattle were not grazed or mustered directly in the Paraburdoo area prior to mining. There are other mines currently operating in the immediate vicinity, these being Eastern Range and Channar mines.

6.2 Proposed post-mining land use

Options for post-mining land use are limited in the Pilbara region, with mining and pastoralism the only industries that have historically proven viable. Inland regions are sparsely populated, with the largest inland towns (such as Tom Price, Paraburdoo and Newman) established specifically to support the mining industry. Beneficial uses for the mining area (e.g. recreation or aquaculture) that might have potential in areas supported with a higher population base are unlikely to be viable.

The proposed post-mining land use assumes that the site will be rehabilitated to create a safe, stable and non-polluting landscape vegetated with native vegetation of local provenance, to maximise environmental and cultural heritage outcomes and ensure the site minimises adverse impacts on the surrounding land use. The post-mining land use will be determined prior to closure during final planning phases and in consultation with relevant stakeholders.

Due to the nature of the mining activity undertaken, the final landform will include large voids, pit lakes and waste dumps, and will therefore present challenges for effective pastoral operations. However, it is recognised that surrounding flat areas are likely to remain subject to pastoral activity and that Paraburdoo closure needs to be undertaken in such a manner that minimises impacts to surrounding land uses.

7 Closure objectives

7.1 Rio Tinto vision for closure in the Pilbara

Closure objectives have been developed with consideration of Rio Tinto's general vision for closure, which is to:

- relinquish its mining leases to the Western Australian State Government;
- preserve, protect and manage the cultural heritage values of the area in cooperation with the Traditional Owners and other stakeholders;
- develop and implement strategies for closure which consider the implications on local communities;
- achieve completion criteria which have been developed with stakeholders and agreed with the West Australian State Government;
- develop landforms that are safe, stable and compatible with the surrounding environment and post-mining land use;
- achieve environmental outcomes that are compatible with the surrounding environment;

- implement a workforce strategy which addresses the impacts of closure on employees and contractors; and
- achieve successful closure in a cost effective manner.

7.2 Paraburdoo closure objectives

The ultimate goal of mine closure at Paraburdoo is to relinquish the site to the State Government. This goal can be achieved once the government and community agree that the condition of the site is compatible with the agreed post-mining land use. Closure objectives reflect the aspects of closure that the government and community stakeholders have indicated are key to evaluating the site condition. They do not represent the full range of issues that need to be addressed upon closure; rather they represent the key objectives against which the ability to relinquish will be assessed.

Closure objectives were included as part of the 2018 Closure Plan which was submitted to the Department of Jobs, Tourism, Science and Innovation (**JTSI**) in October 2018. One change has been made with the addition of an objective related to pit lakes, which is linked to the expansion of the 4EE BWT pit (Table 4). Due to the early stage of closure these objectives have yet to be agreed with key stakeholders and are likely to evolve in future versions of this plan as knowledge of closure issues progresses and detailed closure discussions commence. Indicative completion criteria and measurement tools have been drafted for each of these objectives, and are discussed further in Section 8.

Table 4: Paraburdoo closure objectives

Number	Closure objectives
1	Cultural heritage values have been preserved where possible.
2	Public health and safety hazards have been appropriately managed.
3	Contamination ¹ risks have been appropriately managed.
4	The final landform ² is stable and considers hydrological factors.
5	Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use.
6	Surface water flows of the Seven Mile and Pirraburdu Creeks have been maintained.
7	Pit lakes do not result in a significant ecological impact.
8	Infrastructure has been appropriately managed.

¹ Contamination – in relation to land, water or a site, means having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value.

² 'Landform' includes all post-mining constructed features; waste dumps, tailings storage facilities, abandonment bunds and mine voids.

COMPLETION CRITERIA

8 Completion criteria

Completion criteria are defined as the indicators used to determine whether closure objectives have been met. They are used to measure the success of closure implementation against objectives, and to facilitate relinquishment of mining tenure.

Indicative completion criteria (Table 5) have been developed in consideration of the predicted closure outcomes. Measurement processes, and the associated supporting data (evidence and / or metrics), that could be used to evaluate closure success are also described in Table 5.

The completion criteria are subject to ongoing review and update, informed by the outcome from studies, monitoring and ongoing stakeholder consultation. The completion criteria contained in this plan should be considered indicative only. As the site approaches scheduled closure, the completion criteria will contain more measurable and time-bound parameters.

Table 5: Indicative completion criteria

Objective	Indicative completion criteria	Verification process/method	Evidence
Cultural heritage values have been preserved where possible.	<ul style="list-style-type: none"> • Safe access to sites of cultural significance has been implemented in consultation with key stakeholders. • Key heritage sites have not been impacted by closure implementation. • Closure strategies have been developed in consultation with Traditional Owner representatives. • The final landform is deemed suitable from a visual amenity perspective. 	<ul style="list-style-type: none"> • Designated access pathways have been identified and communicated. • Abandonment bund restriction areas are communicated. • Heritage survey, ethnographic survey and/or site inspection confirms heritage sites of significance have not been impacted. • Stakeholder consultation. • Visual impact assessment. 	<ul style="list-style-type: none"> • Maps of designated access pathways. • Maps of abandonment bund locations and restriction areas. • Heritage and ethnographic survey report. • Consultation register. • Visual impact assessment report.
Public health and safety hazards have been appropriately managed.	<ul style="list-style-type: none"> • Health and safety risks have been identified. • Measures to mitigate the identified public safety and human health hazards have been agreed with key stakeholders and have been implemented. • Transfer of any residual liabilities is agreed with stakeholders. 	<ul style="list-style-type: none"> • Risk assessment conducted and mitigation actions implemented. • Relevant stakeholders have been engaged on risk mitigation measures to be employed. • Independent audit(s)/review to confirm that hazard mitigation measures have been implemented. • Process for transfer of residual liabilities is documented. 	<ul style="list-style-type: none"> • Risk assessment report. • Audit report to confirm effectiveness of controls. • Records of stakeholder engagement. • Liability transfer agreement/s.
Contamination risks have been appropriately managed.	<ul style="list-style-type: none"> • Requirements under the <i>Contaminated Sites Act 2003 (WA)</i> have been met for the identification, recording, management, remediation and transfer of any contaminated sites as appropriate. 	<ul style="list-style-type: none"> • The site has been appropriately assessed for the presence of suspected or known contaminated sites. • Suspected or known contaminated sites have been appropriately reported under the <i>Contaminated Sites Act 2003</i>. • Appropriate management measures to address contamination have been implemented. • Process for transfer of residual liabilities is documented. 	<ul style="list-style-type: none"> • Contaminated sites investigation report/s. • Reports submitted to DWER (if required). • Liability transfer agreement/s (if required).

Objective	Indicative completion criteria	Verification process/method	Evidence
The final landform is stable and considers hydrological factors.	<ul style="list-style-type: none"> Final landforms have been rehabilitated to design specifications derived from local climatic conditions and physical characterisation of the mineral waste types within them. There are no erosion features present that compromise landform integrity, and if present, erosion features are stable. The final landform was designed and constructed with consideration given to its stability during intense rainfall and large flood events. Final landforms are outside predicted zones of instability of pits. 	<ul style="list-style-type: none"> Rehabilitation monitoring program including quantitative evaluation of behaviour of rills and gullies (if required) over time. Analysis of aerial imagery to provide qualitative analysis of landform stability. Post-closure landform review to confirm that risks have been appropriately managed. Mineral waste physical characterisation. 	<ul style="list-style-type: none"> Rehabilitation monitoring results. Post-closure landform evaluation report. Remote sensing imagery assessment. Characterisation data and batter selector tool.
Vegetation on rehabilitated land is self-sustaining and compatible with the post-mining land use.	<ul style="list-style-type: none"> Seed used in rehabilitation works is of local provenance³. Native plants within rehabilitated areas are observed to flower and/or fruit. Recruitment of native perennial plants is observed. Species richness⁴ of native perennial plants within rehabilitated areas is not less than reference sites. Any weed species recorded within rehabilitation areas are present within the local area. 	<ul style="list-style-type: none"> Seed management procedures. Rehabilitation monitoring/site inspections. Analysis of historical monitoring data. 	<ul style="list-style-type: none"> Rehabilitation seed list. Seed database. Rehabilitation monitoring reports.
Surface water flows of the Seven Mile and Pirraburdu Creeks have been maintained.	<ul style="list-style-type: none"> Creek flows have been modelled and flood protection structures designed accordingly. Flood protection structures at the 4 West, 11 West, NLC and 4 East pits are effective in preventing the pits from intercepting creek flows. 	<ul style="list-style-type: none"> Flood modelling. Engineered design of flood protection structures. Flood protection structures inspection program. 	<ul style="list-style-type: none"> Flood modelling report. Flood protection structures design report. Flood protection structures inspection reports/photos.

3 Note: Some seed used in rehabilitation predates accurate recording of collection area. Note 2: Local for Paraburdoo based on the NVCP conditions is defined as from within a 200 km radius and within the same IBRA subregion of the area cleared.

4 Richness is defined as the number of different species in the defined area.

Objective	Indicative completion criteria	Verification process/method	Evidence
Pit lakes do not result in a significant ecological impact.	<ul style="list-style-type: none"> Pit lake water quality does not impact regional ecology 	<ul style="list-style-type: none"> Environmental monitoring Pit lake modelling 	<ul style="list-style-type: none"> Environmental monitoring and investigation reports Pit lake model validated using on-site monitoring data
Infrastructure has been appropriately managed.	<ul style="list-style-type: none"> Legal agreement to transfer residual liability completed (if required). Where transfer of liability is not established, infrastructure has been decommissioned and removed as appropriate. 	<ul style="list-style-type: none"> Appropriate agreements and transfer processes in place and communicated for any infrastructure remaining post-closure. Decommissioning and demolition. 	<ul style="list-style-type: none"> Agreements in place with party assuming liability for infrastructure. Close out report. Visual inspection.

COLLECTION AND ANALYSIS OF CLOSURE DATA

The closure knowledge database (Appendix C) is a collection of baseline studies, models and interpretations, which are used to inform the closure planning process presented in this closure plan. The knowledge may be specific to the site or generally applicable to the Pilbara region; and includes information on the performance of closure-related trials completed at other Pilbara mining operations (where appropriate). At this stage of the closure plan development, only summaries of these reports are provided and the relevant information has been included below. The relevant knowledge base reports will be included in the final closure plan.

9 Climate

Climate, particularly rainfall, rainfall intensity, cyclone frequency and evaporation influence closure planning aspects such as landform design and revegetation success.

The closest official Bureau of Meteorology (**BOM**) weather recording station is at Paraburdoo Airport (station 007185). Climatic information has been captured from this site since 1974. In addition to the BOM weather station, Rio Tinto maintains an automatic weather station at the Paraburdoo mine itself.

9.1 Climate and significant weather events

The climate in the area can be characterised as arid tropical with two distinct seasons, hot wet summers and cooler dry winters. Mean daily maxima temperatures range from 41°C in summer to 25°C in winter (Figure 8). Evaporation rates in the region greatly exceed rainfall, which is typical for similar climate conditions around Australia. Annual average pan evaporation rate is 3200-3600 mm/year, as shown in Figure 9.

The north/north-western coastline of Australia has experienced more tropical cyclones than anywhere else on mainland Australia. Most tropical cyclones are observed during the late summer, occurring between November and May. Tropical cyclones can produce damaging wind gusts in excess of 150 km per hour, with heavy rains resulting in regional flooding. Five tropical cyclones are expected off the coast of the Pilbara each year, with two expected to make landfall.

Precipitation is driven by summer cyclonic activity, with the months of September, October and November having the lowest average rainfall and January, February and March recording the highest average rainfall (Figure 10). Annual rainfall is also highly variable, as evidenced by historical data from 1974 to 2016 (Figure 11).

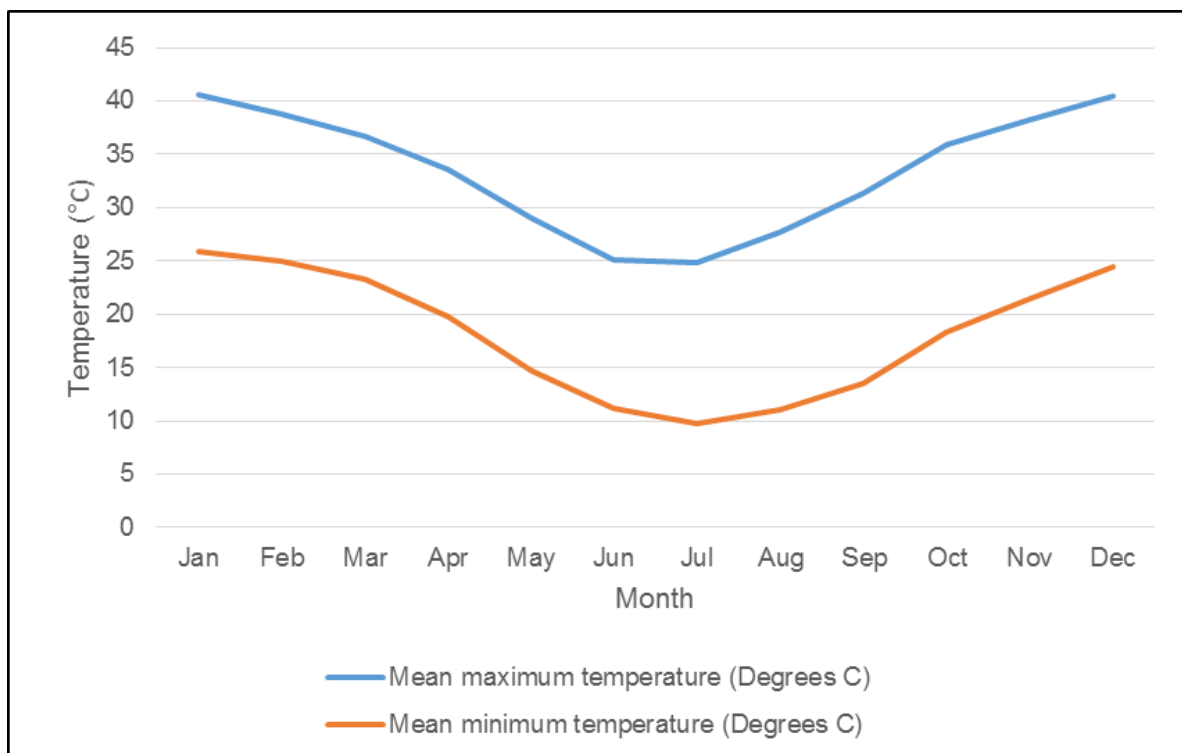


Figure 8: Mean monthly temperatures (degrees Celsius), Paraburdoo Airport 1996-2017⁵

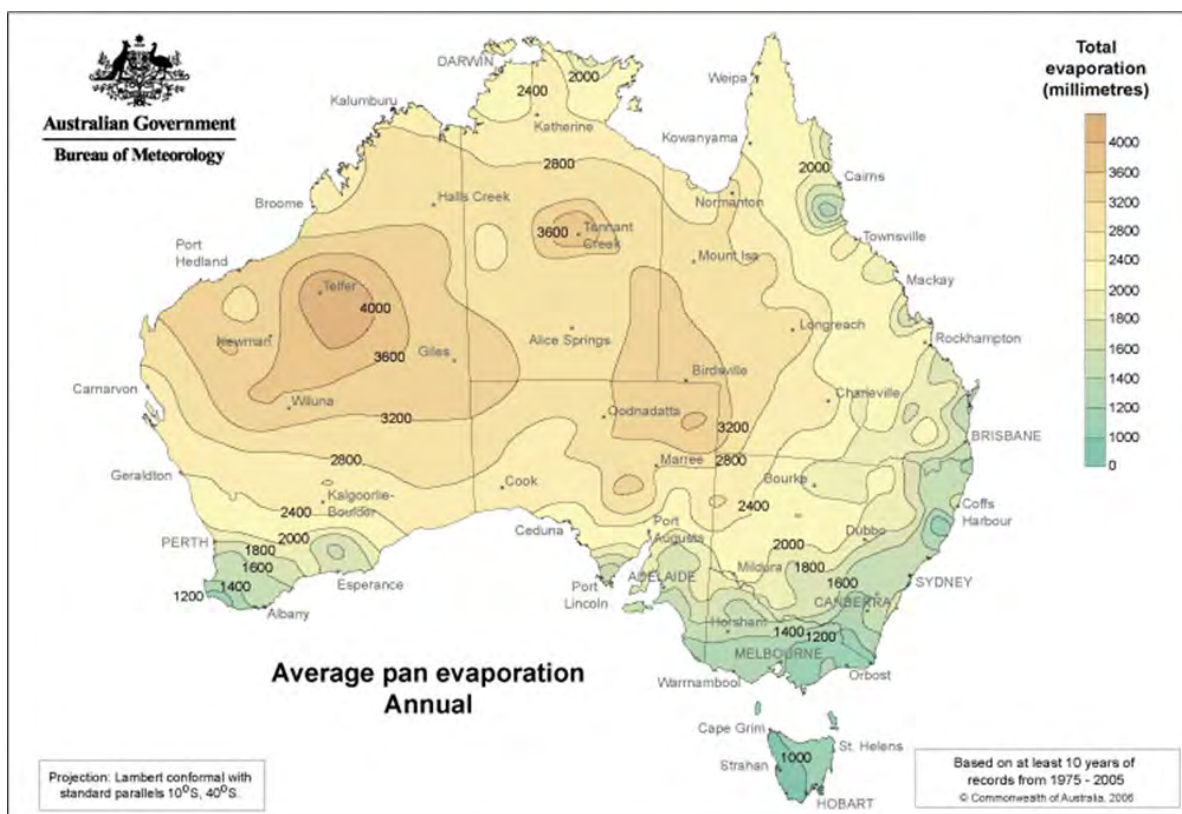


Figure 9: Annual average pan evaporation

⁵ Bureau of Meteorology, Paraburdoo Airport dataset, Accessed: 21 September 2017.

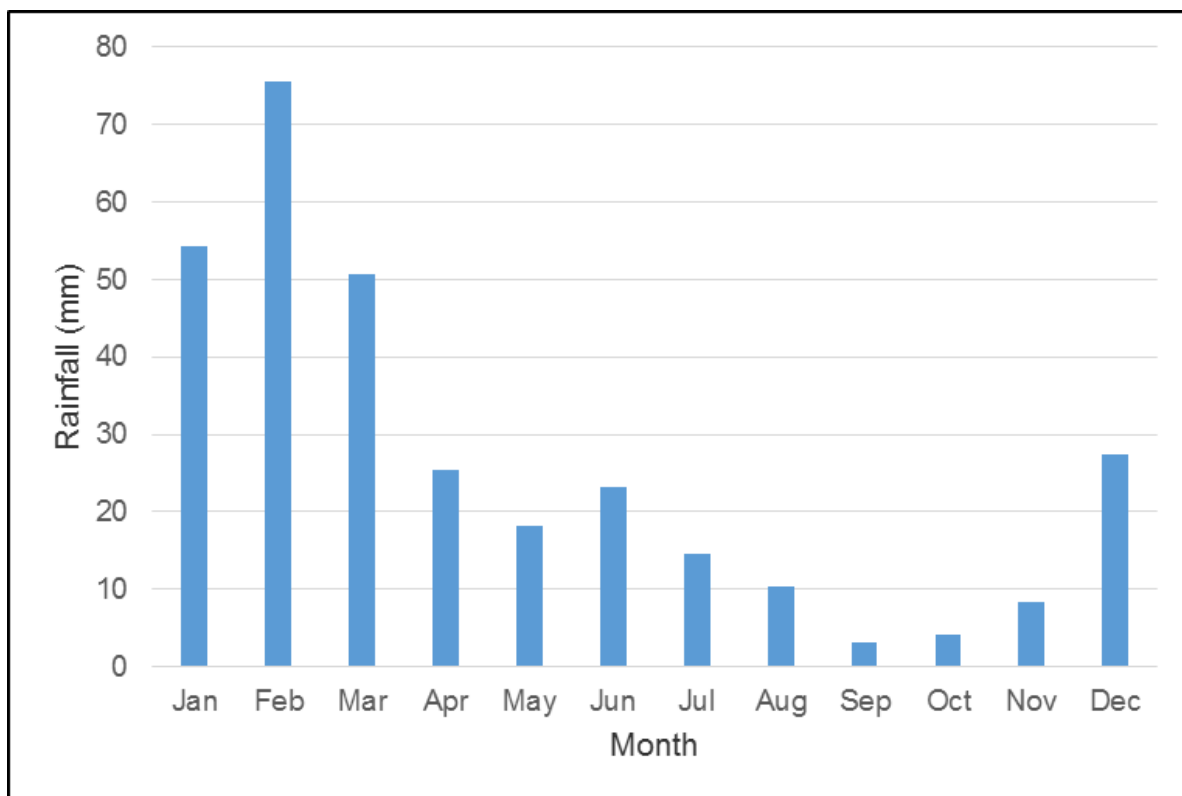


Figure 10: Mean monthly rainfall (mm), Paraburdoo Airport 1974 to 2017⁶

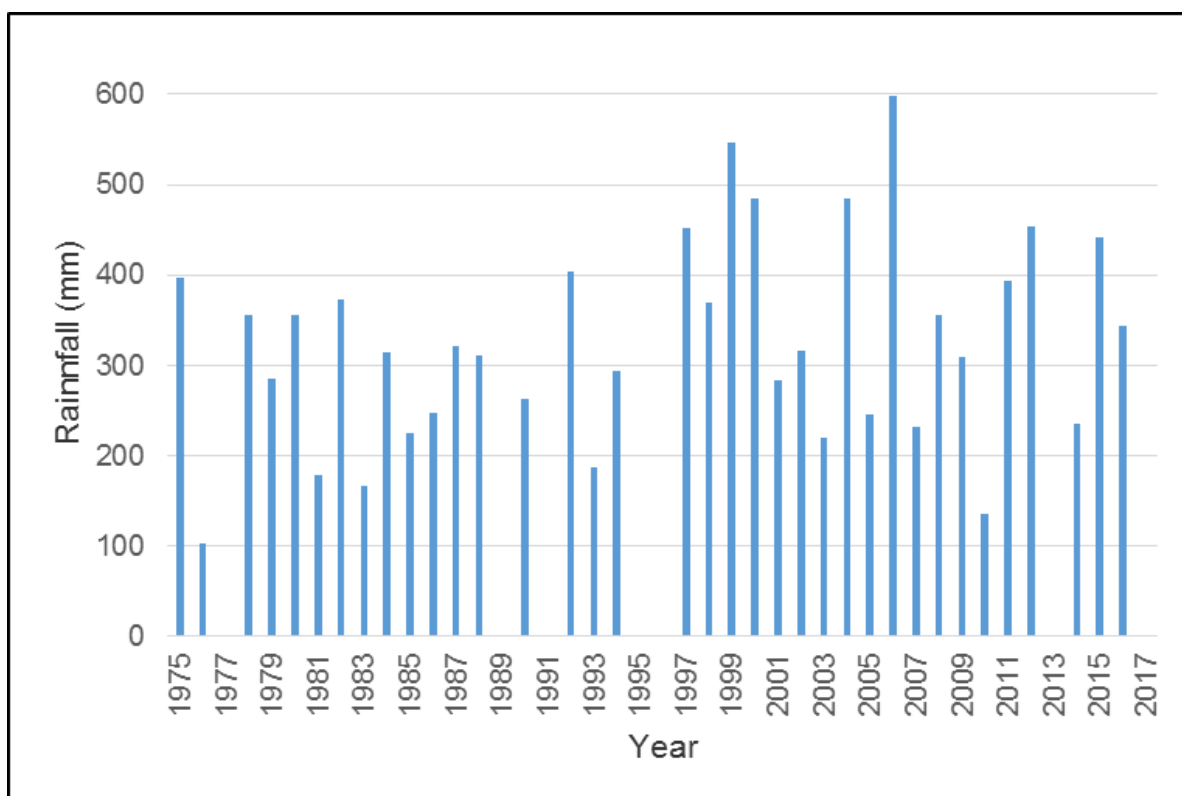


Figure 11: Historical annual rainfall (mm) from 1975 to 2016 at Paraburdoo Airport⁷

⁶ Bureau of Meteorology, Paraburdoo Airport dataset, Accessed: 21 September 2017.

⁷ Bureau of Meteorology, Paraburdoo Airport dataset, Accessed: 21 September 2017.

9.2 Climate and landform stability

The heavy, intense rainfall experienced in the Pilbara makes rainfall the key climatic factor that influences surface stability. Rainfall erosivity (measured in mega joule millimetre per hectare per hour per year - MJ.mm/ha/hr/yr) is the term used to describe the erosive force of rain. For Pilbara sites, long-term annual erosivity values range from ~1,000-1,600 MJ.mm/ha/hr/yr. Rainfall in the Pilbara is typically more erosive than Perth's rainfall, even though it only receives on average half the rainfall that Perth receives on an annual basis. For comparison, average annual erosivity values for Perth are ~1,000 MJ.mm/ha/hr/yr from an average of 780 mm of rain a year.

Rainfall erosivity is highly variable for each rainfall event. Studies of Pilbara rainfall concluded that at Tom Price, for example, erosivity for the period 1998 to 2009 ranged from 212 – 6,349 MJ.mm/ha/hr/yr. The most erosive year recorded was 2007 at Channar, where 421 mm fell during February (704 mm fell over the whole year). This singular rain period embodied 11,994 MJ.mm/ha/hr/yr of erosive force, or 89% of the entire erosivity of rain for that year. Given the pattern of intense and infrequent rainfall events in the Pilbara, it can be expected that only a few events every year (~1-3 events) will generate the majority of runoff and erosion of that occurs each year.

The studies showed a rapid decline in erosion or sediment yield occurs when annual rain decreases below about 300 mm per year due to a corresponding decline in rainfall volumes and rainfall erosivity. However, when annual rainfall increases above ~300 mm, vegetation growth increases and becomes increasingly effective in controlling soil erosion. Hence, there is a point of maximum erosion potential at an annual rainfall value of ~200-400 mm such that surface (vegetation) cover is low due to lack of rain and ineffective for controlling erosion, yet rainfall erosivity is sufficiently high to cause erosion, as observed in the Pilbara. Outcomes from these studies have informed development of the Rio Tinto Iron Ore (WA) Landform Design Guidelines for achieving stable waste dumps.

9.3 Climate and vegetation growth

Water is generally the limiting factor for plant growth in the Pilbara's arid environment. As a consequence of the hot temperatures, high evaporative demand and infrequent and irregular rainfall, much of the vegetation displays xeromorphic adaptations (plant structural adaptations for survival in dry conditions). These adaptations include the ability to regulate water loss from leaves, extract water from very dry soils and match reproductive strategies with wetter periods. Many species are ephemeral and persist in soil seed banks in between wetter periods.

The adaptive capacity of Pilbara species implies a degree of resilience to changes to hydrological regimes. However, the impacts to Pilbara vegetation as a consequence of climate change are not clear. Changes in vegetation density and water use will alter the amount of runoff that occurs after a rainfall event, which in turn will alter creek flows and groundwater recharge.

9.4 Climate change

The understanding of how climate will change in the future in the Pilbara is guided by the outcomes of climate modelling, commissioned privately by Rio Tinto and other Australian government agencies. The main climate drivers for the Pilbara are the El Niño Southern Oscillation (**ENSO**) and Indian Ocean Dipole (**IOD**) ocean currents. However, these ocean currents are not well represented in most global climate models, and as a result, climate predictions for the northwest of Western Australia vary significantly. Consequently, the impact of climate change, the change in water availability and influence on ecosystems, in the Pilbara is still unclear.

The ENSO and IOD ocean currents are currently being researched by Commonwealth Scientific and Industrial Research Organisation. At the same time, modelling is being progressively improved by various Australian Government agencies to expand our understanding of the climate drivers in the southern hemisphere, to understand the associated impacts on water availability and to predict changes to existing ecosystems.

From the modelling completed to date, our understanding of Pilbara climate change suggests the region will experience the following climate trends:

- A shift in the historical tropical cyclone season, with an earlier start and potentially later finish.

- For the period 2051 to 2099, compared to present day, tropical cyclone frequency could decrease by half, and the duration of a given tropical cyclone by 0.6 days on average. Projections also suggest that tropical cyclones could increase in size and intensity
- Continuation of the highly variable multi-decadal scale rainfall trends.
- Projected rainfall reductions range from 1 to 24 percent for mid-century, and 9 to 24 percent for the end of the century
- A significant warming trend, influencing maximum temperatures, with the largest changes during the January to March period.
 - On average, maximum temperatures are expected to increase by 2.1 to 3.2°C by mid-century and by a total range of 3.8 to 4.6°C by the end of the century. For minimum temperatures the corresponding averaged increases are 1.9 to 2.4°C (mid-century) and 4.1 to 4.6°C (end of the century).

These changes, if realised as modelled, are likely to make successful rehabilitation in the Pilbara more challenging. Current landform designs are undertaken with inbuilt conservancy that allows for increased erosion factors, however lower average rainfall will affect the ability to establish vegetative cover.

10 Land

10.1 Biogeographic overview

Paraburdoo lies within the Pilbara Craton, a bioregion defined by the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara bioregion is divided into four subregions: Chichester, Fortescue Plains, Hamersley and Roebourne Plains. The study area is located in the Hamersley subregion which is described as a *“mountainous area of Proterozoic ranges and plateaus with low Mulga (Acacia aneura) woodland over bunch grasses on fine textured soils, and Snappy Gum (Eucalyptus leucophloia) over Triodia brizoides on the skeletal sandy soils of the ranges.”*

10.2 Geological setting

Paraburdoo lies within the Hamersley Iron Province on the southern margin of the Hamersley Basin. The mine deposits lay along the east-west aligned Paraburdoo Range which is the eroded south-dipping limb of the Bellary Anticline. The geological setting is structurally complex and includes folding, low to high angle faulting and dolerite intrusions. Both the Brockman and Marra Mamba Iron formations are present as two loosely sub-parallel south-dipping ridges. The Brockman Iron Formation features seven ore lenses from 18E through to 27W that extend over a strike distance of 14 km. The Marra Mamba hosted mineralisation is confined to the 5W, NLC and 18E deposits. These deposits are all located within 7 km of the Paraburdoo Mine infrastructure.

The Paraburdoo iron ore deposits are a mixed resource consisting of High Phosphorous Brockman (HPB, >0.10% P) and Low Phosphorous Brockman (LPB, <0.10% P) ores. Most of the high grade ore is hosted within the Dales Gorge and Joffre Members of the Brockman Iron Formation, with a lesser amount of lower grade material being hosted within the Whaleback Shale Member and minor detrital lenses occurring south of the range. At surface the mineralisation has been affected by weathering and is referred to as the Hydrated Zone or Hardcap. A typical geological cross section is presented in Figure 12. Approximately 60 percent of the mineralisation remaining at Paraburdoo is below the water table.

Stratigraphic units known to be associated with mineral waste material types at Paraburdoo include Alluvial cover, Dolerite, Shale, Dales Gorge and Joffre Banded Iron formation (BIFs) and Mt McRae Shale (**MCS**). The fibrous mineral risk of the Dales Gorge and Joffre BIF's is low. Pyritic Shale (i.e. black shale) is the dominant lithology within the MCS and this unit may be divided into the upper MCS, middle MCS and the lower MCS based on sulfide content (Figure 13). Depending on the quantity of sulfide in the unit, the MCS can be delineated into either “cold” or “hot”; both pose an acid and/or metalliferous drainage (**AMD**) risk, but the “hot” MCS poses an additional self-heating/spontaneous combustion risk due to higher sulfide concentrations. The AMD risk associated with MCS is discussed further in Section 10.4.2.

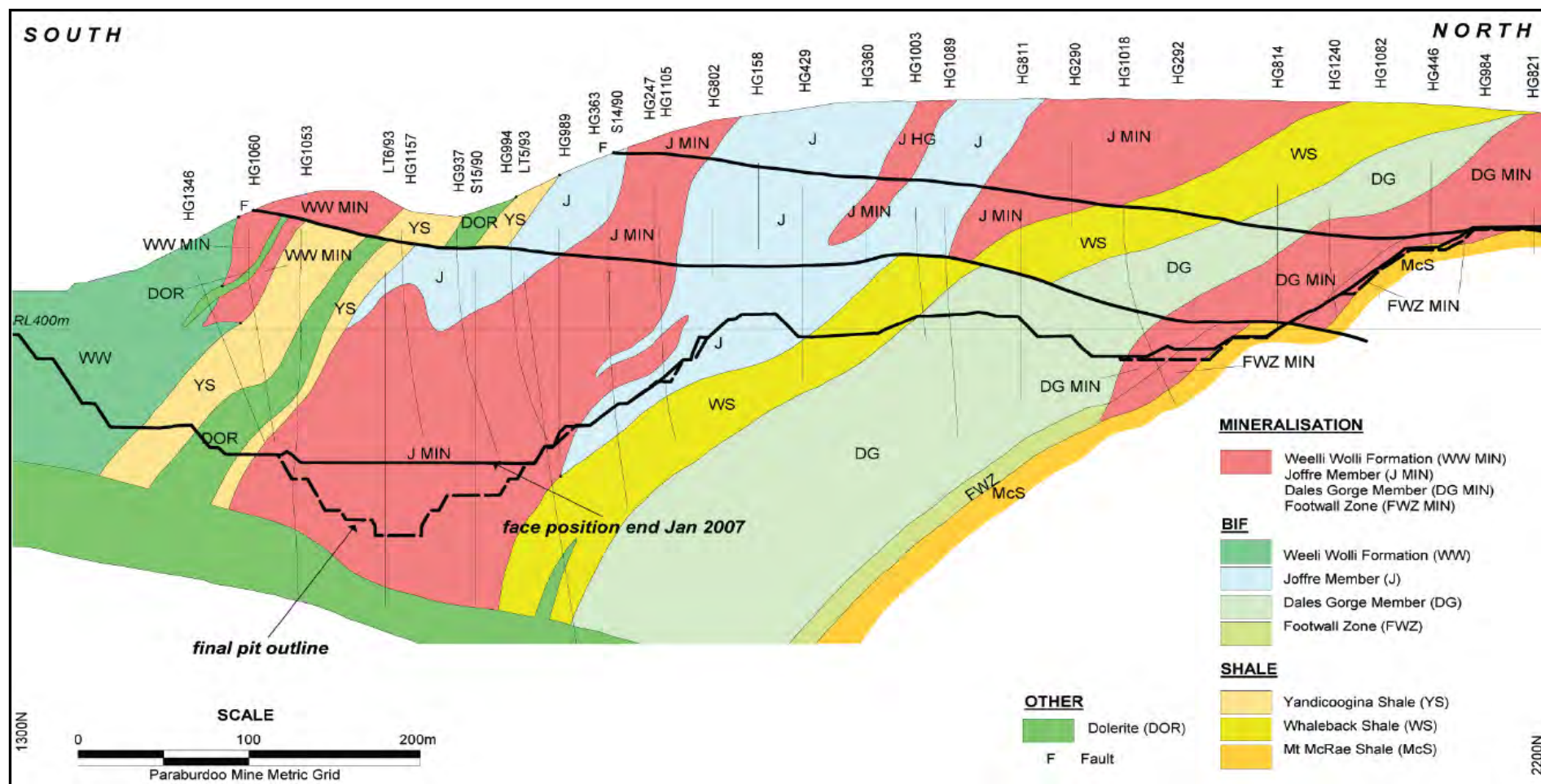


Figure 12: Cross-section of Paraburdoo 4 East deposit showing Brockman Iron hosted mineralisation (looking west)

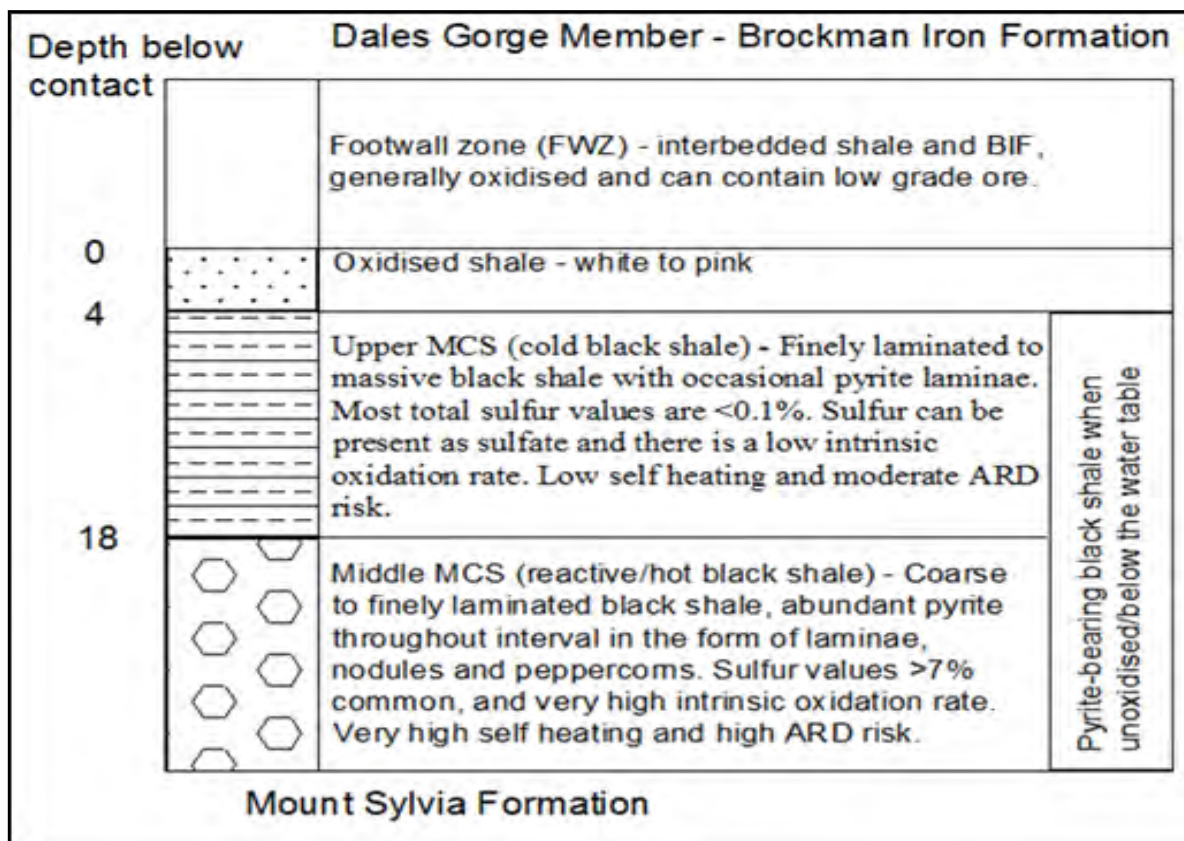


Figure 13: Typical stratigraphy of Mount McRae Shale at Paraburdoo. Depth below contact (meters)

10.3 Geotechnical stability of pit walls

Rio Tinto plans to partially backfill some pit voids to varying levels via in-pit dumping of mineral waste material at Paraburdoo; however significant open voids will still remain after closure. These will not be reshaped or rehabilitated and the remaining pit walls will be retained in the same configuration as when mining ceases. It is recognised that there will be some degree of geotechnical instability, and that walls will have the potential to collapse in some areas thereby posing a risk to persons accessing the post-mining landscape. Abandonment bunds will be used to prevent inadvertent public access as described further in Section 20.5.

The zones of geotechnical instability methodology is based on the angle method described in DMIRS abandonment bund guideline⁸, using the conservative assumption that all pit walls are embedded into weathered rock (i.e. the polygons are lines drawn at a 25° angle from the base of the pit). Further geotechnical evaluation is being undertaken, and may result in a change to the current polygons.

Preliminary zones of geotechnical instability have been identified around all pits covered within the scope of this closure plan and are shown in Figure 14 and Figure 15. It should be noted that these images are based on conceptual pit and backfill waste dump designs, and will be refined as closure approaches. In particular, the zones of pits near Seven Mile and Pirraburdu Creeks will require further refinement as pits located on creek lines (11W, 4W, NLC and 4EE) will be partially backfilled (or at the minimum have appropriate bunding) to prevent any possible creek interception, and as such the zone of instability will change.

Conceptual abandonment bund locations have been developed based on natural topography greater than 35° acting as a natural barrier and abandonment bunds being constructed in all other areas, this is discussed further in Section 20.5. Further geotechnical evaluation will be undertaken throughout mine life and the ZOI will be refined with pit design, backfill design and mine plan changes.

⁸ Department of Industry and Resources (currently DMIRS), *Safety Bund Walls Around Abandoned Open Pit Mines*, December 1997

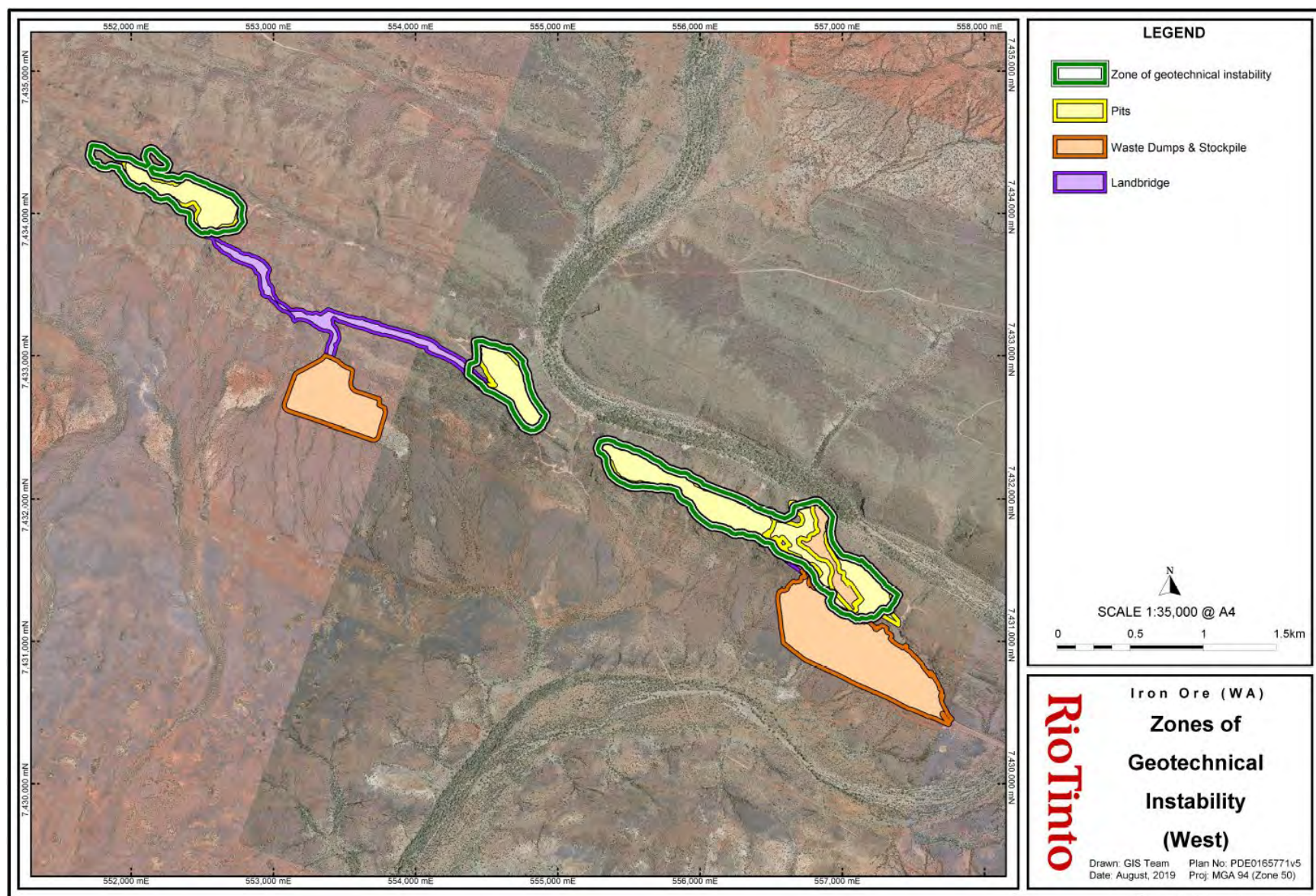


Figure 14: Zones of geotechnical instability around pits (27W, 20W, 14-16W and 11W)

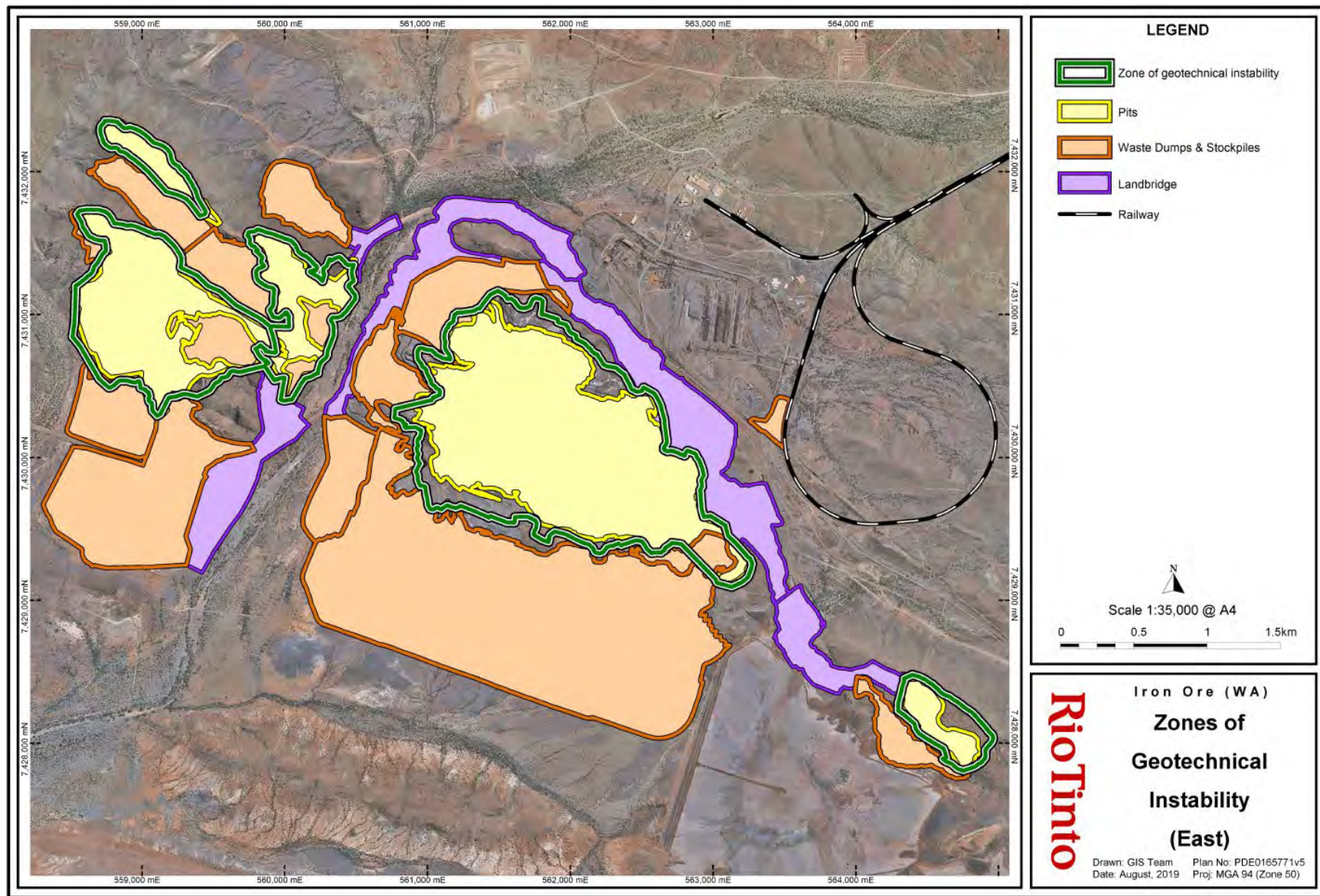


Figure 15: Zones of geotechnical instability around pits (18E, 4EE, NLC, 4W and 5W)

10.4 Mineral waste characterisation and inventory

Developing a comprehensive understanding of the types and volumes of mineral waste materials that will remain at the completion of mining at Paraburdoo is critical for the effective design, construction and rehabilitation of the mining landforms. Rio Tinto has a well-developed process for the collection and analysis of data that is developed from early exploration works and continues through the life of the mine. Long term material behaviour can also be predicted through characterisation of representative waste types and correlation to similar waste materials present at other Pilbara sites.

10.4.1 Physical characteristics

The key physical property of mineral waste material that is applicable to the closure design is how susceptible the material is to erosion. Materials are assessed and classified into one of three levels of erodibility – low, medium or high. Materials which are classified as low erodibility are competent hard rock that is suitable for placement on the outer surface of waste landforms to provide long term protection against erosion. Wastes classified as medium erodibility can also be placed on the outer surface; however the batter slope length (shorter lift heights and/or shallower batter angles) must be reduced to align with the higher erosion potential. High erodibility waste has low rock content and must not be on the outer surface of waste dump batters at Paraburdoo in order to prevent unacceptable levels of erosion. Waste types at Paraburdoo have been assessed using a combination of site-specific geophysical test work and extrapolation of block model data using equivalent material at similar sites.

Table 6 lists the waste material types by erodibility class, volume and percentage of total mineral waste predicted to be generated during operations. This information is used to inform the landform design and management strategies during operations and closure. Volumes are based on current mining models and are subject to change. Over half of all waste is expected to be resistant to erosion (low erodibility) and the remainder classified as medium or high erodibility. Due to the historical nature of mining at Paraburdoo, a small portion of waste is unknown. The proportion of each waste type, within each waste landform is expected to vary; this will result in different stable rehabilitation designs. The erosion classification of individual landforms is included in Appendix F.

Table 6: Paraburdoo mineral waste erodibility and approximate volumes

Waste material type	Erodibility	Volume (m ³)	Percent total waste (excluding tailings)
Joffre (JOF)	Low	66,511,310	27%
Dales Gorge (DG)	Low	38,611,369	16%
Hydrated Zone (HYD)	Low	7,437,447	3%
Weeli Wolli (WW)	Low	24,213,532	10%
Footwall Zone (FWZ)	Low	6,266,748	3%
Nammuldi Member (NAM)	Low	820,633	<1%
Whaleback Shale (WS)	Medium	26,781,107	11%
McRae Shale (MCS)	Medium	16,715,983	7%
Dolerite (DOR)	High	24,932,470	10%
Yandicoogina Shale (YS)	High	11,869,172	5%
West Angelas Shale (WANG)	High	35,259	<1%
Detritals (DET)	High	663,888	<1%
Other	Undefined	17,816,097	7%
Total		242,675,019	100%

10.4.2 Geochemical characteristics

Rio Tinto has undertaken an extensive program of geochemical testing over several years to understand the potential for acid and/or metalliferous drainage (**AMD**) to occur as a result of exposing rock types common to mining operations in the Pilbara. The geochemical characterisation process aims to establish relative elemental abundance as well as sulfur content as an indicator of AMD potential, and to undertake static acid base accounting (**ABA**) and, if appropriate, kinetic testing of

materials. This information is applied to the geological block model and subsequent mining model, to ensure materials posing potential geochemical risks are identified prior to mining, and managed appropriately. This work is in accordance with the *Rio Tinto Iron Ore (WA) Mineral Waste Management Plan for Undeveloped Resources and Studies* and the *Rio Tinto Iron Ore (WA) Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan*.

The most significant geochemical risk in Pilbara iron ore bodies is associated with sulfides, such as pyrite (FeS_2), which can form sulfuric acid when exposed to oxygen and water. The geological unit most commonly associated with pyrite and AMD in the Pilbara is the Mount McRae Shale (**MCS**), which is exposed at Paraburdoo. Pyrite can also occur within other stratigraphies, including black shale in the Mount Sylvia Formation (**MTS**) as well as in the Wittenoom Formation (**WF**), which underlie the orebody in some pits at Paraburdoo. Sulfate minerals also found in Pilbara rock types include alunite and jarosite, as well as schwertmannite, which can also pose a geochemical risk, albeit the risk is lower due to self-limiting chemical processes. Sulfur may also be present as gypsum and within goethite, which would be unlikely to produce acid.

The measured acid neutralising capacity (**ANC**) of material, along with the maximum potential acidity (**MPA**) of that material (which is calculated from measured total sulfur content and the likely sulfur forms present) can be used to calculate the ANC/MPA ratio; this ratio is frequently used as a means of assessing the risk of acid generation from mine waste materials. This ratio is also known as the Neutralisation Potential Ratio (**NPR**). In general, an ANC/MPA ratio (or NPR) of 2 or more signifies there is a high probability that the material will remain circum-neutral in pH. The use of total sulfur to estimate the MPA is a conservative approach which assumes measured sulfur content occurs as pyrite (rather than the sulfate minerals such as alunite and jarosite).

Mining activities at Paraburdoo include the disturbance of PAF material from the MCS, and may also expose black shale associated with MTS and WF. The data in Table 7 provides an indication of the acid generation risk level for various mineral waste types. It is compiled from a subset of MCS, MTS and WF samples from the Greater Paraburdoo area, where there has typically been a bias toward elevated-sulfur samples; the ANC/MPA ratios represent the samples tested, where the average sulfur value is notably higher than what may be expected to present during mining (i.e. for oxidised MCS and MTS).

Table 7: Summary of static acid base accounting testing for the Greater Paraburdoo area mineral waste types associated with black shale

Waste Type	Number of ABA samples ⁹	Likely sulfur forms	Median			Average		
			S (%) content	ANC (kg H ₂ SO ₄ /t)	NPR ¹⁰	S (%) content	ANC (kg H ₂ SO ₄ /t)	NPR ¹⁰
MCS (ox)	47	sulfates	0.01	2.6	5.3	0.44	12.3	83
MCS (cold and hot BS)	111	sulfates and sulfides	0.47	5.0	0.3	2.50	16.1	7
MTS (ox)	6	sulfates	0.01	4.5	21	0.17	4.2	23
MTS (cold BS)	15	sulfates and sulfides	0.45	11.2	1	1.24	67.4	10
WF (cold BS)	8	sulfates and sulfides	0.05	21.0	16	0.38	18.5	17

⁹ Samples which have been tested for acid neutralising capacity (ANC) are considered "ABA samples".

¹⁰ NPR median/average value is calculated from individual ABA samples within indicated rock type.

Static ABA tests have been completed on a total of 302 samples from the Greater Paraburdoo area (including Western Range, Paraburdoo, Channar and Eastern Range), while short-term liquid extract tests have been completed on 306 samples (Table 8). In addition, comprehensive kinetic tests have been undertaken on analogous material deemed to pose a significant geochemical risk (e.g., black MCS from Tom Price). Based on ABA test work, a value of 0.1% total sulfur concentration has been adopted as the boundary value to denote PAF material from inert/non-acid forming (**NAF**) material.

Table 8: Summary of static acid base accounting and short-term liquid extract tests completed on Greater Paraburdoo area samples

Waste Material type	Number of samples with ABA data	Number of samples that have liquid extract data
Tailings	19	7
Detritals (CAL)	7	0
Detritals (DET)	0	7
Dolerite (DOR)	22	21
Weeli Wolli Formation (WW)	10	16
Yandicoogina Shale Member (YS)	4	11
Joffre Member (JOF)	11	38
Whaleback Shale Member (WS)	7	22
Dales Gorge Member (DG)	12	45
Footwall Zone (FWZ)	12	11
MCS (oxidised)	47	38
MCS (black)	111	29
MTS (oxidised)	6	7
MTS (black)	15	7
Wittenoom Formation (WF)	11	9
West Angelas Member (ANG)	0	1
Marra Mamba Iron Formation (MM)	2	32
Fortescue Group (FOR)	5	5
Total	302	306

More than 223,000 drillhole samples from Paraburdoo have been analysed for the major chemical element suite of Al, Ca, Fe, K, Mg, Mn, Na, P, S and Ti, as well as As, Ba, Co, Cr, Cu, Mo, Ni, Pb, Sn, Sr, V, Zn and Zr. The extent of enrichment of a sample can be reported as the Global Abundance Index (**GAI**), which relates the actual concentration with average crustal abundance. A GAI value of zero indicates the element is present at a concentration similar to, or less than, the average crustal abundance, and a GAI value of 6 indicates approximately a 100-fold enrichment above the average crustal abundance. The main purpose of the GAI is to provide an indication of elemental enrichment that may be of environmental importance. As a general rule, a GAI of 3 or greater signifies enrichment that warrants further examination, while a GAI of 1 or 2 indicates the element may be elevated. The average concentrations from drillhole samples were also contrasted with Ecological Investigation Levels and Health Investigation Levels provided in the *Contaminated Sites Management Series Assessment Levels for Soil, Sediment and Water* as well as US EPA Ecological Soil Screening Levels.

As part of the supplemental ABA test work, and to support the liquid extract analyses, select samples from Greater Paraburdoo have also been analysed for Ag, B, Be, Cd, F, Hg, Mo, N, Sb, Se, Th and U, while liquid extracts are analysed for the following parameters: pH, electrical conductivity (EC), Ag, Al, As, B, Ba, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, HCO₃, Hg, K, Mg, Mn, Mo, Na, Ni, NO₃, Pb, Sb, Se, SO₄, U and Zn.

The following elements have been identified as being enriched or commonly elevated in Paraburdoo rock types: As, Cl, Fe, Co, Cr, Cu, Mn, Pb, S, Sb, Se, Sn, V and Zn. Leach testing on low-sulfur drillhole samples generally resulted in leachates with most trace elements (including nitrate) measured at concentrations that were close to or below the limits of detection.

10.4.2.1 Pits and deposits

A geochemical risk assessment has been updated in 2019 for the Paraburdoo mining area. It takes into account results from ABA test work, data related to elemental abundance and sulfur concentrations within drillhole samples, the tonnes of PAF rock types derived from the mining model, and the modelled PAF surface exposures throughout the life of the mine and upon closure. The assessment concluded that mining within the 4E (including 4EE) pit poses a high AMD risk based on the exposure of black shale expected in the final pit wall. The 4W pit has been classified as posing a low-moderate AMD risk based on historic exposures of black shale. The AMD risk ratings for 11W and NLC have been down-graded to low based on the current pit shell designs avoiding underlying black shale. The 18E, 5W, 14-16W, 20W and 27W areas also pose a low risk.

Sulfur content is considered to indicate whether the MCS will be classified as 'cold' (e.g. where sulfur is generally less than 0.3%) or 'hot' reflecting the propensity for spontaneous combustion. In addition samples associated with elevated-sulfate (where sulfur values may range from 0.1% to greater than 1%) have been classified as potentially acid forming in a low capacity. A sulfur cut-off of both 0.1% and 0.3% are considered for the purpose of characterisation. The relative proportion of drillhole samples (focusing on waste samples) with sulfur values greater than 0.1% and 0.3%, and results of the AMD risk assessment (taking into account the calculated ANC/MPA ratios and current pit shell designs) are shown in Table 9.

Black shale was mined historically at Paraburdoo from the 4E and 4W pits and has been mapped within those pit shells. The historic 4ENW black shale exposure (~ 1,900 m²) is currently encapsulated by up to 35 m of inert backfill. Based on the current final pit shell design for the 4EE pit, hot black MCS is conservatively modelled to represent up to 7% of the final pit catchment area (Figure 16). The MTS and Wittenoom Formation may also contain cold black shale, and this material is modelled to represent up to 4% of the final pit catchment area. Exposed PAF on the pit wall has the potential to produce AMD when in contact with oxygen and water (direct rainfall, surface water runoff). This may impact the water quality within the pit lake that forms on the cessation of dewatering. Pit lake water quality modelling indicates the resulting post-mining pit lake will have a circum-neutral pH, where evapo-concentration processes will likely cause increasing salinity over time. This aspect is discussed in more detail in Section 20.3

Historic black shale exposures in the 4W pit (Figure 17) cover approximately 2,900 m², making up less than 1% of the pit catchment area. Based on the sulfur values of drill holes from this area, and historical records that black shale was smoking in this pit, it is likely that these exposures represented hot black shale. However, based on the exposure time lapsed (i.e. greater than 23 years), it is likely they now represent cold black shale. Black shale is currently (2019) exposed in 4W, however, based on the current planned relative level for backfill (i.e. 413 mRL) with inert waste creating 4W_03WD, the majority of the exposure will be covered. It is possible residual black shale exposures in the 4W pit may be covered with tailings during operations. At the time of writing this closure plan the details of tailings deposition was under evaluation and final heights had not been determined; it is possible a small portion of black shale will remain exposed on the pit wall on closure. Alternatively a pit lake may form post closure should tailings not be placed in-pit.

Table 9: Acid-forming potential risk, based on sulfur values at Paraburdoo. Summary of drillhole sulfur analysis (reporting relative percentage of all waste drillhole samples (a subset of total 223,000 samples), per deposit mining area and located in-pit, assayed for sulfur)

Mining Area	Total deposit area waste samples			In-pit waste samples			Geochemical Risk
	Approx. number of samples assayed	Rel.% with S>0.1%	Rel.% with S>0.3%	Approx. number of samples assayed	Rel.% with S>0.1%	Rel.% with S>0.3%	
4E (incl. 4EE)	67,600	5%	3%	41,400	3%	1%	High
4W	11,300	5%	3%	3,500	4%	1%	Low-Moderate
NLC	8,000	5%	2%	1,850	3%	1%	Low
11W	7,700	2%	1%	1,400	1%	1%	Low
18E*	7,700	6%	1%	140	18%	4%	Low
5W	1,500	5%	1%	300	7%	0%	Low
14W, 16W, 20W, 27W	7,800	3%	2%	1,000	0.50%	0.10%	Low

Note: *18E: Rel.% is based on small number (n=26) of all in-pit samples (n= 140 samples); DOR and MAC waste where 17 DOR samples represent one drillhole, where DOR is also associated with acid neutralising capacity; and nine (near-surface) MAC samples represent three drillholes where sulfur is likely in the form of sulfate. Total five waste samples with S>0.3%.

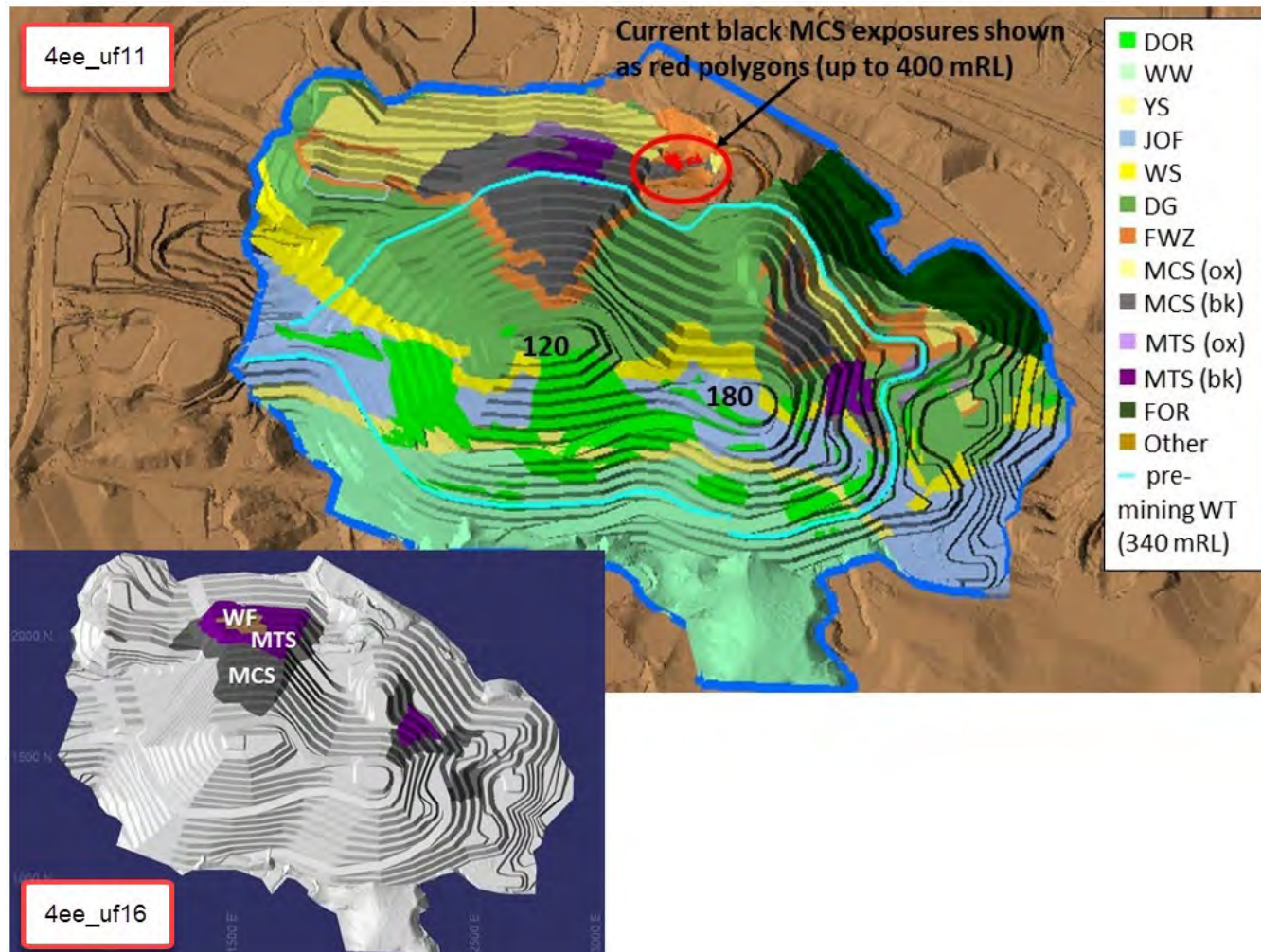


Figure 16: Modelled lithology exposures on the proposed 4EE final pit shell (4ee_uf11) and updated MCS (black), MTS (purple) and WF (brown) exposures modelled against the 4ee_uf16 pit shell¹¹

¹¹ Pit floor levels (mRL) have been labelled. The pit wall intersection of the pre-mining water table at 340 mRL has also been indicated

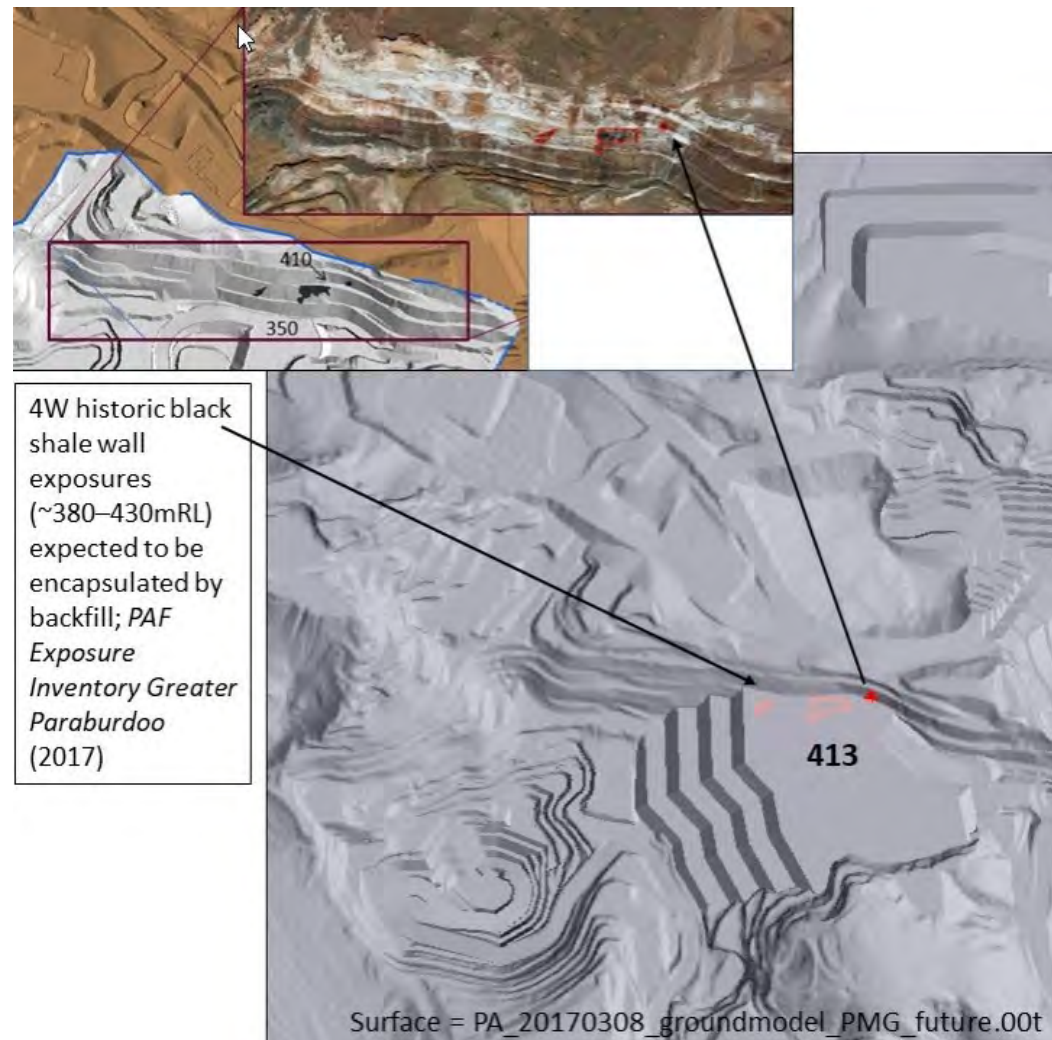


Figure 17: 4 West pit showing exposures of black shale on the final pit shell.¹²

¹² Please note details of tailings deposition have not been finalised and as such heights have been excluded from the image

10.4.2.2 Waste dumps

Black shale was historically mined at Paraburdoo from the 4E and 4W pits. There are not complete records of the quantity of black shale that was excavated historically, nor for the locations where it was dumped. To determine where black shale was likely disposed and quantities, a desktop reconciliation review was undertaken in 2018. This reconciliation included a review of both historical aerial imagery and survey data dating back to 1989. Based on this information it was possible to identify the respective dumps for which black shale from pits 4E and 4W was likely placed.

Black shale was mined between 1989 and 1996 from 4W pit. Whilst it is unclear how much black shale was actually mined, a review of the block model indicates a conservative estimate would be that 38 kilotonne (kt) of black shale was mined. The likely locations for this material are in 4W_WD01 and 4W_WD02. These dumps are considered to pose a low acid and metalliferous (AMD) risk based on the low volume of black shale likely to have been placed within the dumps, as well as considering the majority of black shale would likely be encapsulated by sufficient (i.e. greater than 5 m) inert waste. Furthermore, groundwater monitoring is currently in place and ongoing, where results show no obvious indicators of AMD. Although 4W_WD01 is classified as low AMD risk, there are two areas located on 4W_WD01 that have been identified as AMD risk areas, and that may not be sufficiently encapsulated by inert waste material. These areas will require further investigation to determine if additional encapsulation is required prior to rehabilitation.

Black shale was mined from the 4E pit prior to 1989 and up to 2004. Black shale waste from 4E pit was likely dumped in the external waste dumps 4E_WD and 4EX3_South_WD, and the in-pit waste dump 4EX_WD. The 4E_WD and 4EX3_South_WD dumps are considered to pose a low to moderate AMD risk based on the estimated volume of black shale possibly contained within them. Groundwater monitoring bores in the vicinity of 4E_WD has not shown any obvious indicators of AMD influence to date. The in-pit 4EX_WD is considered to pose a low AMD risk as indications are that any potential black shale backfilled in this pit is already encapsulated by sufficient (i.e., greater than 5 m) inert waste.

Expansion of the existing 4E pit to create the 4EE pit on closure will result in additional volumes of inert waste and PAF material including black shale. Waste from 4EE pit will be deposited into the newly created above ground 4EE_WD. This waste dump will encapsulate historic 4EX3_South_WD and 4EMX_WD waste dumps and partially encapsulate 4E_WD. As such these existing waste dumps and waste from 4EE pit will be referred collectively as 4EE_WD. Based on the current mining model, approximately 6 Mm³ of black shale is estimated to be produced from 4EE pit, which includes 4.5 Mm³ of hot black shale. This waste will be deposited within 4EE_WD and encapsulated with inert waste. Based on the volume of PAF material contained within the 4EE_WD the dump has a high AMD risk rating (Table 10). Black shale will be managed according to *Iron Ore (WA) SCARD Management Plan* and is discussed in greater detail in Section 20.1.2.

Black shale is not expected to be mined from pits 14-16W, 20W and 27W. As such, the resultant waste dumps (14W_WD, 16W_WD, 20W_WD and 27W_WD) will be classified as having a low AMD risk.

In summary the following waste dumps are currently classified as PAF as they may presently, or in the future contain PAF material: 4W_WD01, 4W_WD02, 4EX_WD and 4EE_WD. The AMD risk ratings of these dumps range from low to high, and are based on likely quantities of PAF material contained and/or inert encapsulation of greater than 5 m (Table 10). Management of these AMD risks at closure is described in Section 20.1.

Table 10: Waste dumps classified as PAF and estimated maximum volume of PAF contained within them

Waste dump	Max. tonnes of black shale in the dump (Mt)	AMD risk rating
4W_WD01 + 4W_WD02	0.038	Low
4EX_WD	0.08	Low
4EE_WD	13.4	High

Note: Max tonnes of black shale contained in 4EE_WD includes estimated tonnes contained within 4EX3-South_WD and 4E_WD.

10.4.3 Fibrous minerals

Naturally occurring silicate minerals can have fibrous characteristics. These minerals can be associated with iron ore deposits in the Pilbara. Fibrous minerals present a health hazard if fibres of a respirable size (approximately 6 microns) become airborne and are inhaled.

There have not been any hazardous fibrous occurrences during mining to date, although fibres have been intersected in resource evaluation drillholes only. Based on conservative geological interpretation rather than confirmed occurrence, there could be some potentially fibrous occurrences in the 18E and 5W areas (within the unmineralised Marra Mamba Iron Formation), however no further mining is planned in these pits. Similarly, mining in the NLC and 4EE pits may expose some potentially fibrous areas associated with fresh dolerite, these areas will be geologically assessed after further drilling to be re-classified as either “normal” or “designated” fibrous mining areas. The fibre occurrence risk associated with 14-16W to 27W is considered low based on no hazardous fibrous occurrences to-date from drilling in those areas.

Should hazardous fibres be identified during future mining, fibrous material would be stored in the designated fibrous in-pit waste dump 4W_WD03. Should fibres not be encountered and disposed of within this waste dump, its classification will be downgraded to inert.

The *Rio Tinto Iron Ore (WA) Fibrous Minerals Management Plan and Site Operations Fibrous Minerals Management Plan* describe and provide guidelines for the management of fibrous minerals encountered during mine production, such as the encapsulation of intersected fibrous mineral waste in 2 m thickness of non-fibrous mineral waste.

In summary, no designated fibrous waste has been mined to date and it is unlikely to be mined in the future.

10.5 Local soils

Topsoil is recognised as an important factor in achieving high quality rehabilitation. Characterisation of soils provides an indication of soil properties and their potential impacts on vegetation establishment, growth and landform stability; although it is important to recognise that they will be altered as a result of clearing processes. Appropriate characterisation can also help ensure soils with adverse properties are identified and appropriately managed.

Soils from the Greater Paraburdoo area have been tested and compared to those of other Pilbara soils. The physical and chemical properties of local topsoil are provided in Table 11. Topsoil properties are within the range typical of that found elsewhere in the Pilbara. Topsoils are generally classified as loamy sand with a coarse material fraction of 65%. Soil pH is circa neutral and the soils have low salinity and are non-sodic (exchangeable sodium percentage <6%). Both organic carbon and nutrient levels vary according to landscape position: they are typically very low in the higher portions of the landscape, but are present in higher levels in low-lying areas and drainage lines. Local soils possess low hydraulic conductivity indicating that they could be naturally susceptible to increased surface run off, surface erosion and less water availability to plants.

Subsoil has physical properties that are suitable for plant growth, and generally has chemical properties that are amenable to plant growth, although it does lack the nutrient content, organic matter, soil seed bank and mycorrhizal fungi properties of topsoil. It has been seen to support native vegetation growth and is being stockpiled as a supplement for topsoil where stockpiled topsoil volumes are not sufficient to meet rehabilitation demand.

Table 11: Comparison between local topsoil and typical Pilbara soil parameters

Properties		Pilbara Soils	Local Topsoil
Physical Properties	Soil texture (<2 mm soil fraction)	Sand – Clay Loam	Loamy Sand
	Coarse material content (%)	0 - 93.0	65.2
	Aggregate stability (Emerson Class)	2 - 6	5
	Soil Strength (Modules of Rupture (kPa))	0 - 267	58.6
	Plant available water holding capacity	-	Moderate
	Hydraulic conductivity (Ksat (mm/h))	-	2.0
Chemical Properties	Soil pH	5.3 – 9.5	6.8
	Salinity (dS/m)	0.007 – 0.233	0.08
	Organic Carbon (%)	0.07 – 3.74	0.37
	Macro-nutrient status	-	Low
	Micro-nutrient status	-	Low to moderate
	Effective Cation Exchange Capacity (meq/100g)	1.9 – 16.8	1.16
	Exchangeable Sodium Percentage (%)	0.21 – 6.39	4.31
	Total metal concentrations	Low	Low

10.6 Soil inventory

Topsoil is often a limited resource in the Pilbara with topsoil recovery often being restricted due to the nature and terrain of the landscape. The goal of soil management is to maximise the collection of topsoil and subsoil, and to store it to maximise its viability and productivity to ensure there is sufficient soil for subsequent use in rehabilitation.

Where practical a minimum of 200 mm of topsoil and 600 mm of subsoil is collected when new areas are disturbed. This is to ensure that adequate volumes of soil will be available for rehabilitation, which requires soil to be spread to a depth of 200 mm. Due to the historical nature of mining at Paraburdoo and difficulties in collecting topsoil in areas of steep and rocky terrain it is expected that there will be a topsoil deficit at Paraburdoo. As such this deficit will be supplemented with stockpiled subsoil, although it should be noted that subsoil will be less favourable for rehabilitation quality than topsoil.

Table 12 provides the current and projected soil inventory for Paraburdoo and the predicted volume required for rehabilitation purposes at closure. Based on the current soil reconciliation for the life of mine there will be a deficit at Paraburdoo. It is predicted clearing and recovery of topsoil/subsoil from future mining areas will reduce the deficit.

Table 12: Predicted LOM soil balance for Paraburdoo (as of January 2019)

	Current balance	Future predicted clearing and recovery	Total at Closure
Topsoil volume (m ³)	316,213	492,291	808,504
Subsoil volume (m ³)	471,667	1,208,350	1,680,017
Total soil volume (m ³)	787,880	1,700,641	2,488,521
Total disturbance area (ha)	2,319	448	2,767
Pit areas not rehabilitated (ha)	494	80	574
Completed rehabilitation (ha)	159		2,341
Area requiring topsoil (ha)	1,814	368	2,182
Soil volume required 200 mm (m ³)	3,628,000	736,050	4,364,050
Soil Deficit/Surplus (m ³)	- 2,840,120	964,592	- 1,875,528
Soil Deficit/Surplus (%)	22	231	57

10.7 Alternative growth media

Whilst rehabilitation areas have proven to perform best with topsoil application, absence of topsoil does not necessarily mean that rehabilitation will fail, or that completion criteria will not be achieved.

Since 2010 Rio Tinto has commissioned studies into use of mine waste materials as an alternative rehabilitation growth medium. The studies reviewed soil, tailings and mineral waste characteristics from select Pilbara mining operations, to identify material combinations that may be suitable as a topsoil substitute or supplement in cases where topsoil volumes may be insufficient for rehabilitation requirements. In these cases a topsoil strategy will be developed whereby topsoil would be applied to high risk areas such as waste landforms first and lower risk areas such as laydown areas may receive alternative growth media. Rehabilitation of waste landforms with alternative growth medium is also probable.

The Paraburdoo samples included in the 2010 study and deemed as suitable to moderately suitable as an alternative growth media were Barminco fines and aluminous low grade ore. These materials were considered favourable and within the acceptable range for salinity, pH, exchangeable sodium percentage (**ESP**), soil texture, aggregate stability, soil strength, plant available water holding capacity, total metal concentrations and nutrients. It was however noted the Barminco fines may require mixing with competent rocky material due to their relatively low coarse material content if used for rehabilitation of slopes.

Rio Tinto is continuing its search for alternative growth material. In 2017 detrital material mined from 64 East Pit 5 at Channar was identified as a suitable growth medium, and as such this material has been stockpiled for future rehabilitation purposes. Trials on growth media commenced in 2011 at the Channar CH84E5 waste dump and have now extended across a range of landforms. These include Tom Price landfill (2017), Channar weather station (2017), Tom Price MMW4 waste dump (2018) and at the 94E8 waste dump at Channar (2019). In addition to this, the Tom Price site also undertook rehabilitation of the Marra Mamba East (**MME**) waste dump with no growth medium, and the 94E8 waste dump at Channar was completed in March 2019 without the addition of a growth media. The performance of these trials will help inform the approach taken at Paraburdoo.

During future mining operations, materials that are identified as a potential alternative growth medium will be sampled and assessed for a range of parameters to assess their suitability for rehabilitation purposes. If found to be favourable, these materials will be stockpiled and recorded in relevant soil inventories.

11 Water

11.1 Surface water

The Greater Paraburdoo region is located within the Seven Mile Creek and Turee Creek catchments, and the Paraburdoo mine site is situated within the Seven Mile Creek regional catchments (Figure 18). The Seven Mile Creek catchment drains from Tom Price to Paraburdoo via Bellary Creek, where it merges with Tableland Creek to form Seven Mile Creek immediately downstream of the Paraburdoo Airport.

The Pirraburdu Creek is a major tributary of Seven Mile Creek and drains north to south through the western portion of the mine site, it joins Seven Mile creek approximately 12 km south-west of the mine site. Seven Mile Creek is located between the 4 East and 4 West mining areas, and continues its path downstream and discharges into the Ashburton River at Deolan Pool. Mining across Paraburdoo disturbs less than 1.5% of the entire Seven Mile Creek catchment area (upstream of Deolan Pool) of 2,470 km².

The surface hydrology characteristics in the Greater Paraburdoo region are determined primarily by climatic conditions. All streams in the area are ephemeral and are dry for the most part of the year, only flowing after substantial rainfall events.

There are a number of areas which currently contain surface water at the Paraburdoo mine site. Ratty Springs is located on Pirraburdu Creek. It occurs where the Pirraburdu Creek alluvial aquifer intercepts the impermeable upper Nammuldi member of the Marra Mamba Formation, which likely forms a barrier to alluvial flow and groundwater is subsequently expressed at surface. These springs hold cultural significance for local Aboriginal communities.

A number of other locations along Seven Mile Creek, such as Kelly's Pool, contain surface water periodically and are the result of surface water capture by man-made earthen bunds following licensed water discharge, rainfall events and creek flow. Upon the cessation of mining activities, these areas are expected to return to pre-mining conditions.

The Neerambah and Mud Springs are positioned outside of the Paraburdoo mining footprint, south of the Channar and Turee Creek borefields. Neerambah is located in a local depression 4 km south-west of the Channar Mine site and 500 m north of Turee Creek. The Neerambah Spring site occurs as a dry sandy pocket, in the surrounding environment. There is no evidence of spring flow; however, the site supports many large trees.

Hydraulic surface modelling was undertaken in 2018 on conceptual post-mining topography without mine expansion and details of this were presented in the 2018 Paraburdoo Closure Plan. The modelling was undertaken on the Seven Mile and Pirraburdu Creek systems and was used to estimate flood depths and velocities along the creek lines, and the influence of these on pits and waste dumps located in the flood zone. Risk locations were identified using the model results and determined as areas where:

- Seven Mile Creek or Pirraburdu Creek could flow into pit voids; and/or
- end of mining landforms are subject to high velocities and require erosion protection.
- Most recently additional flood modelling was conducted on the conceptual post-mining topography with mine expansion (2019). This included expansion to existing pits and additional mineral waste dumps. At the time of writing this closure plan the project was ongoing and had not yet been completed. Information is presented in Section 20.2 and provides an overview of what has been completed to date, and conceptual closure prescriptions for flood management.

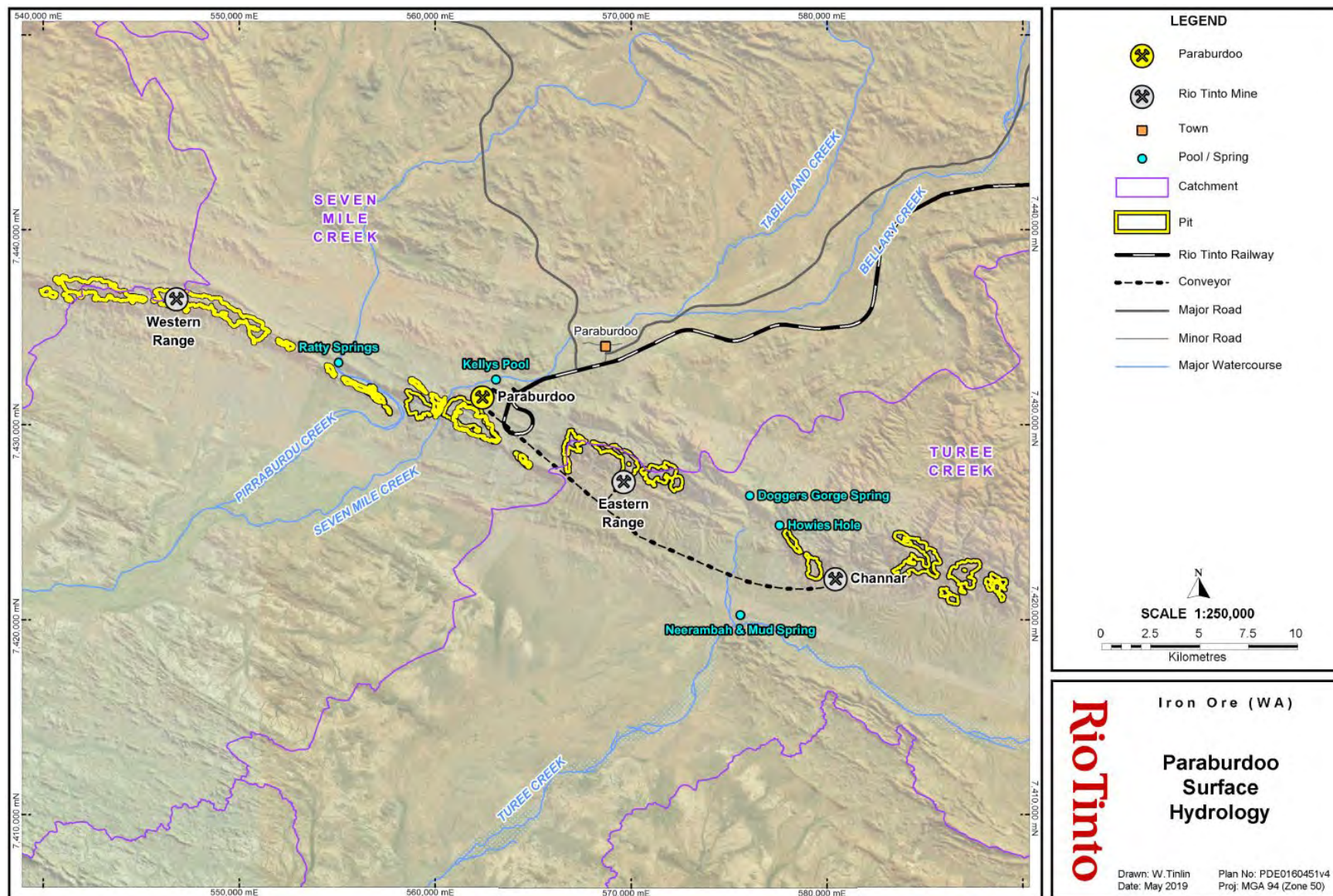


Figure 18: Paraburdoo surface water hydrology and pools

11.2 Groundwater

Groundwater at Paraburdoo is located within shallow alluvial aquifers and underlying fractured basement rocks of the Hamersley and Wyloo Groups. Groundwater recharge in the area occurs via the infiltration of rainfall during intense rainfall events when evaporation is low. Recharge will be enhanced in zones of high permeability such as outcrops/subcrops of mineralised and fractured bedrock and also along minor drainage lines (Seven Mile, Pirraburdu and Turee Creeks) where increased surface water runoff occurs. The following sections detail the key groundwater features linked to the Paraburdoo mining operations.

11.2.1 Below water table deposits

4 East Extension

The 4EE deposit aquifer is hosted in mineralised areas of Dales Gorge Member, Whaleback Shale formation and Joffre Member banded iron formation units within the Brockman Iron Formation. These deposits are complex in structure with numerous faults, and water levels are observed to vary on either side of dolerite dykes. The 4EE aquifer is recharged by surface water flows infiltrating into the alluvial and Dales Gorge Member aquifers of Seven Mile Creek, in addition to connection to the Wyloo Group to the south of the aquifer. The 4 East deposit pre-mining water table was at the 340 mRL, with some fluctuation in level due to rainfall recharge. The 4 East dewatering borefield commenced operation in 2001 and the current water table is ~275 mRL.

Dewatering will increase at Paraburdoo to enable mining of the 4EE pit to a depth of 120 mRL (165m deeper than existing depths). Water produced from dewatering activities will be utilised on site for activities such as ore processing, camp water supply, dust suppression and use at the proposed Western Range mine. Increased abstraction from 4EE will result in a reduction of abstraction from the Channar, Turee Creek and Southern borefields. Surplus water produced from dewatering will be managed on tenure via in-pit discharge (pits 14-16W and 11W) and creek discharge (limited to prevent flow off tenure). Aquifer re-injection is also under investigation.

Post-mining, rainfall, surface water runoff and groundwater will flow back into the 4EE pit creating a pit lake. Aquifer groundwater levels are anticipated to recover to pre-mining water levels in most areas post-closure given significant groundwater level recharge noted to occur from wet season flood events in local creeks. Pit lakes are discussed in section 20.3.

4 West

The 4 West deposit aquifer is hosted in mineralised areas of the Dales Gorge Member, Whaleback Shale Formation and Joffre Member. Groundwater movement outside of the orebody aquifer is inhibited by low permeability units (or dolerite intrusions); however development of secondary permeability through faulting and fracturing enhances groundwater movement and provides hydraulic connectivity. The orebody aquifer is partially recharged by direct infiltration of rainfall and runoff; and significant seasonal water level variation is noted within the deposit associated with recharge from adjacent Pirraburdu and Seven Mile Creeks. The 4 West deposit pre-mining water table was at the ~340 mRL with some fluctuation in level due to rainfall recharge and subsequent discharge to Pirraburdu Creek. The 4 West borefield commenced operation in 2003 and the current water table is ~260 mRL.

11.2.2 Borefields

Channar and Turee Creek Supply Borefields

The Channar and Turee Creek supply borefields are located to the east of the Paraburdoo mine and source groundwater from the Turee Creek palaeochannel where groundwater is hosted within a sequence of alluvial, colluvial and chemical sediments and the underlying fractured and weathered basement rocks of the Wyloo Group (Figure 19). An un-confined shallow aquifer and a confined deep aquifer exist throughout the Channar and Turee Creek borefields. The depth to groundwater ranges between two and 14 metres below ground level (**mbgl**) in the shallow aquifer, and between 10 and 60 mbgl in the deep aquifer. Groundwater elevation within the shallow un-confined aquifer mimics topography and flow generally occurs from northeast to southwest. Groundwater within the deep confined aquifer predominantly follows topography and flows from east to west.

Recharge of the shallow aquifer has been observed to respond quickly to rainfall events. In the deep aquifer this rainfall recharge response is muted or non-existent, however water level recovery is observed during periods of reduced abstraction. On the cessation of abstraction it is anticipated that groundwater levels in these aquifers will recover to their pre-mining water levels over time.

It is intended that these borefields will continue to supply water to the Greater Paraburdoo operations post the closure of the adjacent Channar mine, although alternative water sources at Western Range are being investigated and increased dewatering volumes from the proposed 4EE pit are expected to ease the demand on these borefields.

Southern Borefield

The Southern Borefield (previously named Mine Wellfield) abstracts groundwater from a sequence of alluvials and the Wyloo Group. The current depth to groundwater ranges from 15-40 mbgl. Groundwater level ranges from between 328 (PMO3A) to 293 (PMO7) mRL and the pre-mining ranged from 332 (PMO3a) to 336 (PMO7) mRL. Recharge is primarily via infiltration from rainfall runoff and connection to adjacent alluvial aquifers of Pirraburdu and Seven Mile Creeks. Aquifer groundwater levels are anticipated to recover to pre-mining water levels upon closure, given the significant groundwater level recharge noted to occur from wet season flood events.

Groundwater Quality

Groundwater quality for all operating production bores is sampled regularly to monitor for changes, with results presented in both the site Annual Environmental Review and the Pilbara Annual Aquifer Review. Groundwater quality has the potential to be impacted by AMD generated from black shale exposure. Monitoring to date shows concentrations of metals are low and a 2017 analysis of groundwater chemistry found no indicators of AMD. Additional monitoring bores will be installed adjacent to waste dumps planned to receive PAF waste prior to PAF being mined to provide baseline and continuous AMD monitoring.

11.2.3 Pit lake potential

At closure, three areas will have been mined below water table at Paraburdoo; these being pits 4W, 4EE and NLC. At closure it is planned that the 4W pit will be partially backfilled with waste to prevent creek interception during flood events, the remainder of the pit will either: be backfilled with tailings to above the post-closure water table level, or remain as a pit lake should tailings deposition not occur. Upon completion of BWT mining at NLC the pit will be backfilled with waste to above the pre-mining water table level on the completion of mining, this will prevent the formation of a pit lake in this location.

The 4EE pit is the final pit to be mined at Paraburdoo, therefore the below water table stages of the pit cannot be progressively backfilled during operations. On the cessation of mining and dewatering, rainfall, surface water runoff and groundwater will flow into the pit void and it is predicted a pit lake will form in 4EE post-closure. Groundwater levels in the vicinity of the pit lake are anticipated to recover and stabilise at shallower depths than pre-mining levels due to the increased proportional impact of evaporation in the water balance. It is predicted the final recovered water level in the 4EE pit will be supported by rainfall, surface water runoff and from inflows from the Seven Mile alluvial creek aquifer, and that a 200 m deep pit lake will form. Pit lakes may impact local groundwater quality, conceptual modelling has been completed and is described in Section 20.3.

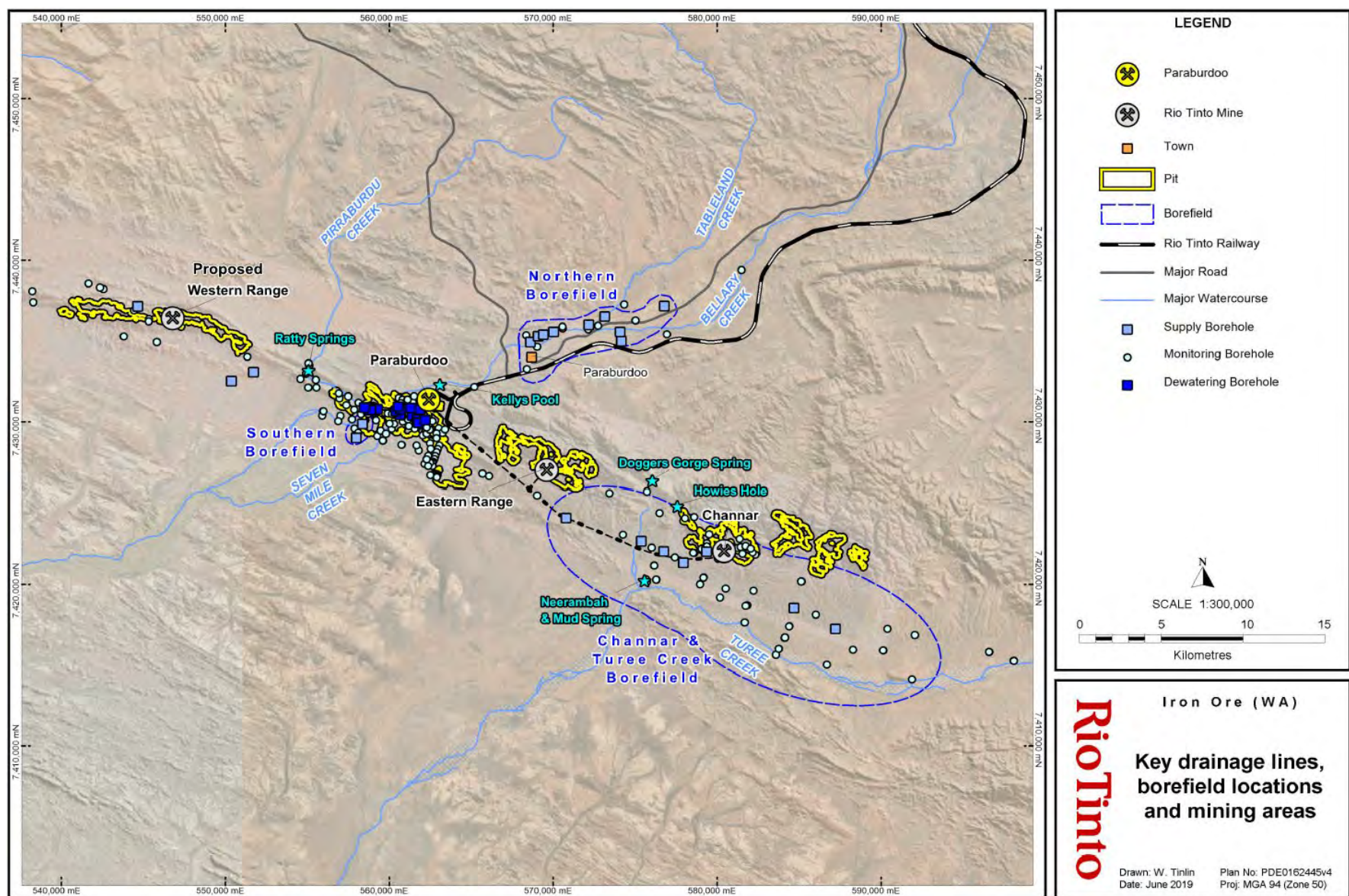


Figure 19: Map illustrating the location of the key drainage lines, borefields and mining areas

11.2.4 Tailings Storage Facility

Currently one ex-pit above ground TSF is present at the Paraburdoo mine. Deposition of tailings into this facility has historically resulted in local increases in groundwater levels that were not recorded regionally. Localised groundwater mounding that occurred in the mid-2000's has now subsided and water levels are below the range of pre-deposition levels. Water quality in TSF groundwater monitoring bores is noted to have high electrical conductivity. The TDS values obtained from bores located near the TSF in 2018 ranged from 554 to 17,500 mg/L.

It is proposed waste tailings will also be deposited in-pit into 4W pit, although the feasibility of in-pit disposal is currently under evaluation. As such final tailings heights and volumes are under consideration. Preliminary groundwater modelling has indicated some solute migration may occur, although groundwater impacts will be localised. Additional groundwater modelling and investigations will be undertaken once in-pit TSF designs and parameters are more clearly defined.

The existing TSF and proposed 4W in-pit TSF are discussed further in Sections 18.2 and 20.6.

11.2.5 Groundwater Dependent Ecosystems (GDEs)

Ratty Springs

Ratty Springs is a culturally significant water feature located where the Pirraburdu Creek crosses the Paraburdoo Range (Figure 20). Deep groundwater rises from the Fortescue group, supporting the shallow alluvial aquifer. As the creek line narrows and passes through the Paraburdoo Range, the impermeable Marra Mamba bedrock rock forms a barrier to flow and groundwater is subsequently expressed at surface (Figure 21). Ongoing monitoring of water quality and wetting extent at Ratty Springs has found that there is an annual wetting and drying of pools fed by the Spring associated with rainfall.

During the wet season increased recharge into the shallow alluvial aquifer results in water table rise and an increase in pool size. During the dry season increased evapotranspiration results in the lowering of groundwater level in the shallow aquifer and the pool may become completely dry. The nearest pit is the proposed 20W (above water table), located approximately 600 m south or downstream of the Springs. The nearest below water table pit is 4W, located 4.5 km south east. Dewatering of the 4W and 4E pit has not impacted the Springs to date, and it is predicted dewatering of the proposed 4EE pit won't result in any new impacts to the area.



Figure 20: Ratty Springs. Photo taken December 2003

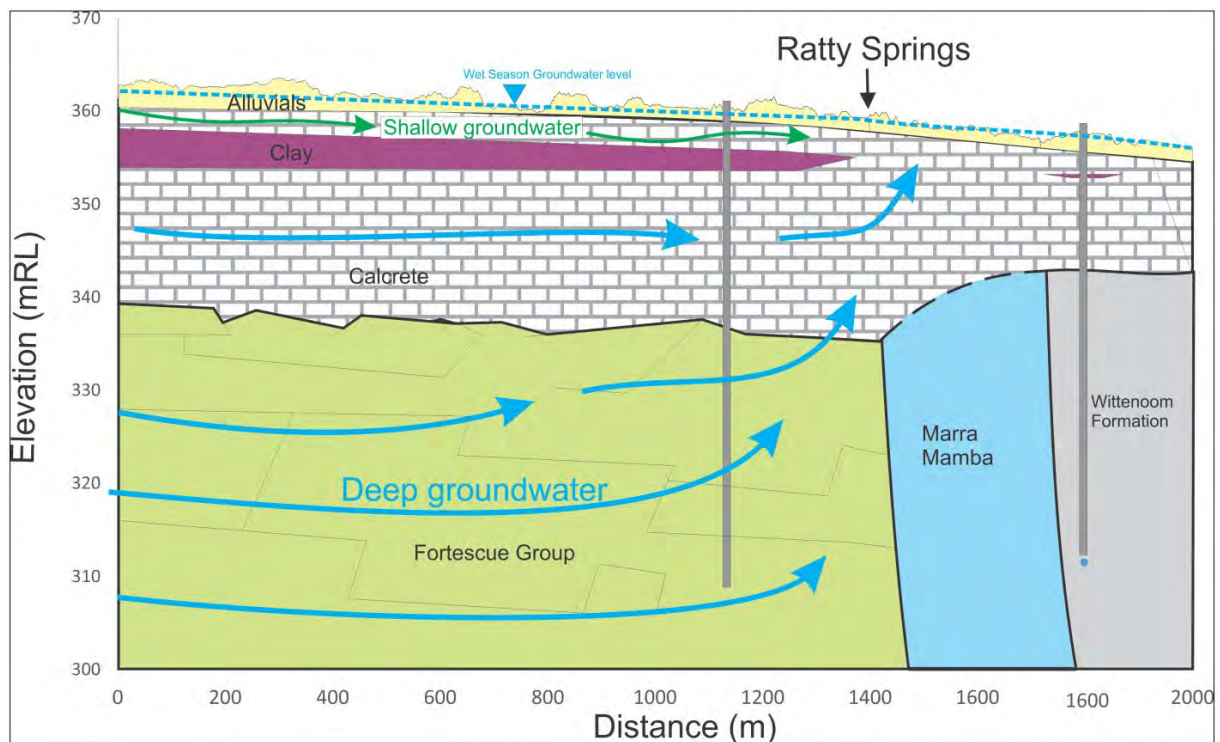


Figure 21: Ratty Springs hydrogeological conceptual cross section

Neerambah and Mud Springs

The Neerambah and Mud Springs site is positioned in a local depression 4 km south-west of the Channar Mine site, and 500 m north of Turee Creek. Both Neerambah and Mud Springs occur as a dry sandy pocket in the surrounding environment, there is no evidence of spring flow; however, the sites support many large trees (Figure 22 and Figure 23). No baseline data was collected at this location in the 1980's, prior to the operation of the adjacent borefields.

In the vicinity of the Springs there is a shallow alluvial aquifer system, underlain by palaeovalley clay that increases in thickness towards the north (away from the creek), and a deeper aquifer system that underlies the palaeovalley clay, confined from the shallow aquifer. Historical records suggest the deep aquifer once supported artesian head pressures (up to 9 m above ground level). The deep aquifer groundwater level response after rainfall recharge is muted or non-existent; however, water level recovery is observed during periods of reduced abstraction. Groundwater monitoring and modelling is being undertaken to improve the conceptual understanding of the Springs, and investigate the potential interaction with the Channar and Turee Creek borefields.



Figure 22: Neerambah and Mud Springs vegetation



Figure 23: Neerambah Spring (June 2018)

12 Biodiversity

12.1 Terrestrial habitat

Five broad habitat types were mapped at Paraburdoo prior to mining (Table 13), all of which are expected to be represented in undisturbed areas after closure. These habitats include hills and hilltops, low hills and stony plains, lower slopes, plains and broad valleys and drainage.

Hills and hilltops and drainage habitats are considered to hold elevated value due to the diversity of microhabitats and potential to provide core habitat for conservation significant fauna species. Low hills, stony plains, lower slopes and plains and broad valleys are considered to hold comparatively lower value due to the lower diversity of microhabitats available and lack of permanent or semi-permanent freshwater pools.

On closure, the land will be returned to self-sustaining ecosystems using native species of local provenance. The physical factors associated with the closure landform provide a starting point to identify which habitat units could best be reinstated across the mined area, given the changes to the land resulting from mining activities, in order to establish native self-sustaining ecosystems. Optimal species selection and habitat reformation of post-closure landforms will continue throughout mine life (during progressive rehabilitation) and during development of future closure plans, and will be informed by ongoing research activities.

If only a low level of land disturbance has occurred, the land can usually be returned to the pre-mining habitat or closest equivalent from the surrounding area. Through the act of mining, there will also be areas associated with pit development that cannot be rehabilitated due to safety and access issues. This usually includes the pit high walls and benches, and areas above the high wall where access is cut off as ore is mined. These areas are demarcated as cleared habitat units. Usually these areas have little to no soil cover, are rocky and could be subject to some erosion over time. Consequently, cleared habitat is always located within the geotechnical zone of instability. Cleared habitats provide

little food, shelter, water or any other life essentials. As a consequence cleared habitat, land that will not be rehabilitated after mining, is considered to have little to no habitat value.

Re-introduction of fauna is not considered as part of this closure plan. Instead, natural migration of fauna species into rehabilitated land is encouraged by creating habitats with similar composition to pre-mining communities in appropriate locations and with consideration of the post-closure soil and landforms design.

Table 13: Description of pre-mining habitats identified at Paraburdoo

Type	Basic description
Hills and hilltops	<p>Hilltops and slopes, gorge/gullies and breakaways and dissected drainage lines. Soils are generally skeletal, stony or red shallow loams.</p> <p>This landform is characterised by a scattered overstorey of mixed <i>Acacia</i> shrubs (Mulga complex (<i>Acacia</i> spp.), <i>A. pruinocarpa</i>, <i>A. tetragonophylla</i>, <i>A. synchronicia</i>), scattered <i>Eremophila</i> shrubs (<i>Eremophila fraseri</i> subsp. <i>fraseri</i>, <i>E. canaliculata</i>, <i>E. cuneifolia</i>) and scattered <i>Senna</i> spp. shrubs over <i>Triodia epactia</i> hummock grasslands.</p> <p>This habitat creates a diverse array of microhabitats and refugia. Rocky, sheltered ridges, bases of cliffs, crevices and breakaways provide suitable microhabitats for restricted native flora. Overhangs, caves, gorge/gullies and ephemeral pools provide potential core habitat for native fauna, including conservation significant species.</p> <p>This habitat zone will be present in undisturbed areas of the mine and may evolve around the edge of the disturbed mine area especially where the pit shell intersects local hills after erosion processes occur. However this habitat type will not be restored or rehabilitated as part of rehabilitation activities.</p>
Low hills and stony plains	<p>Low hills and mesas and isolated stony plains. Soils are generally red shallow loams. This landform is characterised by scattered overstorey of <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> trees, Mulga complex (<i>Acacia</i> spp.) and Snakewood (<i>A. xiphophylla</i>) and <i>A. tetragonophylla</i> open to scattered tall shrublands, <i>Eremophila cuneifolia</i> and <i>Senna</i> spp. scattered shrublands and <i>Triodia wiseana</i> open hummock grasslands.</p> <p>This habitat supports limited microhabitats; with <i>Acacia</i> shrublands providing no tree hollows and little ground cover present. The minor drainage lines occasionally associated with this landform provide suitable foraging/flyway habitat for fauna.</p> <p>This habitat zone will be present in undisturbed areas of the mine. Characteristics of this habitat may be considered on waste dumps or flat areas.</p>
Lower slopes	<p>Gently inclined stony lower slopes and plains below hill systems consisting of predominately depositional surfaces and dissected drainage lines. Soils are generally stony and red shallow loams.</p> <p>This landform is characterised by stony slopes/plains supporting an overstorey of Mulga complex (<i>Acacia</i> spp.), Snakewood (<i>A. xiphophylla</i>) tall open shrublands, <i>Eremophila</i> spp. and <i>Senna</i> spp. scattered low shrublands. Snakewood dominates the plains and Mulga dominates the lower slopes areas.</p> <p>This habitat type contains limited microhabitats; with <i>Acacia</i> shrublands providing no tree hollows, and little to no ground cover present. The dissected drainage lines provide suitable habitat for the Priority species <i>Hibiscus campanulatus</i>.</p> <p>This habitat zone will be present in undisturbed areas of the mine. Characteristics of this habitat may be considered on waste dumps and/or where disturbance has been minimal such as flat areas.</p>

Type	Basic description
Plains and broad valleys	<p>Gently undulating to undulating stony or cobble plains and valley floors consisting mostly of depositional and erosional surfaces. Soils are generally loam and clay stony soils and some gilgai.</p> <p>This landform is characterised by an overstorey of Mulga complex (<i>Acacia</i> spp.), Snakewood (<i>A. xiphophylla</i>) tall open shrublands, <i>Eremophila</i> spp. and <i>Senna</i> spp. scattered low shrublands. Some broad plains consist of Snakewood (<i>Acacia xiphophylla</i>) and other <i>Acacia</i> spp. low woodlands over <i>Eremophila</i> spp. <i>Senna</i> spp. and mixed Chenopod shrublands and perennial herblands. Some braided creek lines within plains support open woodlands of <i>Eucalyptus victim</i>, <i>E. camaldulensis</i> over mixed <i>Acacia</i> shrublands and <i>Triodia epactia</i> hummock grasslands.</p> <p>This habitat type contains limited microhabitats; with <i>Acacia</i> shrublands providing no tree hollows, and little to no ground cover present. The dissected drainage lines provide suitable habitat for <i>Hibiscus campanulata</i> (p1). The minor drainage lines occasionally associated with this landform provide suitable foraging/flyway habitat for fauna.</p> <p>This habitat zone will be present in undisturbed areas of the mine. Characteristics of this habitat may be suitable for rehabilitation planning and could be considered where there has been minimal disturbance to the soil profile.</p>
Drainage	<p>Active floodplains river terraces subject to fairly regular overbank flooding from watercourses, sandy banks and poorly defined levees and associated cobble plains. Soils are generally red shallow loams and red shallow sands.</p> <p>This landform is characterised by <i>Eucalyptus camaldulensis</i>, <i>E. victim</i> open forests over <i>Acacia</i> spp. and <i>Melaleuca glomerata</i> tall shrublands over open sedgeland, hummock and tussock grasslands.</p> <p>This habitat creates a diverse array of microhabitats and refugia. Springs and freshwater pools are more likely to persist in this habitat after it has evaporated elsewhere, providing potential core habitat for native fauna (including conservation significant species) and flora species restricted to riparian systems. Logs, hollows, debris and soft soils provide suitable microhabitat for fauna. Creek habitats provide suitable foraging and act as wildlife corridors for fauna movement and dispersal.</p> <p>This habitat zone will be present in undisturbed areas within the lease. Drainage habitat characteristics may be introduced to rehabilitation areas located along the creek lines.</p>

12.2 Conservation significant flora

The species of Threatened and Priority flora that have been identified at or near the Paraburdoo operation, and have biodiversity value associated with their conservation status are described in Table 14. Threatened and Priority flora identified at or near the Tom Price to Paraburdoo railway spur are also listed in Table 14.

Table 14: Conservation significant flora identified at or near Paraburdoo, and the railway spur

Flora taxon	Conservation status WA	Habitat comments
Paraburdoo Operations		
<i>Aluta quadrata</i>	T	Edge of creek beds, base of cliffs, rocky crevices and near the crest of ridges.
<i>Eremophila</i> sp. Hamersley Range (K. Walker KW 136)	P1	Rocky slopes, gullies and rock faces associated with large hills and cliffs.
<i>Hibiscus campanulatus</i>	P1	Sheltered or rocky drainage areas below associated cliff lines or rocky ridges. Often in soils associated with Canga detrital formation.
<i>Solanum octonum</i>	P2	Gorge tops, steep hill slopes and riverine areas.
<i>Eremophila coacta</i>	P3	Moderate to steep slopes, along ephemeral drainage lines and laterite hills.
<i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Taxonomic status uncertain. Known with certainty only from the vicinity of Mulga Downs homestead in the Pilbara.
<i>Grevillea saxicola</i>	P3	Upper scree and breakaway slopes and crests often associated with banded iron formation outcropping.
<i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642)	P3	Skeletal soils in rocky areas; scree slopes and rock piles in full sun.
<i>Ptilotus trichocephalus</i>	P4	Clay flats, sandy colluvial soils and gibber plains associated with Mulga.
Tom Price to Paraburdoo Railway spur		
<i>Abutilon</i> sp. Pritzelianum (S. van Leeuwen 5095)	P1	Undulating cobble plains, shallow soils. Mulga over hummock grassland.
<i>Indigofera ixocarpa</i>	P2	Hills and drainage lines, usually in skeletal soils over massive ironstones.
<i>Pentalepis trichodesmoides</i> subsp. <i>hispida</i>	P2	Summits and slopes of low hills, basaltic soils supporting <i>Acacia</i> spp. shrublands over hummock grasslands.
<i>Geijera salicifolia</i>	P3	Skeletal soils, stony soils. Massive rock scree, gorges.
<i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Taxonomic status uncertain. Known with certainty only from the vicinity of Mulga Downs homestead in the Pilbara.
<i>Grevillea saxicola</i>	P3	Upper scree and breakaway slopes and crests often associated with banded iron formation outcropping.
<i>Olearia mucronata</i>	P3	Mesic areas amongst ironstone boulders and along creek lines.
<i>Rostellularia adscendens</i> var. <i>latifolia</i>	P3	Protected areas near drainage or along shaded rocky ridges, dry gullies and gorges.
<i>Acacia bromilowiana</i>	P3	Skeletal loam high in the landscape; steep slopes, ridge tops and breakaways.
<i>Lepidium catapycnon</i>	P4	Skeletal soils. Hillsides (frequently south facing slopes).

One species of Threatened flora, *Aluta quadrata*, has been recorded within the Paraburdoo lease boundary. *A. quadrata* is a shrub between 0.8 and 2.6 m high with white flowers appearing in June (Figure 24). It is usually found growing on the edge of creek beds, at the base of cliffs, rocky crevices and near the crest of ridges around the Paraburdoo locality over a range of approximately 40 km. This species is highly restricted to the Paraburdoo locality and genetic analysis conducted using microsatellite markers suggest that *A. quadrata* consists of three genetically distinct populations at Western Range, Pirraburdu Creek (Paraburdoo) and Howie's Hole (Channar) (Figure 26). This population of *A. quadrata* is situated near Pirraburdu Creek (Figure 25). *A. quadrata* is listed as Threatened under the *Biodiversity Conservation Act 2016*.

Propagation studies on wild harvested *A. quadrata* material have indicated that the species cannot be readily propagated from cuttings. Seed germination trials have been conducted with limited success. However, laboratory trials have demonstrated that seed from this species can be germinated if the seed is manually excised from the indehiscent fruit. Seeds germinated in this manner have been successfully grown on to the seedling stage in pot trials. However initial attempts to establish seedlings into the Pilbara environment have been largely unsuccessful.

Paraburdoo Operations to date, and the mining areas detailed in the current Paraburdoo life of mine plan do not occur in proximity to the Pirraburdu population of *A. quadrata* and therefore it is expected there will not be an impact from mining operations on this population.



Figure 24: *Aluta quadrata* habitat and foliage

12.3 Priority and Threatened Ecological Communities

The majority of vegetation communities in the Paraburdoo area are considered to be widespread and representative of the Pilbara bioregion, and much of the area has been impacted by historical pastoral activity, although vegetation units in drainage lines are considered more notable. There is no known Threatened Ecological Community under the *Environment Protection and Biodiversity Conservation Act, 1999*, located in the vicinity of the site.

The “Four plant assemblages of the Wona Land System” Priority Ecological Community (**PEC**) partially intersects a small section of the rail corridor. This PEC description is derived from the Department of Agriculture and Food Technical Bulletin 92 description of the BUTG site type; Basaltic upland tussock grassland. This is a distinctive community occurring in elevated parts of the landscape specifically on cracking clay soils with clear boundaries with other site types such as Hill spinifex grassland.

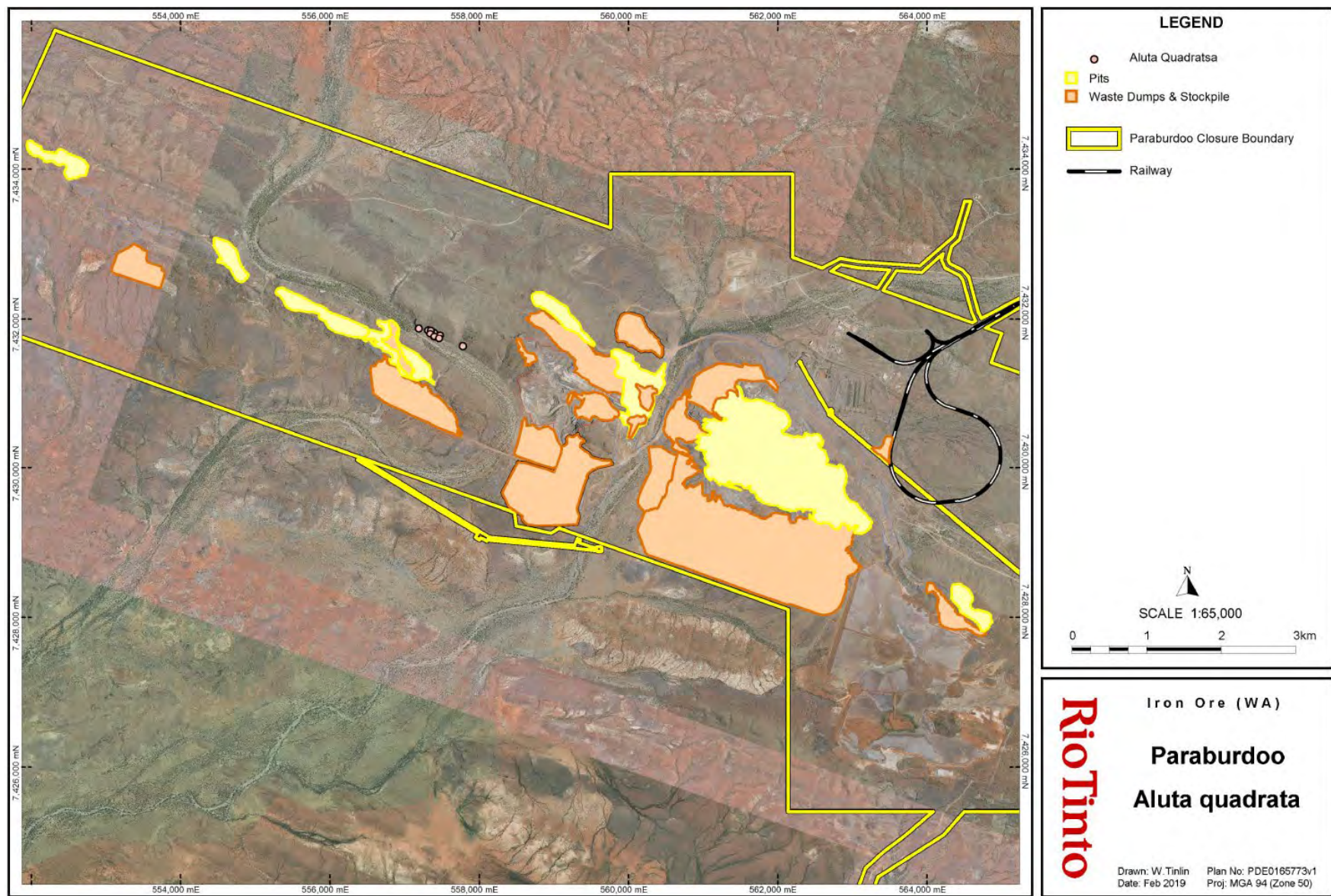


Figure 25: Aluta quadrata populations located at Pirraburdu Creek

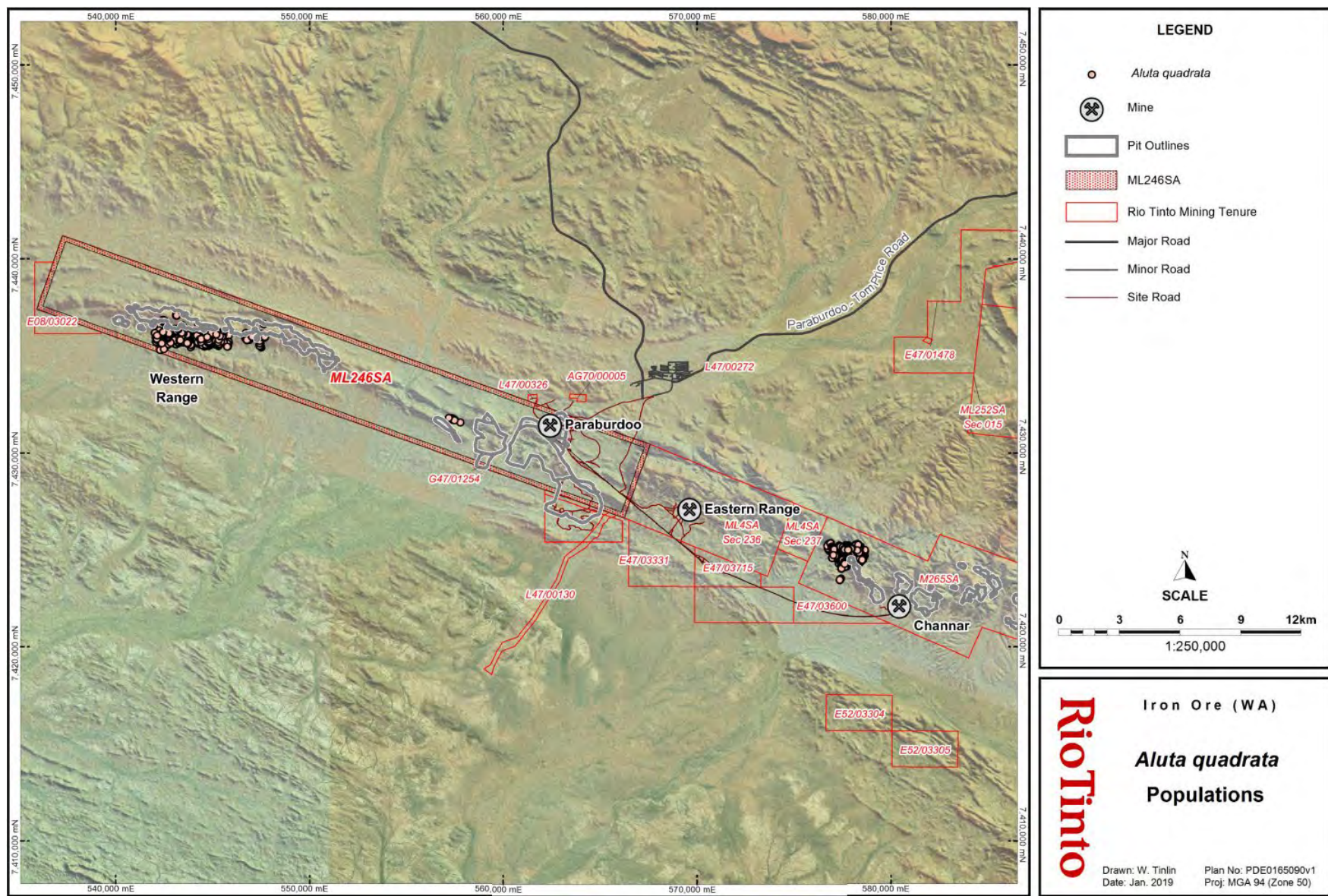


Figure 26: *Aluta quadrata* populations located at Western Range, Paraburdoo and Channar

12.4 Seed provenance and selection

Locally collected seed is needed to assist in revegetation and the creation of a self-sustaining ecosystem. Over time the viability of seeds in stockpiled topsoil decreases, and thus the value of the topsoil deteriorates. In addition the topsoil that was salvaged prior to disturbance may not contain seeds of all the target species of its new location / habitat.

Seed mixes for rehabilitation are of local provenance. Specific seed mixes are selected to provide a range of species appropriate to the desired habitat, taking into consideration landscape position and slope. In areas where erosion risks are identified, seed mixes may be modified to include or increase the portion of species that provide rapid cover.

Rio Tinto purchases seeds from commercial seed suppliers, with emphasis on ensuring that there are appropriate volumes of local provenance seeds available for rehabilitation of each of its sites. Seeds are stored in purpose-built, climate controlled storage facilities to maximise long term viability.

The inclusion of rare and threatened species in rehabilitation programs is limited by:

- habitat preference (preference for drainage lines, gullies, calcretes or other habitat not suitable or similar to those likely to be present in the rehabilitation landscapes);
- abundance – very few populations or small populations from which to source seed;
- difficult taxonomy / unresolved taxonomy issues and thus status of species highly uncertain;
- growth form – e.g. short lived annual species with preference for growth under woodland canopies;
- seed production – some species do not regularly produce seed;
- propagation methods – some species are not able to germinate from seed and cuttings are required which is not a suitable method for broad scale application in an arid environment;
- availability of seed at the time when rehabilitation occurs; and/or
- seed dormancy.

Given these issues, the main focus of rehabilitation programs is to restore vegetation complexes that include the more common species present in the particular habitat type, and to achieve a diverse range of strata. Seed mixes may include species of conservation significance if they are available, but presence of these species in rehabilitation areas is more likely to result from natural recruitment from surrounding areas.

12.5 Invasive flora

Flora and vegetation surveys have recorded 28 introduced (weed) species in the Paraburdoo mine and railway spur area (Table 15). One species is listed on the Department of Biodiversity, Conservation and Attractions (**DBCA**) as a 'priority alert' species for the Pilbara region (*Ricinus communis*). Twenty species are listed on the Department of Biodiversity, Conservation and Attractions (DBCA) Impacts and Invasiveness Ratings list for the Pilbara as having rapid or moderate invasiveness. The DBCA weed species ranking takes into account the ecological impact and invasiveness to derive a final broad qualitative weed species ranking corresponding to specific management actions. Many weed species recorded from the Paraburdoo area have a ranking of high through this process.

Table 15: Weed species recorded at Paraburdoo and the railway spur

Scientific Name	Common Name	Ecological Impact	Invasiveness
<i>Aerva javanica</i>	Kapok Bush	High	Rapid
<i>Argemone ochroleuca</i>	Mexican Poppy	Unknown	Rapid
<i>Asphodelus fistulosus</i>	Onion Weed	Unknown	Rapid
<i>Bidens bipinnata</i>	Beggars Tick	Unknown	Rapid
<i>Cenchrus ciliaris</i>	Buffel grass	High	Rapid
<i>Cenchrus setiger</i>	Birdwood Grass	High	Rapid
<i>Chloris barbata</i>	Purpletop Chloris	High	Rapid
<i>Chloris virgata</i>	Feathertop Rhodes Grass	Unknown	Unknown
<i>Citrullus amarus</i>		Unlisted	Unlisted
<i>Citrullus colocynthis</i>	Colocynth	Unknown	Medium
<i>Citrullus lanatus</i>	Pie Melon	Unknown	Medium
<i>Cynodon dactylon</i>	Couch	High	Rapid
<i>Datura leichhardtii</i>	Native Thornapple	Unknown	Unknown
<i>Echinochloa colona</i>	Awnless Barnyard Grass	High	Rapid
<i>Euphorbia hirta</i>	Asthma Plant	Low	Slow
<i>Flaveria trinervia</i>	Speedy Weed	Unlisted	Unlisted
<i>Hibiscus tridactylites</i>	Bladder Ketmia	Unlisted	Unlisted
<i>Lactuca serriola</i>	Prickly Lettuce	Unlisted	Unlisted
<i>Malvastrum americanum</i>	Spiked Malvastrum	High	Rapid
<i>Melochia pyramidata</i>	Pyramid Flower	Unlisted	Unlisted
<i>Oxalis corniculata</i>	Creeping woodsorrel	Unlisted	Unlisted
<i>Passiflora foetida</i> var. <i>hispida</i>	Stinking Passion Flower	High	Rapid
<i>Phoenix dactylifera</i>	Date Palm	High	Rapid
<i>Ricinus communis</i>	Castor Oil Plant	Unlisted	Unlisted
<i>Ruellia simplex</i>	Ruellia	Unlisted	Unlisted
<i>Rumex vesicarius</i>	Ruby Dock	High	Rapid
<i>Setaria verticillata</i>	Whorled Pigeon Grass	High	Rapid
<i>Sisymbrium orientale</i>	Indian Hedge Mustard	Low	Unknown
<i>Solanum nigrum</i>	Black Berry Nightshade	Low	Rapid
<i>Sonchus oleraceus</i>	Common Sowthistle	Low	Rapid
<i>Trianthema portulacastrum</i>	Giant Pigweed	Unlisted	Unlisted
<i>Tribulus terrestris</i>	Caltrop	Unknown	Medium
<i>Vachellia farnesiana</i>	Mimosa Bush	High	Rapid
<i>Washingtonia filifera</i>	Cotton Palm	High	Rapid

12.6 Conservation significant fauna

Conservation significant species that have been identified as present at or near the site and/or may be present at the site due to the presence of appropriate habitat within their known range are listed in Table 16.

Table 16: Fauna of conservation significance and associated habitats

Fauna species	Conservation status WA	EPBC Act status	Habitat	Recorded and/or suitable habitat
Northern Quoll	Endangered	Endangered	Rocky habitats such as ranges, escarpments, mesas, ranges, gorges, breakaways, boulder fields, major drainage lines.	Suitable habitat
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	Vulnerable	Vulnerable	Deep caves, abandoned mine shafts with sable, warm and humid microclimate.	Recorded (known roost)
Ghost Bat (<i>Macroderma gigas</i>)	Vulnerable	Vulnerable	Undisturbed caves or disused mine shafts.	Recorded (echolocation)
Pilbara Olive Python (<i>Liasis olivaceus barroni</i>)	Vulnerable	Vulnerable	Gorge, rock pools breakaway/escarpment and riparian zones	Recorded
Grey Falcon (<i>Falco hypoleucos</i>)	Vulnerable	-	Variety of habitats; open woodlands, open acacia shrubland, hummock and tussock grassland	Recorded
Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	Priority 4	-	All hill habitats	Suitable habitat

12.7 Feral animals

Seven introduced fauna species have been identified within the Greater Paraburdoo mining area: house mouse (*Mus musculus*), dog (*Canis lupus familiaris*), red fox (*Vulpes vulpes*), cat (*Felis catus*), donkey (*Equus asinus*), horse (*Equus caballus*) and cow (*Bos taurus*). Feral carnivores (e.g. cats, dogs, foxes) can create locally increased predation pressure on native fauna as well as increase competition with native species for resources such as space (territory), water and food. Feral herbivores (e.g. cattle, camels, donkeys) can also have a significant impact in rangeland areas, such as the Pilbara. In dry times, grazing pressure reduces the abundance of palatable native species, impacting biodiversity and can create conditions that encourage weeds to grow. Foot traffic by livestock impacts the soil structure and, in combination with over grazing, can encourage soil erosion. Overgrazing and damaged soils have a flow-on effect to native fauna species that rely on this vegetation for food and shelter.

13 Progressive rehabilitation

Regular reviews of the mine plan are used to identify disturbed areas at Paraburdoo where mining activity has been completed. These areas are then reviewed for potential to undertake progressive rehabilitation works. Completion of mining in a particular pit may be expected to trigger areas becoming available for progressive rehabilitation. Once areas have been signed off by internal stakeholders as no longer required by operations, they are added to the progressive rehabilitation implementation schedule. Detailed design work is undertaken and when the necessary resources have been secured, rehabilitation earthworks are completed.

Table 17 provides an overview of the main areas of progressive rehabilitation that have been undertaken at Paraburdoo, these include waste dumps, airstrips, borrow pits and flat areas. The oldest rehabilitation areas at Paraburdoo (borrow pits) are estimated to have been completed in 1992. However, records for early rehabilitation works at the site are limited. The most recent rehabilitation

was completed at the Paraburdoo landfill in 2019. The majority of early rehabilitation areas have been rehabilitated for the purpose of trialling methods and material types to determine optimal rehabilitation strategies for closure of other areas. Lessons learnt in these areas have facilitated successful rehabilitation of waste dumps at the nearby Channar mine site, and some of these areas are used as examples in the below sections to indicate likely outcomes for the Paraburdoo operations. Furthermore, lessons learnt are also used to inform and update our standard rehabilitation management practices. Implementation of such advances includes:

- area specific rehabilitation designs based on mineral waste characterisation and site specific climatic conditions;
- survey control of rehabilitation earthworks to the rehabilitation design; and
- seed management practices (viability testing and pre-treatment).

These advances have resulted in an overall improvement in rehabilitation quality seen across the company's Pilbara operations.

Table 17: Summary of key progressive rehabilitation areas at Paraburdoo

Location	Category	Area Rehabilitated (approximate Ha)	Year of Rehabilitation (estimated)
5 West WD	Waste Dump	5	2003*
4_EX3_South WD	Waste Dump	7	2004*
4 East WD	Waste Dump	38	1999*
4 West WD02 (Also called 4WN)	Waste Dump includes Bactivate trial area	25	2015
4 West WD (Road) (Also called 4WR)	Waste dump	4	2015
Paraburdoo Old Airstrip	Airstrip	43	2014
Truck Training Ground	Flat area	12	2014
Site wide	Borrow pit	11	Post 1992
Paraburdoo landfill	Landfill	14	2019

- * Rehabilitation area may require re-work

Rehabilitation trials are conducted as the need and opportunity presents i.e. application of 'Bactivate plus'. Bactivate plus was applied to the 4 West waste dump with the aim to determine if application improved nutrients levels and seedling establishment. This is discussed in more detail in Section 13.2.

Reference sites, also known as controls or analogues, are located within uncleared native vegetation and are representative of the local area where the rehabilitation is located. Reference sites allow comparison between the rehabilitation area and undisturbed areas. The suite of reference sites was reviewed in 2017 to provide a greater set of reference analogues for comparison with rehabilitation monitoring sites across the Greater Paraburdoo mining area. Monitoring of rehabilitated and reference sites is scheduled and conducted according to Rio Tinto's Rehabilitation Monitoring Procedure. The objective of the rehabilitation monitoring program is to evaluate development of the rehabilitation, and provide useful feedback for the improvement of rehabilitation techniques, and to help assess progress towards long term rehabilitation goals. Monitoring also provides information which can be used to set realistic and achievable completion criteria.

13.1 Low impact disturbance areas, roads and borrow pits

The old Paraburdoo airstrip and the truck training ground were rehabilitated in 2014. These areas were earthworked to compliment surrounding undisturbed ground, deep ripped on the contour and machine seeded. Topsoil was not applied due to limited resource availability and high risk areas such as waste dump slopes having priority to receive topsoil over low disturbance and flat areas. To date the rehabilitation performance of these areas is developing well for their age with most vegetation

parameters within the range recorded from the reference sites. Floristically the Truck Training Ground recorded a composition similar to the reference sites and species richness was high. Whilst perennial cover had not increased substantially since 2015, the cover of *Spinifex* increased three-fold between 2016 and 2017, as shown in Figure 27. Varied strata consisting of *Spinifex*, overstorey shrubs and trees had also developed. In terms of surface stability both areas were flat and appeared stable. The Old Airstrip recorded no erosion in 2017 and the rip lines were still evident. A single erosion gully was noted on one transect of the Truck Training Ground and four weed species were noted in the area.



Figure 27: Paraburdoo Truck Training rehabilitation area showing establishment of *Spinifex*

13.2 Waste dumps

Progressive rehabilitation of waste dumps has occurred at Paraburdoo since 1999. Many of these earlier examples have not resulted in successful rehabilitation, and as such improvements in rehabilitation techniques and quality control have occurred since this time. The 4 East waste dump was initially rehabilitated in 1999 and included landform shaping, ripping and seeding, however topsoil was not applied. Following poor vegetation establishment, additional seed and fertiliser was applied by dozer in 2004. The area was last monitored in 2015 and was found to be highly eroded and recorded low perennial vegetation establishment. As such, this area is no longer monitored and will require re-working prior to, or at the time of closure. The 5 West waste dump has shown similar results to 4 East waste dump, and is a consequence of historical rehabilitation methods and absence of GPS contour and ripping quality control. Following additional seed and fertiliser application in 2004, the area showed moderate erosion features and poor vegetation cover and species richness. This area will also require re-working prior to, or at the time of closure.

In contrast the 4 West waste dump 02 (4W WD02; also called 4WN) and 4 West Road (4WR) areas are examples of how rehabilitation techniques have improved over time. These areas were rehabilitated in 2015, and as part of the design process characterisation of waste material types to identify their erodibility was undertaken. The batters were pushed down to 20 linear degrees, with 20 m lift heights and 10 m wide berms back sloping at 6 degrees. As the toe of the 4W 02 waste dump is adjacent to the Pirraburdu Creek rock armoured bund was installed at this location to provide erosion protection from flood events. Topsoil was spread on the surface to a depth of 100 mm and the area was deep ripped on the contour. A native seed mix was machine seeded at this time. Figure 28, Figure 29 and Figure 30 depict the progression of rehabilitation works on the rehabilitation area. Despite the use of best practice rehabilitation techniques, a large rainfall event occurred in January 2016 and produced 89 mm of rainfall in one day. This event facilitated the development of gully erosion and may have compromised the early establishment of vegetation by burying and washing away seed, reducing the success of the rehabilitation. However this rainfall event confirmed the design and construction of the berms were effective in their purpose of holding runoff (Figure 31). Future rehabilitation monitoring will determine if erosion features are stabilising or if remedial works are required.



Figure 28: The 4W WD02- pre-rehabilitation earthworks



Figure 29: The 4W WD02- during rehabilitation earthworks



Figure 30: The 4W WD02- post rehabilitation earthworks



Figure 31: 4W WD02- showing water ponding in berms

As part of the rehabilitation work on 4W WD02, a microbial soil conditioner called 'Bactivate plus' was applied in trial areas in conjunction with the seeding. The application of 'Bactivate plus' on rehabilitation was hypothesised to provide established seedlings with increased nutrients needed for growth. Bactivate plus was applied in 2015 and monitoring has shown slightly higher cover of perennial species and a slightly higher density of perennial plants in the trial areas compared to the reference sites. It is still somewhat early to draw any conclusions, and future monitoring programs will provide an indication of the level of success of this ameliorant.

Rehabilitation techniques have improved markedly over the last decade, and the following paragraphs discuss recent rehabilitation projects undertaken at the neighbouring Channar mine site. The conditions at Channar mine site are very similar to those at Paraburdoo. These techniques and learnings will be transferred to future rehabilitation projects at Paraburdoo.

Rehabilitation of the Channar East 3 waste dump (CHE3), located at the adjacent Channar mine site, was completed in 2007, and included topsoiling and seeding. Monitoring was last undertaken in 2016 and results indicate the rehabilitation areas are performing well with native plant species richness, plant density, spinifex density and plant cover all within, or above, the range found in the reference sites (Figure 32). The rehabilitation at this site is likely to become similar to the reference sites in terms of floristic structure, density and composition. Erosion monitoring of the CHE3 waste dump identified two gullies and these have been scheduled for future monitoring.



Figure 32: Channar East 3 waste dump rehabilitation (left) and reference site (right) monitoring transect

Rehabilitation of the Channar 84 East 5 waste dump (84E5 WD) occurred in 2011 and is a good example of a rehabilitation area performing well without topsoil application (Figure 33). The success of the rehabilitation area is largely due to improved earthworks practices and quality control. During earthworks the lifts were completed in a top to bottom sequence and the final surface was finished to a high specification before moving to the next area. This ensured that the final surfaces were very close to the design and all windrows were finished and in place with each lift. Topsoil was unavailable so ripping was completed after all surfaces were re-profiled. Ripping was via a winged tyne and the dozer undertaking the ripping had machine guidance GPS installed to ensure accuracy. The most recent rehabilitation monitoring assessment undertaken in 2016 suggests rehabilitation has developed well. Plant species richness, density and cover were generally found to be within the range of the reference sites. Minor erosion features were present in some areas, however they do not threaten overall landform stability. Some weeds, predominantly Buffel Grass and Kapok Bush, were present but only at low densities.



Figure 33: Channar 84E5 WD dump rehabilitation in 2011 (left) and in 2018 (right)

14 Contaminated sites

Rio Tinto maintains registers for potentially contaminating activities and known or suspected contaminated sites which have been formally reported under s11 of the *Contaminated Sites Act* 2003 (WA). The registers are informed by regular review of operations and, where required, preliminary or detailed site investigations (PSI or DSI) to assess contaminants associated with such activities and assess their risk of harm to human health, the environment and environmental values.

Potentially contaminating activities and land uses as described in the guideline '*Assessment and management of contaminated sites*' (DER, 2014), that may be associated with mining activities onsite include, but are not limited to:

- automotive repair workshops (light and heavy machinery);
- substations and transformers;
- fertiliser and explosives storage;
- landfill sites;
- mineral processing, mining, screening and crushing facilities;
- rail transport corridors;
- hydrocarbon storage, handling and dispensing facilities;
- sewage waste water treatment plants; and
- disturbances of potentially acid forming materials during the course of mining.

Based on observations in 2011 of fuel seeping through the concrete slab of the Paraburdoo Heavy Vehicle Refuelling (HME) Facility, the area was reported to the Department of Environmental Regulation (now DWER) under s11 of the *Contaminated Sites Act* 2003 (WA). The area is used as a heavy vehicle refuelling area for mine equipment and has been used for this purpose since 1972. A subsequent investigation found that hydrocarbons (such as from diesel) were present in the soils at concentrations exceeding Health-based Investigation levels for commercial and industrial sites and Ecological Investigations Levels. However it was demonstrated that the area of hydrocarbon impacted soils was confined in nature and would not have a significant impact on any human or environmental receptors due to the depth of contamination, depth to groundwater (>125 mbgl), concrete capping and the ongoing site use as a refuelling facility. Accordingly the site was classified in January 2012 as

'contaminated- restricted use'. This classification recognises that the site is compatible with the current industrial use, but may not be suitable for a more sensitive land use.

The Paraburdoo bulk fuel terminal and locomotive refuelling area have also been reported to DWER and been classified as '*possibly contaminated – investigation required*'. The Paraburdoo bulk fuel terminal has been used as a bulk diesel fuel storage facility since 1972. An environmental assessment found that hydrocarbons were present in the soil at concentrations exceeding Health-based Investigation Levels for commercial and industrial sites and Ecological Investigation Levels. Remedial works of impacted soils surrounding the tanks were subsequently carried out; however areas directly under the storage tanks were not able to be investigated. To assess the risk from potential residual soil contamination, groundwater investigations have been undertaken which have demonstrated declining total recoverable hydrocarbon (TRH) concentrations in groundwater. Based on these recent investigations the risk associated with the minor contamination concentrations to on-off premises personnel and ecological freshwater receptors is either unlikely or the pathway is incomplete.

The locomotive refuelling area is located hydraulically up gradient of the bulk fuel facility and was reported because historic soil investigations of the site undertaken in 2001 identified TRH concentrations in the soil above HIL-F investigation criteria. Localised remedial works were carried out at the site in December 2013; however an inspection in 2014 identified surface staining along the railway ballast was still apparent. Detailed site investigations of the immediate area have not been possible due to topography and infrastructure constraints, however the down gradient bores of the locomotive refueling area (up gradient of the bulk fuel facility) have demonstrated declining TRH groundwater concentrations.

These sites will continue to be managed and investigated as required during operation in accordance with their site classification. Prior to closure and as part of the decommissioning process, these sites, in addition to other areas identified as potentially contaminating activities will be reassessed based on the proposed post-mining land use. This assessment will also include investigations that could not previously be undertaken due to operational infrastructure constraints. Based on this assessment specific plans will be developed to remediate or manage contaminants, where required, and confirm the area classification is appropriate to support the post-closure land use.

15 Cultural heritage

Rio Tinto recognises and respects the significance of Australia's cultural heritage, and in particular the cultural heritage of Aboriginal people who have traditional ownership of, and/or cultural connections to, the land on which we operate. Extensive archaeological and ethnographic surveys have been undertaken in the Paraburdoo area, and these surveys help to inform the heritage values. We take all reasonable and practicable measures to prevent harm to cultural heritage sites, this includes during works associated with rehabilitation and closure. Where this is not possible, steps are taken to minimise or mitigate impacts and ensure required statutory approvals are obtained. Closure works consider issues such as post-closure access requirements to culturally significant sites and the appropriate return of any artefacts salvaged during mining operations.

15.1 Relevant Aboriginal groups

The Paraburdoo mining operations are located within the traditional lands of the Yinhawangka People. The Yinhawangka People have native title rights over the areas covered by the Yinhawangka People native title determination area (WCD2017/003). The extent of the Yinhawangka country in relation to Paraburdoo is shown in Figure 4. Yinhawangka Aboriginal Corporation (**YAC**) is the Registered Native Title Body Corporate representing the Yinhawangka People for native title and cultural heritage matters. Yinhawangka members are geographically dispersed with key locations being Paraburdoo, Bellary Springs Community (near Paraburdoo), Tom Price, Wakathuni Community and West Side Community (near Tom Price), Onslow, Roebourne and Karratha.

On 31 January 2013 Rio Tinto Iron Ore executed a Claim Wide Participation Agreement and subsequently executed an Indigenous Land Use Agreement (**ILUA**), with the Yinhawangka People (collectively the Agreements), with the latter being registered with the National Native Title Tribunal on 5 July 2013. Pursuant to the Agreements, forums have been established for consultation and ongoing engagement with the native title holders on processes such as: land access; life of mine planning; tenure acquisition; cultural heritage management and environmental management relating to Rio Tinto's operations.

Consultation with YAC with regards to closure of Paraburdoo has been limited to date, and more detailed consultation will be undertaken with the Yinhawangka People as closure approaches. Topics that require consultation include the on-going access to heritage sites post-closure, landform rehabilitation methodology, the selection and distribution of native plants during rehabilitation, management of hydrological processes and the ultimate resting place, or repatriation, of any salvaged artefacts.

There is no native title claim on the Paraburdoo to Tom Price railway spur.

15.2 Ethnographic and archaeological values

Archaeological and ethnographic surveys have been undertaken at Paraburdoo since 1998 and some limited surveys have been conducted along the railway spur from Paraburdoo to Tom Price, and the Channar/Turee borefield situated to the south-east of the site. The gas-pipeline route was also heritage surveyed in 2005. All surveys were undertaken with the full participation and involvement of representatives from the Yinhawangka People. Multiple Aboriginal heritage sites have been identified from these surveys.

Rio Tinto maintains a Cultural Heritage Management Plan (**CHMP**) for Paraburdoo which includes strategies for maintaining or restoring cultural values and is regularly updated; it covers an area of 225 km² of which half of the area has been subject to heritage surveys. A total of 456 heritage sites have been listed within the CHMP as protected. The most commonly recorded heritage site types are artefact scatters (a cultural element in 76% of these sites) and rock shelters (a cultural feature in 20% of the sites). Other sites consist of quarries, water-related features, stone structures, scar trees, grinding patches and mythological sites.

The most significant cultural heritage site located in proximity to the Paraburdoo mine is Ratty Springs, located on Pirraburdu Creek. Another culturally significant area, Neerambah and Mud Springs, are located to the south of the Channar/Turee borefields in the vicinity of Turee Creek. In addition to these areas, there are several areas within the mining area (e.g. rock shelters) that may hold cultural significance. This closure plan complements the Paraburdoo CHMP, by recognising that post-closure access to some of these sites may be required and that the area will need to be made safe for this purpose.

In some cases where disturbance is unavoidable, cultural material may be salvaged under Section 16 and 18 of the *Aboriginal Heritage Act 1972 (WA)* where consent is granted following consultation with Traditional Owners, and placed into storage to facilitate mining activity. To date 91 heritage sites have been cleared in the Paraburdoo area, and include along the railway line, the gas pipeline and along the Turee and Channar borefields. The material that is salvaged is stored at the Paraburdoo Keeping Place located at Paraburdoo.

Rio Tinto maintains a geographical information system (**GIS**) and associated relational heritage database for all heritage sites within the CHMP area. Rio Tinto has established geographic exclusion or restriction zones around known heritage sites and these zones are reviewed prior to any ground disturbance activities being internally approved.

16 Regional community

16.1 Regional community

The town of Paraburdoo is located approximately 5 km to the north-west of the Paraburdoo mine site. Paraburdoo was established in 1972 specifically to support the adjacent Paraburdoo mine. A large proportion of the workforce at the Greater Paraburdoo Operations, of which Paraburdoo, Channar and Eastern Range mines are part, reside in the town. The 2016 Australian Bureau of Statistics Census recorded a population of 1,380 in the town¹³. While the communities associated with Paraburdoo are specifically excluded from the scope of the closure plan as they are considered separately, detailed workforce planning, baseline studies and social impact assessments will be undertaken during the detailed closure studies to determine potential social impacts to these communities as a result of closure of the Paraburdoo mine, and this will inform the development of mitigation strategies to

¹³ Australian Bureau of Statistics *2016 Census QuickStats – Paraburdoo*. Released 23 October 2017.

manage impacts. The closest pastoral leases are Rocklea and Mininer stations, which partially overlap portions of the mine lease, and Turee Creek station which is located south of the Channar mine.

16.2 Aboriginal community

There are no permanent Aboriginal communities in close proximity to the Paraburdoo mine. The closest Aboriginal community is Bellary Springs, located approximately 30 kilometres north of the town of Paraburdoo.

17 Workforce

The Paraburdoo workforce is a combination of both Fly-in Fly-out (**FIFO**) workers and a residential workforce residing in the town of Paraburdoo. The majority of FIFO staff are flown directly from Perth to the Paraburdoo airport, with smaller numbers also flying directly from regional centres. The FIFO personnel are housed in one of two fully serviced accommodation facilities in the Paraburdoo town. The residential workforce resides in company and privately owned houses in Paraburdoo.

With the approval of mining at 4EE mining activities are anticipated to continue at Paraburdoo until 2039. As mentioned in previous sections, should mining of Western Range proceed, ore from Western Range will be processed at the Paraburdoo plant. As such the life of the Paraburdoo plant and infrastructure will extend to 2042. It is anticipated mining activities will continue at a similar rate across the wider Pilbara region after the Paraburdoo mine ceases to operate. Thus regional employment opportunities and mine related services are not anticipated to be significantly impacted by closure of the Paraburdoo mine. The existing workforce will be managed through a transition plan that will be developed as part of the detailed closure planning work Rio Tinto undertakes as each asset approaches the end of its mine life.

18 Tailings storage facility

18.1 Above ground Tailings Storage Facility

Wet processing of ore produces a benign residue that is disposed of safely at the site into the Paraburdoo Tailings Storage Facility (**TSF**). The TSF is located approximately 9 km south of the processing plant and 16 km from the Paraburdoo town (Figure 5), and is split into two cells known as the northern and southern cells (Figure 34).

The Paraburdoo mine commenced operations in 1972; however, no fines slurry was produced as part of the mining and processing operations until 1995 when the Further Fines Processing Plant (**FFPP**) was commissioned and the TSF was constructed to contain the material rejected from the FFPP. The fines material is a by-product of a physical crushing, washing and separation process designed to separate saleable iron ore from fine material. The separation process does not involve grinding or chemical alteration of the ore. The ore that is processed in the FFPP is generated from the Paraburdoo, Channar and Eastern Range mine sites, this is planned to extend to Western Range once that mine is approved.

The TSF is a traditional cross-valley storage facility; the fines within the northern cell are contained by the main embankment. The tailings within the southern cell are contained by the western and south eastern saddle embankments. Dividing the two cells is a central embankment and the crest heights of all embankments are at an RL of 371 m. The most recent embankment raise was 2m to the southern cell, and was completed in late 2017, with tailings being deposited early in 2018. The additional storage is expected to add approximately 2.5 years to the life of the TSF. Table 18 provides a summary of the construction sequence that the facility has undergone over time. Figure 34 shows a layout plan.

Table 18: Construction phases of the Paraburdoo TSF

Year	Construction Phase
1995	Main Embankment Constructed to RL 358 m
1997	Main Embankment raised to RL 362 m Western Saddle raised to RL 369 m
2000	Northern/Southern Cell created with central southern embankment constructed to RL 369 m
2002	Main Embankment Upstream Raise to RL 369 m
2007	Decant causeway constructed to RL 369 m
2009	South Eastern Saddle Embankment constructed to RL 369 m
2014	Main & Central Embankment and decant causeway raised to RL 371 m
2017	Central, Western and South East Embankments raised to RL 371 m

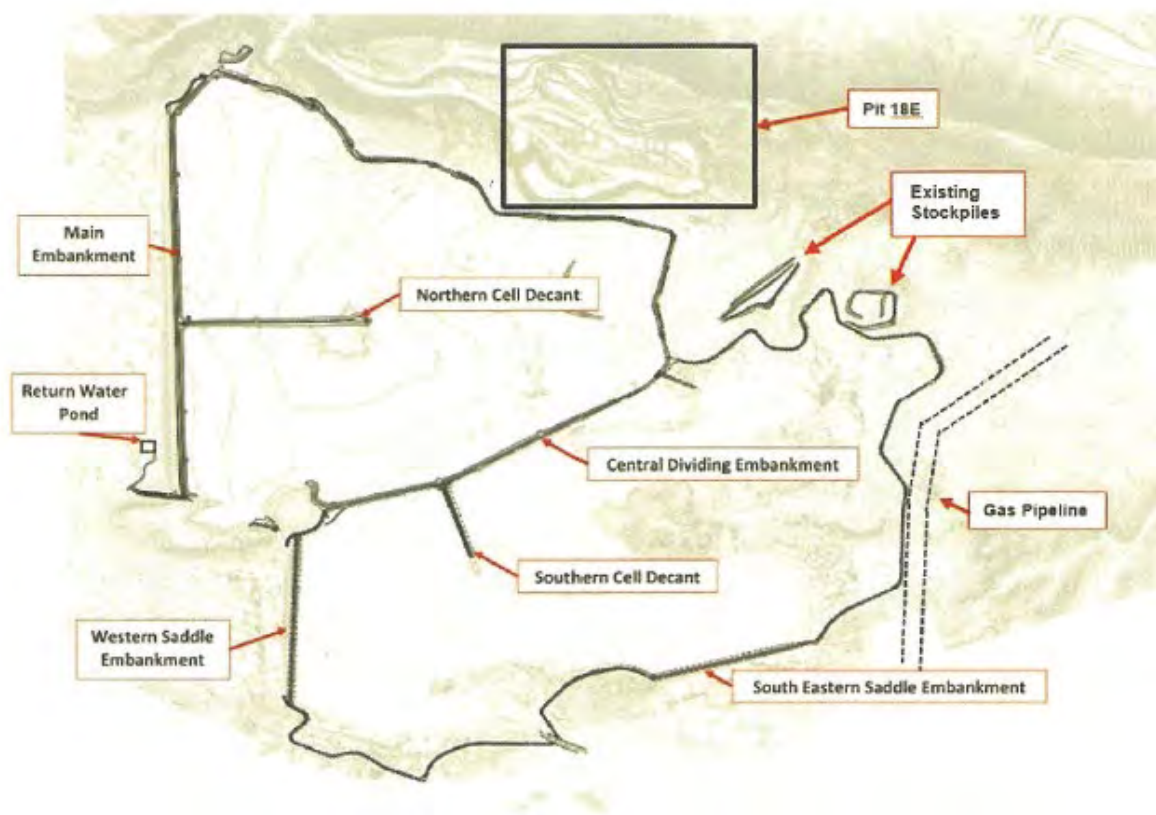


Figure 34: Paraburdoo Tailings Storage Facility

Any future tailings storage requirements past 2020 (including mining of the Western Range and 4EE deposits) will require additional containment. A life of mine TSF plan has been developed, that requires continued cycling between the northern and southern cells with several further wall lifts to a final embankment height of 378 mRL in 2040. Tailings disposal in the 4W pit is currently under investigation that would reduce the volume of tailings stored in the current TSF (discussed in Section 18.2).

The adopted downstream profile; will be inherently stable under both static and seismic loading conditions, will provide a stable drainage system, and will allow for re-vegetation. The TSF hazard rating is classified as a 'category 1', due to the maximum embankment height being greater than 15m, in accordance with the Department of Mines, Industry, Regulation and Safety (previously Department of Mines and Petroleum (**DMP**)) Guidelines on the Safe Design and Operating Standards for Tailings Storage (1999). The TSF Consequence Category was also classified as "significant" in accordance with ANCOLD Guidelines (2012).

A flood assessment was completed for Paraburdoo in 2018 to determine the impact of flood events on the end of mining landforms at Paraburdoo. Three rainfall event magnitude scenarios were modelled from rainfall being received by the upper catchments of Seven Mile and Pirraburdu Creeks, these being 1:100 Annual Exceedance Probability (**AEP**), 1:1,000 AEP and Probable Maximum Precipitation Flood (**PMP-F**). Based on modelled scenarios surface water depth and velocities were determined at the TSF toe. The modelling indicated that due to the TSF being located approximately 3.5km to the east of Seven Mile Creek, interaction with the Creek is minimal.

The external catchment also extends upstream to the north east of the TSF. The catchment consists of steep hills and shallow, flat areas closer to the TSF. Surface water flows during flood events from the upper catchment will need to be considered in more detail and incorporated into the final closure design.

Fines deposited during operation has been via perimeter deposition along the embankment walls and is coordinated in such a way to manage the pond of each cell around the central decant structure. This results in beaching towards the centre of the northern and southern cells. Both cells have central decant towers that feed water into the Return Water Pond. This water is then recycled and pumped back to the process plant. The deposition strategy will be reviewed prior to closure to ensure it aligns with the closure design.

In terms of geochemistry, investigations at Paraburdoo have revealed that the fines are non-acid forming (**NAF**) with acid mine drainage not being a risk. Multi element scans of the water have indicated that the majority of metals and metalloids were below detectable limits. Enrichment of arsenic (As), iron (Fe), antimony (Sb) and selenium (Se) were noted within the tailings samples. However, the analysis of tailings liquor indicates the solubility of environmentally important elements is generally low, where As, Se and Sr were noted as being present at low concentrations.

A network of groundwater monitoring bores exist along and downstream of the northern and western embankments. Environmental monitoring is undertaken in accordance with the site operating license issued under Part V of the Environmental Protection Act. Groundwater levels down gradient of the TSF have generally been declining for over ten years and the decline is attributed to dewatering from the 4E pit. In 2012 and 2016, the pH of groundwater in proximity to the TSF ranged from pH 7.4 to 7.9. Elevated salinity is likely attributed to historical seepage and includes higher concentrations of many metals including Al, As, Hg, Cr, Cd, Cu and Pb. The TDS values obtained from bores located near the TSF in 2018 ranged from 554 to 17,500 mg/L. There is no baseline data against which water quality observed in the TSF bores can be compared.

Seepage from the TSF was recently modelled to assess the likely fate of solutes present in groundwater beneath the TSF. Modelling suggests solutes present beneath the TSF may be slowly moving in a north westerly direction towards the 4E pit dewatering bores during operations; at closure they are predicted to move west towards Seven Mile Creek, which is understood to be the pre-mining flow direction. Additional groundwater data will be collected down gradient of the TSF to further understand the seepage plume.

Upon completion of deposition, the closure strategy for the TSF will be to:

- decommission and remove infrastructure such as pipework and decant pumps. The gravity decant outlet pipe will be decommissioned via filling the pipe with grout;
- remove other surface structures and near surface buried services;
- stabilise the land surface such that it is safe, stable and non-polluting;
- cap the surface with an inert waste cover;
- establish self-sustaining vegetation that is compatible with the planned post-closure land use and comparable to surrounding native vegetation; and
- minimise adverse effects on the environmental values of surrounding areas, for example through changes in surface water drainage or weed infestation.

The current conceptual closure strategy for the TSF is a water shedding design. Rehabilitation earthworks will ensure that natural drainage is reinstated where possible. A 1 m inert waste cap over the tailings surface is planned; however the need for this cap will continue to be investigated. The cover will be designed to match the sloped fines beach surface at the time of decommissioning as closely as possible such that closure earthworks are reduced. Rehabilitation of the fines surface will commence following the cessation of deposition into the facility, after sufficient time has passed to

allow drying and enable access. The embankments will be rehabilitated with 200 mm of soil where appropriate or available. A seed mix comprising suitable provenance species that are suited to the site conditions will be applied and the landform will be ripped on the contour. A detailed closure design will be developed as the TSF approaches closure.

18.2 4W in-pit Tailings Storage Facility

The 4W pit has been mined below water table and without backfill is predicted to form a pit lake on closure. It is proposed tailings be deposited into the 4W pit to eliminate the need for construction of further ex-pit tailings capacity. Due to the early stage of this proposal, the final deposition height (RL) of the tailings are unknown, however they will be at a sufficient level to allow consolidation and drying which will enable capping of the facility at closure.

The 4W pit is situated adjacent to Pirraburdu Creek, as such creek flows and flood events will be considered in the closure design to allow sufficient flood protection for long term stability. At the time of writing this closure plan the flood management partial backfill/bund closure designs were being developed and these will consider flood events to prevent creek interception by the pit in a Probable Maximum Precipitation - Flood (**PMP-F**) event, and subsequent long term stability. These closure prescriptions will inform detailed designs for this facility.

A preliminary class 1 groundwater model to determine potential risks of the proposed 4W in-pit TSF to the surrounding environment post-closure has been developed. The assessment focused on water quality impacts associated with salinity. Five scenarios were assessed to determine solute plume movement under various hypothetical conditions over 5, 20, 100 and 500 years post-closure. Results suggest some solute migration will occur, however groundwater impacts will be localised. Frequent flushing from Pirraburdu Creek will reduce solute concentrations. Upon finalisation of the detailed design and specifications of the in-pit facility, the groundwater model will be refined.

IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

19 Risk evaluation process

A closure risk assessment was completed to identify and assess closure issues for Paraburdoo. The risk assessment is included in Appendix D. The assessment was completed by an internal panel of multi-disciplinary subject matter experts with the aim of:

- identifying hazards, aspects and opportunities that could influence the successful closure of the site;
- evaluating the resulting risks to people, property and the environment; and
- defining the actions required to reduce the risk to below the risk acceptance threshold.

Risk was evaluated on the basis of the maximum reasonable outcome consequence and the likelihood of that consequence occurring. Risks were evaluated inclusive of current management and commitments, and represent current residual risk.

Issues are assessed against the following consequence criteria:

- **Costs:** economic impacts if the risk were to eventuate ranging from low to very high, determined as a percentage of the projected closure cost for the operation;
- **Health:** reversible health effects of little concern (very low) to multiple fatalities (very high);
- **Personal safety:** inconvenient first aid treatments (very low) to multiple fatalities (very high);
- **Environment:** reversible impact (very low) to widespread, long-term impacts (very high). These risks are separated into two categories – during decommissioning/active closure implementation or post-closure.
- **Community trust:** mistrust amongst a small section of the wider community (very low) to widespread mistrust with key stakeholders (very high). Also includes potential heritage impacts ranging from reparable damage to a site of low cultural significance (very low) through to irreparable damage to a site of international cultural significance (very high); and
- **Compliance:** non-conformance to internal requirements (very low) to prosecution for breach of regulatory licence(s) (very high).

Risks are classified as follows:

- **Low** (Class I): Risks that are below the risk acceptance threshold and do not require further management.
- **Moderate** (Class II): Risks that lie on the risk acceptance threshold and require regular review to ensure management remains adequate and fit-for-purpose.
- **High** (Class III): Risks that, based on the current level of knowledge, could exceed the risk acceptance threshold and require proactive management and / or resolution of knowledge gaps.
- **Critical** (Class IV): Risks that, based on the current level of knowledge, will exceed the risk acceptance threshold and need urgent and immediate attention to develop an alternative approach.

Actions are assigned to risks that exceeded the risk acceptance threshold and therefore require additional control measures to reduce the risk to an acceptable level. Actions are also assigned to address knowledge gaps where it is assessed that further information is required to better understand and/or adequately assess the risk presented by an issue. This would typically be the case in the early stages of closure where the detailed knowledge of the issues may be low. These actions are captured within the risk assessment and the task list (Appendix F).

20 Management of key issues

The key issues identified during the site closure risk assessment as requiring management at Paraburdoo are:

- Stakeholder expectations (Class III);
- Fibrous materials –asbestos buildings material exposure (Class III);
- Surface water flows (Class III);
- Vegetation establishment (Class III);
- Public safety (Class III);
- Heritage (Class III);
- Acid and metalliferous mine drainage generation (Class III);
- Tailings Storage Facility (Class III); and
- Pit lake (class IV).

The proposed strategies for the management of these issues are discussed in the following sections.

The DMP/EPA *Guidelines for Preparing Mine Closure Plans* lists a number of rehabilitation and closure issues that may be relevant for mine sites, including eleven that were identified during the site risk assessment as key issues at Paraburdoo. An evaluation of the relevance of each of these issues to Paraburdoo is presented in Table 19. The information in this table is intended to complement that contained in the risk assessment presented as Attachment D.

Table 19: Relevance of potential closure and rehabilitation issues to Paraburdoo

Issue	Evaluation of relevance to Paraburdoo	Further discussion
Acid and metalliferous drainage	Geochemical studies have identified an AMD risk for Paraburdoo.	Section 20.1
Challenges associated with rehabilitation and revegetation	Rehabilitation completed to date at Paraburdoo has shown variable success. The site will have a topsoil shortage at closure which will result in some areas being rehabilitated with subsoil or an alternative growth media.	Section 20.2
Dispersive, sodic and erosive materials	Paraburdoo mineral waste has been physically characterised and some is predicted to be highly erodible; however, most is low erodibility.	Section 20.2
Radioactivity	Not a significant issue for this site.	Not addressed further in this chapter
Mine pit lakes	Paraburdoo will have a pit lake post-closure.	Section 20.3
Geotechnical instability	Some waste dump toes may intersect zones of instability around pit walls, and some pits are in close proximity to Creeks.	Section 20.4
Inadvertent public access	Abandonment bunds will be required to restrict inadvertent public access to high risk areas such as mine voids.	Section 20.5
Hazardous materials	Hazardous materials (e.g. hydrocarbons, ammonium nitrate) will be removed prior to, or during, decommissioning.	Not addressed further in this chapter
Hazardous and unsafe facilities	All infrastructure will either be demolished during decommissioning, or handed to the State in accordance with State Agreement requirements. All tailing storage facilities will be decommissioned and rehabilitated.	Section 20.6

Issue	Evaluation of relevance to Paraburdoo	Further discussion
Contaminated sites	Prior to closure any contaminated sites will be assessed, and where required managed, to support the post-mining land use.	Not addressed further in this chapter
Fibrous materials	Some buildings contain asbestos. At the time of decommissioning these will be demolished and disposed of appropriately. No fibrous mineral wastes are expected to be exposed during the life of operations.	Section 20.7
Non-target metals and target metal residues in mine wastes	No chemical processing occurs at the site. Tailings are inert.	Not addressed further in this chapter
Adverse impacts on surface and groundwater quality	There are not predicted to be any significant regional surface or groundwater quality impacts.	Not addressed further in this chapter
Design and management of surface water structures	Surface water flows and velocities modelled for a range of flood events have been evaluated and will inform closure requirements for pits and landforms near creeks. No creek diversions are required.	Section 20.2
Dust emissions	This is not considered to be a significant closure issue for the site.	Not addressed further in this chapter
Flora and fauna diversity/threatened species	A population of <i>Aluta quadrata</i> , a Threatened species, is located within the mining tenure boundary. Habitats for fauna species listed under Matter of National Environment Significance are present within the tenure boundary. Mining exclusion zones have been established around these areas.	Section 20.8
Visual amenity	This is not considered to be a significant closure issue for the site due to its remote location.	Not addressed further in this chapter
Heritage	Management of cultural heritage values is conducted through processes established under the Indigenous Land Use Agreement, and strategies incorporated into Cultural Heritage Management Plans. Springs hold cultural Heritage value.	Section 20.9 Springs are discussed further in Section 20.10
Alteration of the direction of groundwater flow	Alteration of regional groundwater direction flows is not expected. The pit lake is predicted to form a localised sink.	Section 20.10
Alteration of the depth to water table of the local aquifer	Depth to water table in the local mine footprint area will be affected. This will be isolated and is not considered a significant issue. The duration of the alteration of the depth to the water table near the Channar and Turee Creek borefields is unknown and will be investigated.	Section 20.10
Alteration of the hydrology and flow of surface waters	Alterations to the hydrology and flow of surface waters are expected to be localised and not significant.	Section 20.2

20.1 Acid and/or metalliferous mine drainage

PAF materials have been identified in the mineral waste at Paraburdoo. There is a high AMD risk associated with mining in the 4EE pit, and a low-moderate AMD risk associated with the 4W pit based

on the expected and historic exposure of pyritic black MCS. The AMD risk ratings for 11W and NLC have been down-graded to low based on the current pit shell designs avoiding underlying black shale. There is a low AMD risk for 14-16W, 20W, 27W, 18E and 5W pits.

Expansion of the 4EE pit will result in additional inert and PAF waste material. This material will be dumped over existing waste dumps 4E_WD, 4EMX_WD and 4EX3_South_WD, and create the 4EE_WD. The AMD risk rating of 4EE_WD is considered high and is based on likely quantities of PAF material currently contained and expected to be deposited in the future and/or inert encapsulation of greater than 5m.

Black shale was historically mined at Paraburdoo from the 4E and 4W pits. There are not complete records of the quantity of black shale that was excavated historically, and the locations where it was dumped. A desktop reconciliation review was undertaken in 2018 to provide more certainty where black shale was likely disposed and quantities. Based on this review the following waste dumps are classified as PAF as they may contain PAF material: 4W_WD01 and 4W_WD02. The AMD risk rating of these dumps is considered either low or low/moderate, and is based on likely quantities of PAF material contained and/or inert encapsulation of greater than 5m.

20.1.1 Geochemical assessment and management

Acid and/or metalliferous mine drainage is an issue that is common across Rio Tinto iron ore operations in the Pilbara and processes have been developed and implemented to appropriately manage the PAF materials to reduce the risk of AMD generation. This includes the *Iron Ore (WA) Mineral Waste Management Work Practice* and the *Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan*. As AMD has been identified as an issue for the site, the SCARD management plan is required.

The management strategy for PAF material is based upon the following principles:

- identification of black shale distribution and character;
- minimising the exposure and mining of black shale to the extent possible;
- identification and special handling of black shale that must be mined;
- encapsulation of black shale inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated; and
- placement of black shale below the water table in backfilled open pits to limit oxygen contact.

When designing new PAF dumps, the dump location and footprint are selected to minimise potential long term environmental impacts and financial liabilities. Selection and design criteria that must be considered include:

- the PAF dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments;
- in pit disposal should be considered a priority instead of the construction of above ground waste dumps;
- placement of PAF material in pits that already contain PAF exposures is preferable to placement in pits that do not have these exposed on the pit walls;
- PAF dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom Formation;
- PAF dumps should not be placed over or adjacent to significant seeps or springs;
- the number of sites containing PAF material and the footprint of these dumps should be kept to a minimum; and
- PAF dumps should be located near sources of clean waste rock for encapsulation.

In pit disposal of PAF material is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal is the preferred disposal alternative because it:

- reduces the risk of erosion exposing PAF material in the long term;
- inhibits convective oxygen transport because the waste is surrounded by relatively impermeable walls;

- reduces the footprint of the waste disposal facilities;
- reduces the volume of inert or net neutralising waste needed to encapsulate the PAF material; and
- may help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Where the storage of PAF waste material in pits (backfill) is not possible, PAF material will be encapsulated in waste rock dumps on top of the original ground surface. More stringent design criteria are required for external PAF waste dumps than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and the greater likelihood of convective transport of oxygen through the side slopes of the dump. As shown in Figure 35, hot black shale will not be stored under waste dump slopes.

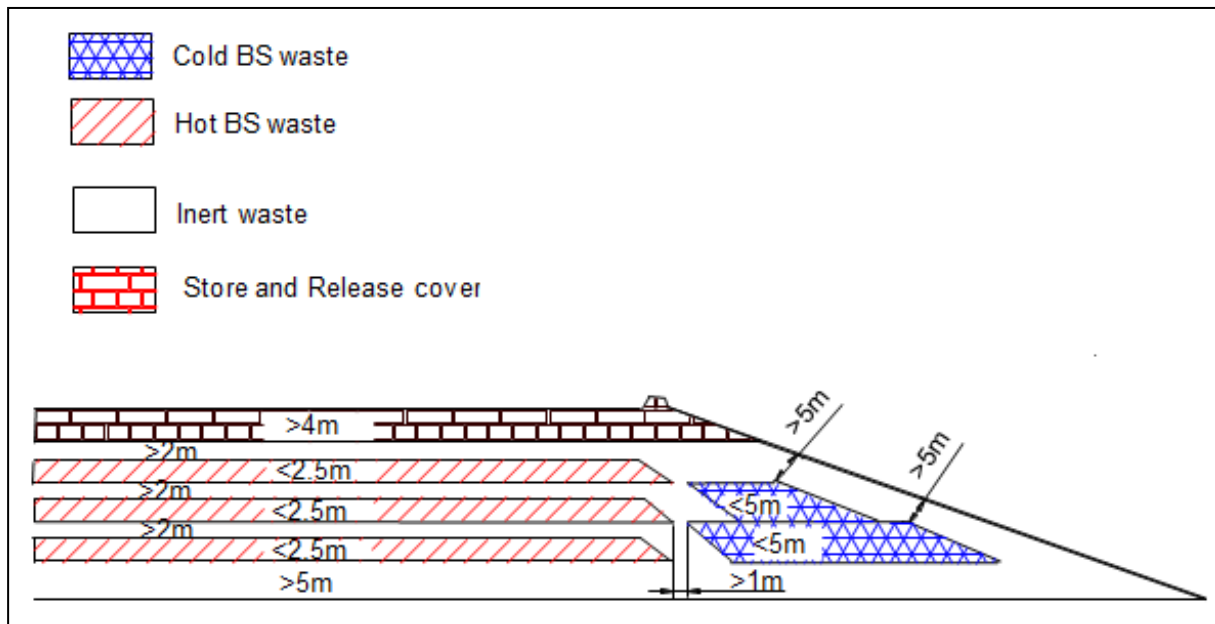


Figure 35: Standard external dump design for PAF encapsulation. It should be noted cold black shale can also be placed where hot black shale waste is stored

Ongoing geochemical assessment will occur throughout the life mine to ensure that any unexpected AMD risks are identified early and appropriately managed. During operations and post-closure, monitoring will be undertaken to assess for any potential contamination of surface and groundwater by acid or metalliferous drainage. If such contamination occurs, appropriate strategies will be developed to monitor and where appropriate, manage this contamination. With proactive management and planning in accordance with the *Iron Ore (WA) Mineral Waste Management Work Practice* and the SCARD Management Plan, AMD is not expected to be an issue for the site as a result.

20.1.2 4EE pit and waste dumps AMD management

Mining of the 4EE pit, which will be a below water table pit, is classified as having a high AMD risk. At the cessation of mining, approximately 309,000 m² of black shale is expected to be exposed on the final pit wall (as shown in Figure 16). Mining in the north western section of the existing 4E pit is complete, and historic exposures located in this area have been covered with approximately 35 m of backfilled inert waste. This in-pit waste dump is known as 4EX_WD.

Mining of 4EE pit will result in the exposure of PAF material located on the north wall from approximately 160-410 mRL. The pre-mining groundwater level was 340 mRL. On completion of mining the predicated post-closure groundwater recovery level is 321 mRL, hence PAF material will remain exposed on the pit wall above the pit lake. Pit lakes are discussed in more detail in Section 20.3.

As discussed in Section 11.2.3 pit lake water quality modelling has been complete for the 4EE pit, and indicates the risk of developing a low pH pit lake is low. Based on this outcome, it is unlikely additional backfill of the pit will be undertaken on closure and therefore a pit lake will persist post-closure.

Additional pit lake modelling will be undertaken to confirm the predicted pit lake water quality as we draw closer to closure.

Annual water quality monitoring around the Paraburdoo area is undertaken for the mine production borefield, the 4E and 4W dewatering borefields and in sumps within the 4E pit. Reviews of surrounding surface water and groundwater data with regard to detecting the onset of AMD has also been completed and will be on-going. Monitoring and analysis of groundwater chemistry to date has shown no obvious indicators of AMD. A review of bore locations and monitoring areas will be undertaken in the future to evaluate expansion areas.

The existing waste dump 4E_WD has been rehabilitated, albeit rehabilitation monitoring has shown poor success to date with erosion and poor vegetation establishment. This waste dump was initially rehabilitated in 1999 using historical rehabilitation methods and prior to modern rehabilitation techniques. As discussed in Section 20.11, this waste dump is located in close proximity to Seven Mile Creek and future rehabilitation prescriptions will consider flood event scenarios. The waste dump is currently located within the 1:100 AEP event flood zone, and will be partially removed at closure to allow the toe of the dump to be outside this flood event flood zone. Any exposure of PAF material during this process will be encapsulated at closure as per the Rio Tinto *Iron Ore (WA) SCARD Management Plan*. In addition, waste from the 4EE pit will partially encapsulate 4E_WD and fully encapsulate 4EMX_WD and 4EX3_South_WD. At this time the amalgamated waste dump will be known as 4EE_WD and the entire area will need to be rehabilitated.

It is anticipated up to 6 Mm³ of black shale will be produced, which accounts for approximately 4% of all waste produced from the 4EE pit. The dumping location, strategy and placement of black shale are currently under evaluation but will be in accordance to the Rio Tinto *Iron Ore (WA) SCARD Management Plan*. Figure 35 shows a standard above ground dump design for a mixed hot and cold MCS dump. The thickness of the hot MCS lifts must not exceed 2.5 m, and will be overlain by a minimum 2 m lift of inert waste rock. The thickness of cold MCS lifts must not exceed 10 m, where no inert waste rock layer is required between lifts. Hot MCS is dumped in this way to manage its spontaneous combustion risk.

20.1.3 4W pit and waste dumps AMD management

Mining of the 4W pit, which is a below water table pit, is classified as posing a low-moderate AMD risk. Black shale exposures are located on the north wall, at approximately 380-430 mRL, and are shown in Figure 17. Black shale is currently exposed; however the backfill strategy during operations indicates that most of the exposure will be encapsulated by inert waste upon closure. The backfill design (waste dump 4W_WD03) is shown in Appendix F. No further management of AMD risks in this pit is planned at closure.

Mining of the 4W pit dates back to the 1970s and whilst it is unclear how much black shale was actually mined at 4W pit, review of the geological model indicates low volumes were excavated. The likely locations of early black shale excavations are thought to have been dumped in 4W_WD01 and/or 4W_WD02. These waste dumps are considered to pose a low AMD risk based on the low volume of black shale likely to have been placed within the dumps, as well as considering the black shale would likely be encapsulated by sufficient (i.e. greater than 5 m) inert waste. Waste dump 4W_WD02 was rehabilitated in 2015 and there have been no indications of PAF material exposure. If black shale is exposed during rehabilitation earthworks on 4W_WD01, a minimum of 5 m inert waste will be placed over the exposure and if it the exposure is on the batters a store and release cover will be installed, as per the *Iron Ore (WA) SCARD Management Plan*.

20.1.4 NLC, 11W, 27W, 20W, 14-16W, 18E, 5W pit AMD management

The 11W pit will be mined above water table and on completion of mining the pit floor will be at a depth of approximately 345 mRL. This pit is classified as having a low AMD risk based on the current pit shell design which avoid exposing the underlying black shale

The NLC pit will be mined below the water table to a depth of approximately 320 mRL. As with 11W, this pit is classified as having a low AMD risk based on the current pit shell design which avoids exposing the underlying black shale. On completion of mining the pit will be backfilled to 350 mRL, which will be approximately 10 m higher than pre-mining groundwater levels (340 mRL). In the event that small areas of black shale are unexpectedly exposed, they shall be encapsulated by backfill.

Based on the low AMD risk for 11W and NLC, no AMD management for these pits is planned for closure purposes.

Pits 27W, 20W, 14-16W, 5W and 18E are above water table pits with a low AMD risk. No management of AMD risks in these pits is necessary at closure.

20.2 Closure landform

20.2.1 Principles of waste landform design

Achieving long term stability of waste landforms is considered fundamental to the successful rehabilitation and closure of a site. Stability is largely controlled by the nature of the surface materials, as well as the rehabilitation parameters adopted.

Waste landforms and landbridges located on mine sites that are operated by Rio Tinto are designed and rehabilitated in accordance with internal Landform Design Guidelines. This document provides guidance on:

- the objectives of waste landform design, which is to achieve landforms that are:
 - safe;
 - stable;
 - aesthetically compatible with the surrounding landscape;
 - vegetated;
 - non-polluting;
 - compatible with the agreed post-mining land use; and
 - progressively rehabilitated;
- selection of appropriate locations for the siting of waste landforms;
- appropriate shapes and designs of waste landforms;
- appropriate surface treatments; and
- links to other relevant internal and external guidance material.

These guidelines are updated on a regular basis to incorporate learnings from research, studies and rehabilitation implementation projects. The most significant recent update occurred in 2012 to provide designs for waste landforms based on the specific waste types present. This was the result of several years of materials characterisation and landform evolution modelling studies of wastes typically found at Rio Tinto Pilbara mines, including those at Paraburdoo, with design recommendations based on the assumption that an average erosion rate of 5 t/ha/year (with a peak of 10 t/ha/year) will be acceptable. Further studies have since been undertaken on additional waste types, and this resulted in further updates in 2014 and 2018.

It should be noted that erosion modelling is conducted on the conservative assumption that slopes are not vegetated. However, vegetation is expected to establish on all slopes, further reducing the erosion potential.

20.2.2 Erosion management

The primary landform design approach proposed across the Paraburdoo site is the battering down of waste dumps and landbridges to achieve a batter and berm style landform. The slope angle, berm width and batter height proposed has been based on the erodibility and physical characteristics of the dominant waste type/s within the landform.

The Landform Design Guidelines indicate that if competent material (i.e. low erodibility) is present in appreciable volumes within a waste landform, or is used to cap the outer surface, than a linear berm and batter design with specifications as presented in Table 20 should lead to the dump being appropriately stable. Specifications are outlined for low and medium erodibility material.

Table 20: Waste landforms berm and batter design specifications based on the erodibility of the waste material

Design specifications	Low erodibility material	Medium erodibility material
Maximum height of lifts	20 m	10 m
Maximum slope angle of lift	20°	20°
Minimum berm width	10 m	15 m
Minimum berm angle	11° (back sloping)	3° (back sloping)

A significant proportion of the mineral waste from Paraburdoo is classified as having low (64%) or medium (19%) erodibility and therefore, the above design specifications are considered appropriate for these landforms.

A portion of the Paraburdoo mineral waste is comprised of geological units that are generally classified as being of high erodibility (17%). Management options for highly erodible waste material have been reviewed with respect to the mine sequence, considering frequency of occurrence for highly erodible waste material, availability of pits for in-pit backfill, availability of materials for capping and stockpile requirements for capping.

Waste landforms that are comprised of material on the outer surfaces that are classified as highly erodible may employ one or more of the following closure design approaches:

- selective handling of wastes to ensure encapsulation of more erodible wastes;
- placement of material into exhausted pits;
- placement of low erodibility material on the outer surface of the landform; and/or
- modified closure design parameters.

Competent material will be placed on the outer surface of high erodibility landforms during construction where practical (i.e. at the completion of each bench), rather than at the end of mining. Where this is not possible, the parameters for the closure design may differ from the '20/20/10' design (20 m lift height, 20 degree slope, 10 m berms) and a smaller lift height and wider berm width may be used. Progressive rehabilitation trials have been undertaken at other nearby Rio Tinto mine sites to determine the success of differing design configurations of highly erodible waste for long term stability. Most recently at Tom Price the closure design of the MME waste dump was designed with a 5 m lift height, 18 degree batter angle and 10 m berm width that was back sloping 3 degrees. The performance of this area from an erosion perspective will be evaluated in future rehabilitation monitoring programs.

As discussed in Section 20.11, several landforms and pits are located in close proximity to Seven Mile and Pirraburdu creeks. Moderate to high flow velocities are expected at the toe of existing waste dumps 4E_WD, 4W_WD02; and landbridges 4E_West_LB, 4W_LB and NLC_LB during the modelled flood scenarios. Suggested closure strategies will be evaluated further but may involve partial or complete waste removal and/or rock armouring. The total volume of rock anticipated to be required to implement the rock armour on lower batters impacted by creek flows, and potential sources for this material, will require further evaluation.

No rehabilitation of in-pit waste dumps or in-pit landbridges is proposed where the waste landform has no potential to impact on the external environment (i.e. any sediment generated will be fully contained within an internally draining pit) and the dump contains only inert material. No re-profiling of pit walls or rehabilitation of pit floors is proposed.

Low grade ore is being stockpiled on site for future sale, however market conditions change over time and there is potential that the stockpiles will remain on the completion of mining. Therefore Rio Tinto is managing the stockpiles as if they are waste dumps to ensure resources, such as funds and competent wrapping material, are available to rehabilitate them if required.

Closure landform rehabilitation designs are detailed in Appendix F and are based on a site specific assessment of materials. A multi-disciplinary pit and waste dump design sign-off process is conducted; which considers landform design guidelines and provides rehabilitation designs. Performance of rehabilitation designs will be reviewed during the life of the mine.

20.2.3 Vegetation establishment

Rehabilitation success across Greater Paraburdoo to date has been variable, with poor rehabilitation outcomes observed in some historical areas. However, significant improvements have been made in recent years in waste characterisation and landform design, leading to reduced erosion rates and improved waste dump stability. These refinements will result in improved rehabilitation outcomes for Paraburdoo.

Prior to rehabilitation being carried out, engineering designs are developed for each landform. These designs are technically reviewed by internal specialists from a range of disciplines and approved prior to implementation. Waste reshaping is then implemented in accordance with the approved design and survey controls and machine guidance systems are also used to ensure strict conformance to the planned landform design is achieved. At the completion of earthworks, areas are cross-rippled on contour and seeded with a native seed mix of local provenance. Seed is purchased from third party suppliers for use in rehabilitation activities. Stringent controls on seed quality, provenance and seed storage are in place and seed pre-treatments are used for some species to maximise the potential of applied seed to germinate under field conditions.

As discussed in Section 10.6, there is expected to be a deficit of topsoil and subsoil material at Paraburdoo at closure. A deficit will still remain despite future predicted topsoil/subsoil recovery from proposed mining footprints which have conservatively been calculated (e.g. waste dump 4EE_WD). One strategy to address this topsoil shortage is to use mined waste materials as alternative growth media. The Greater Paraburdoo Operations team has proactively identified potential alternative materials at the site. Chemical and physical sampling has been conducted on materials mined at nearby Channar and deemed them to be a suitable subsoil substitute. If this material presents in mining at Paraburdoo it will similarly be tested and stockpiled if deemed suitable.

A trial is also underway at the Tom Price operation to validate the suitability of mineral waste material for use as alternative growth media in rehabilitation activities at Rio Tinto operations. The outcomes of this will be used to inform the Paraburdoo closure strategies. Tom Price is also trialling waste dump rehabilitation with no use of topsoil (i.e. direct seeding of the dump landform¹⁴). The 84E5 waste dump at Channar was rehabilitated without addition of a growth medium and is performing well to date. If alternative materials prove viable in rehabilitation success, it is proposed that topsoil application be prioritised on higher risk areas (e.g. PAF material and large waste dumps) and lower risk areas such as laydown or infrastructure areas will receive the alternative growth media or no growth medium. If required, seeding rates may be increased in areas receiving alternative growth media or subsoil material to compensate for the lack of a topsoil seedbank. The application of fertiliser will also be considered for materials that have low nutrient status, although recent evidence suggests the addition of fertiliser is not always beneficial.

20.3 Pit lakes

As described in Section 11.2.3 three pits will be mined below water table. The NLC pit will be backfilled with mine waste during operations. The 4W pit is currently being assessed for backfill with tailings to above water table, if this does not occur then currently a pit lake is predicted to form. The 4EE pit is the final pit to be mined at Paraburdoo, and the BWT stages of the pit cannot be progressively backfilled during operations. A pit lake is predicted to form in the 4EE pit void post-closure. The key characteristics of the potential 4W and 4EE pit lakes are presented in Table 21.

Pit lake water quality modelling has been conducted for the 4EE pit to predict the pit lake properties on closure. Modelling has indicated the lake will be approximately 200 m deep, filling within 5m of the final stable level in 50 years. The lake will have a circum-neutral pH and evapo-concentration processes will cause increasing TDS over time. Whilst several scenarios were modelled, TDS was predicted to be ~2,500 mg/L at 100 years and ~17,000 mg/L at 1,000 years. The climate change scenario that was modelled resulted in overall lower TDS predictions. Several trace elements (As, Se, Mo and Hg) will enter the lake as a first flush from talus and walls/benches, with higher initial concentrations that decrease as groundwater inflow volumes increase.

¹⁴ Rehabilitation works were completed in early 2018 on the MMW4 waste dump using subsoil substitute detrital material. The MME waste dump was rehabilitated in April 2018 utilising no topsoil. The Tom Price Landfill was rehabilitated in 2017 using subsoil.

The current understanding is that the 4EE pit will act as a groundwater sink and is not expected to have a degrading effect on regional groundwater quality. Evaporative losses will exceed total groundwater inflows into the pit. Although pit water salinity is expected to increase over time any poor quality water is expected to be contained within the immediate proximity of the lake. This assumption will be reviewed and updated as further data is collected and research conducted. Continued groundwater monitoring and drilling will provide more information on aquifer properties and water levels in this area.

Due to the predicted terminal nature of the pit lake, no significant pathways exist for groundwater or surface water discharge from the pit lake. However, it is possible some minor density driven flow might occur through the base of the pit if and when the density of the pit water becomes high enough (as salinity increases). It is possible birdlife or bats, both having known populations in the Paraburdoo area, may directly contact pit lake water. The predicted physical nature of the pit lake, such as small littoral and riparian areas suggest birds are unlikely to stay for long periods due to lack of foraging habitat and opportunity. Similarly the possibility of livestock entering the 4EE pit and drinking the water is considered unlikely due to the steep pit walls, predicted water level and abandonment bunds preventing access.

Tailings deposition into the 4W pit is proposed and the current closure strategy is a rehabilitated surface. In the event tailings are not deposited into 4W pit, it is predicted a pit lake will form on closure (Table 21). As described in Section 20.1.3 the majority of PAF exposures on the 4W pit wall will be covered by inert waste at closure. From a conceptual assessment of the lithology's present on the final pit wall and learnings from recent pit lake modelling work, it is anticipated that the 4W pit lake will not become acidic. Recent conceptual pit lake modelling has been undertaken with the intent to provide an indication of likely salinity levels post-closure. Modelling indicates that the pit lake will be characterised with increasing TDS over time. The current understanding based on analysis of data collected to date and preliminary hydrogeological modelling, is that the 4W pit will act as a groundwater sink and is not expected to have a degrading effect on regional groundwater quality. However, if groundwater levels around the pit recover further than predicted levels, a potential flow-through pit lake cannot be excluded.

Opportunistic backfilling of the pits will occur where practical at Paraburdoo, but no post-closure backfill is currently proposed for 4EE or 4W pits for the purpose of preventing a pit lake. It is however planned that partial backfill of some pits located adjacent to Seven Mile and Pirraburdu Creeks, to prevent creek interception during flood events, will occur. This aspect is discussed in more detail in Section 20.2.

During operations and post-closure, monitoring will be undertaken to assess for any potential contamination of surface and groundwater by AMD. If such contamination occurs, appropriate strategies will be developed to monitor and where appropriate, remediate this contamination. Furthermore additional pit lake water quality modelling is planned to determine if leaving a pit lake will provide an acceptable environmental outcome.

Table 21: Predicted closure groundwater level and pit lake depth in Paraburdoo below water table pits

Pit	Post-mining pit crest (mRL)	Pre-mining GW level (mRL)	Post-closure pit floor level (mRL)	Predicted post-closure GW level (mRL)	Pit lake depth (m)
4EE	480	340	120	321	200
4W*	342	340	240	330-340	100

Note:

* Proposed strategy for 4W pit is to backfill with tailings. In the event 4W pit is not used to store tailings, a pit lake is predicted to form post-closure, therefore pit lake details have been provided.

20.4 Geotechnical instability management strategies

At Paraburdoo pit voids will remain after closure. As indicated in Section 10.3, for the majority of pits, there is no intent to reshape or rehabilitate in-pit areas, and the remaining pit walls will be retained in the same configuration as when mining ceases. It is recognised that there will be some degree of geotechnical instability, and that walls will have the potential to collapse in some areas. Conceptual abandonment bund locations are shown in Figure 36 these will be refined as the site approaches closure.

This closure strategy will differ for the pits located adjacent to Pirraburdu and Seven Mile creeks, namely pits 4W and 11W, as intersections of these pits zone of instability (**ZOI**) are in close proximity to the creeks. As discussed in Section 20.2, on closure it is proposed partial backfill will occur in these pits and conceptual designs are shown in Figure 40. However, the use of 4W pit for tailings storage is currently under evaluation and if deposition occurs the partial backfill designs will need to be reviewed.

The western side of the existing 4E pit (which is adjacent to Seven Mile creek) will be backfilled with waste during operations, creating the northern finger of the 4EE_WD. As a consequence the zone of instability for the proposed 4EE pit will be located further away from the Creek at approximately 350 m from the creek edge. The NLC pit which is also located adjacent to Seven Mile Creek is assumed to be backfilled with waste material during operations to a height greater than creek bed height, creating the in-pit waste dump NLC_WD02, this will eliminate the ZOI adjacent to Seven Mile Creek.

All rehabilitation designs for waste dumps and landbridges have taken this potentially unstable zone into consideration; however some toes of existing waste dumps and landbridges to be rehabilitated appear to have minor intersections within the ZOI. The strategy for these areas will be refined as the site approaches closure.

20.5 Inadvertent public access

Mine safety in Western Australia is regulated by the DMIRS under the *Mines Safety and Inspection Act 1994*, the *Mines Safety and Inspection Regulations 1995*, and the *Mines Safety and Inspection Amendment Bill 2009*. For the majority of Rio Tinto operations the issue of public safety is mainly related to the potential for the public to inadvertently access pit voids (or areas of potential instability surrounding pits). Open pits are designed to be stable during the life of the mining operations, but may not be stable in the long term as materials weather and erode, leading to slips and failure of sections of the pit walls. These failures lead to significant risks to people who access these areas in vehicles or on foot.

As with waste landforms, designs for restricting public access need to be considered on a case by case basis after considering a range of factors such as:

- accessibility of the site (e.g. proximity to towns/major roads/areas of interest);
- nature of surrounding landscape (e.g. pits abutting steep natural slopes, floodplains, water courses);
- availability of suitable material to construct structures (e.g. material for abandonment bunds/rock structures);
- pit geology and geometry (e.g. natural stability of the pit, pit backfill, pit lake post-closure);
- post-closure land use (e.g. pastoral areas may require exclusion of cattle from pit voids); and
- location of heritage sites (e.g. sites may require access post-closure).

Paraburdoo mine is situated in a remote location, with the nearest town being Paraburdoo, which is located approximately 5 km north-east of the mine. The primary route for vehicular access to Paraburdoo operation is via the private Paraburdoo Access Road. Additional tracks are located to the south and north of the mining footprint to facilitate exploration activities. Public access into the site is likely to be limited due to its remoteness and the implementation of measures to actively discourage access.

In order to mitigate the risk of inadvertent public access, the following conceptual measures are proposed, with details to be agreed with the Safety Division of the *Department of Mines, Industry Regulation and Safety* as the site approaches closure:

- rehabilitation of tracks that are not required for monitoring and/or maintenance post-closure, and installation of physical barriers (e.g. earthen bunds) where appropriate to prevent access;
- installation of a locked gate on the main access road (and the alternative unsealed access road if it is required to remain post-closure) for the duration of the post-closure monitoring and maintenance period;
- rehabilitation of all access roads prior to relinquishment and installation of physical barriers (e.g. earthen bunds), unless the State wishes the roads to remain accessible for whatever reason; and

- a review of the visitors to access the site, and installation of additional control measures, including abandonment bunding around pits, where appropriate.

Abandonment bunds will also be established to limit access to pit voids. Abandonment bunds will only be placed in areas with potential access exposure and in conjunction with the following alternative methods for limiting access to pits:

- consideration of the potential for local topography to prevent inadvertent public access;
- blocking or removing access tracks and roads where appropriate (e.g. windrows);
- use of large rocks to prevent vehicular access whilst allowing surface water flows;
- enabling safe, controlled access to specific areas where required (e.g. sites of cultural heritage significance);
- installation of gates along roads that need to be accessed (e.g. to facilitate monitoring); and/or
- installation of appropriate signage.

At this stage there is uncertainty about the precise location of final pit shells for current deposits, the potential for further unapproved deposits to be developed and prescriptions for partial backfill of pits located adjacent to creeks. Exact abandonment bund locations have therefore not been decided, but conceptual locations have been proposed (Figure 36). Abandonment bunds will be constructed:

- in accordance with the DMIRS guideline Safety Bund Walls Around Abandoned Open Pit Mines unless an alternative design is approved by the DMIRS;
- outside of the zone of instability around pit walls;
- with consideration of the implications for local drainage; and
- fully around pit edges unless agreement is reached with the DMIRS that the risk of inadvertent access is sufficiently low in specific areas (e.g. due to natural topography, or due to the presence of barriers in other locations).

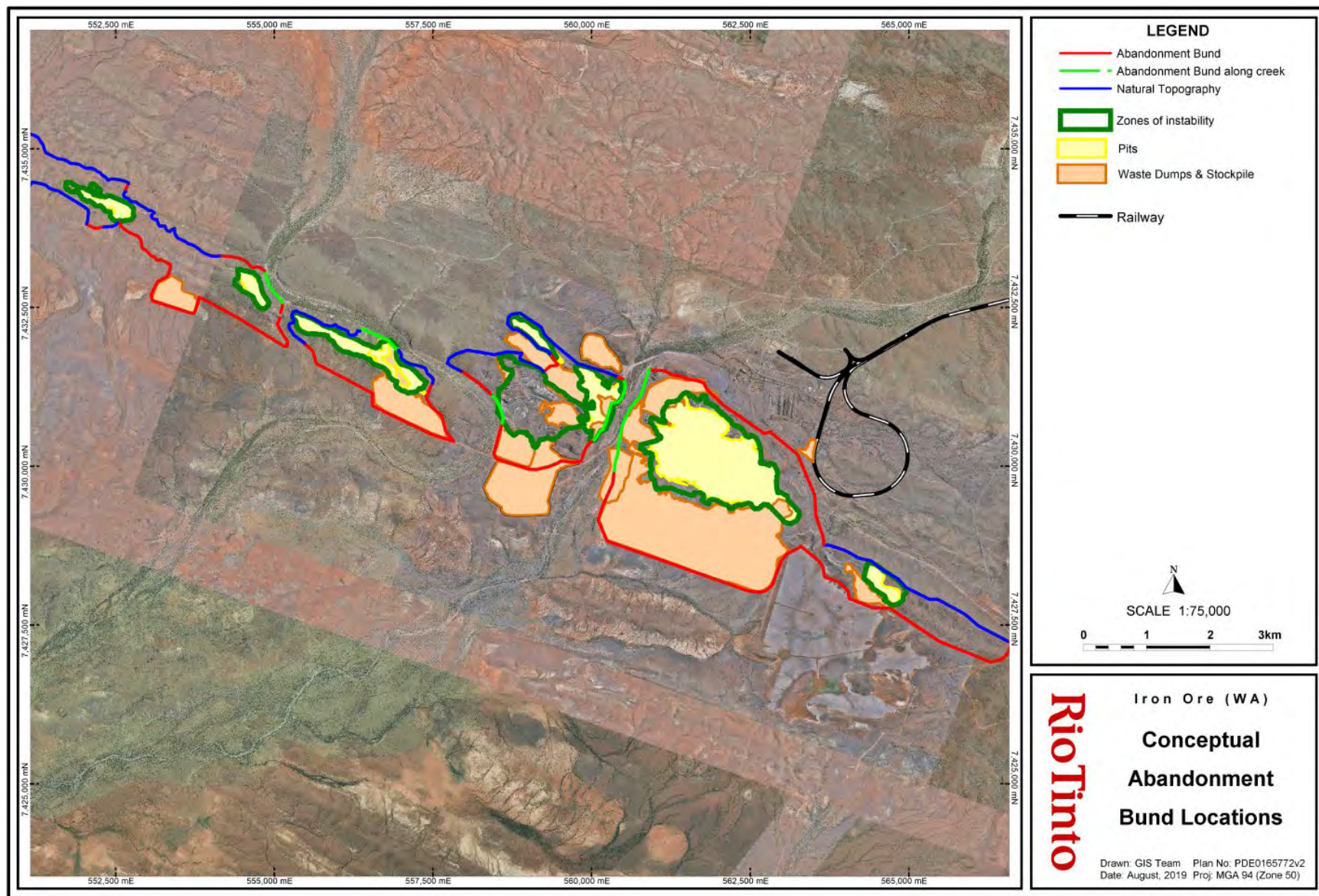


Figure 36: Conceptual abandonment bund locations

20.6 Tailings Storage Facility

Currently one ex-pit, above ground tailings storage facility is present at Paraburdoo. A conceptual closure design for the TSF was created as part of the mining proposal for the TSF Southern Cell Expansion (October 2016), as described in Section 18. The information contained within this document is considered to be fit-for-purpose at this stage. As closure approaches it will be cross checked that the facility has been constructed and operated as intended and a detailed closure design will be developed. The final landform design and surface water management strategies in the vicinity of the TSF will also be considered to ensure the TSF closure design has adequately addressed these matters.

As described in Section 18, Rio Tinto is currently assessing the viability of using 4W pit for storage of tailings and it is proposed tailings be pumped into the pit to a level that will prevent a pit lake forming. Due to the early stage of the proposal, the final RL of the tailings are unknown, however they will be at a sufficient level to allow consolidation and drying to allow capping of the facility at closure.

The 4W pit is situated adjacent to Pirraburdu Creek, as such creek flows and flood events will be considered in the operational and closure design to allow sufficient flood protection for a PMP-F flood event. Closure prescriptions that comprise either bunding or partial backfill will be required to provide sufficient protection against floods. As a minimum the design will consider minimum height required for designed flood event scenario, slope angle, width of bund and constructability including material types and sources. A detailed closure design will be incorporated as part of the design document for the facility.

20.7 Management of fibrous material exposure

Some of the infrastructure and buildings located at Paraburdoo date back to the 1970s and some of the older buildings contain asbestos materials. The Paraburdoo fixed infrastructure is captured under 11(e) of the State Agreement, however given the age and condition it is unlikely the State would have an appetite for these buildings. As such it is likely at closure these buildings will be dismantled and disposed of correctly in accordance with health and safety requirements.

There have not been any hazardous fibrous mineral waste occurrences during mining to date at Paraburdoo, although some isolated occurrences of fibrous material have been intersected in resource evaluation drill holes. Based on conservative geological interpretation, rather than confirmed occurrence, there are some potentially fibrous areas associated with fresh dolerite in the NLC and 4EE areas. These areas will be geologically assessed after further drilling to be re-classified as either “normal” or “designated” fibrous mining areas.

The *Rio Tinto Iron Ore (WA) Fibrous Minerals Management Plan* provides guidance for the management of fibrous minerals should fibres be encountered during mine production. These measures include responsibilities for ensuring as-built waste dump designs which contain fibrous material include 3D plans of the locations and volumes of fibrous material, and that pit face surveys map exposures of fibrous materials. It also outlines the procedure for encapsulating this material with an appropriate amount of inert material in designated waste dumps. This encapsulation methodology takes into account the final rehabilitation design of the landform to ensure that the material remains secure post-closure. A schematic of a typical in-pit fibrous dump is shown in Figure 37 and an external fibrous dump in Figure 38.

Should fibres be excavated during mining, fibrous material would be stored in the designated fibrous in-pit waste dump 4W_WD03. It is possible the ‘designated fibrous’ classification of 4W_WD03 will be downgraded in the future should fibres not be encountered and disposed of within it.

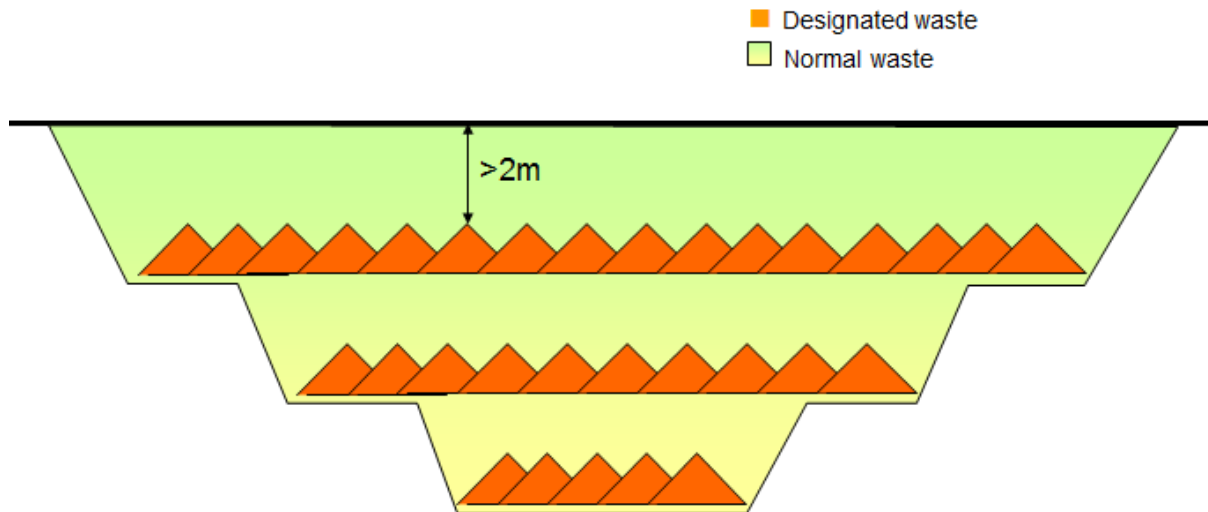


Figure 37: Typical in-pit dump design for fibrous mineral encapsulation

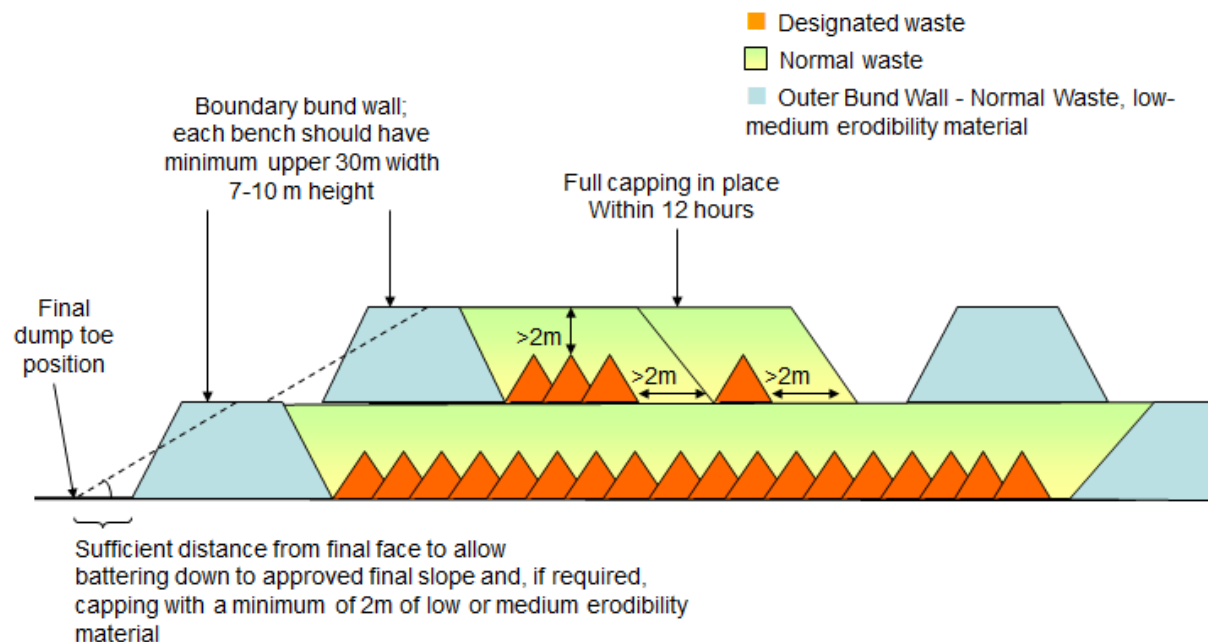


Figure 38: Typical external dump design for fibrous mineral encapsulation

20.8 Flora and fauna diversity and threatened species

Hills and hilltops and drainage habitats at Paraburdoo are considered to hold elevated value due to the diversity of microhabitats (such as sheltered ridges, caves, gorge/gullies and ephemeral pools) and potential to provide core habitat for conservation significant fauna species. Many targeted fauna surveys for species listed under Matter of National Environment Significance have occurred at the Greater Paraburdoo area; specifically for the Pilbara Leaf-nosed Bat, Northern Quoll, Ghost Bat and Pilbara Olive Python. The hills and hilltops and drainage habitats are considered most suitable for these species; in particular areas along Pirraburdu Creek, and specifically the culturally significant area known as Ratty Springs. Exclusion zones and associated controls are in place to avoid any unapproved clearing of these areas during operations and closure.

Extensive survey work has been completed across the Paraburdoo mining area and surrounds to identify the location of *Aluta quadrata* plants. The Paraburdoo *A. quadrata* population is located directly north of Pirraburdu Creek and the nearest pit is 11W, which is located approximately 300 m west from the population, on the opposite side of the creek. Ground disturbance exclusion zones have

been established at all locations where the species has been identified. Rio Tinto's internal ground disturbance permit system ensures that proposed clearing boundaries are checked for potential interactions with exclusion zones prior to any clearing activities being authorised. The closure strategies proposed in this plan are not expected to result in impacts to the Paraburdoo *A. quadrata* population.

20.9 Heritage Values

Management of cultural heritage values will be conducted through processes established under the Claim Wide Participation Agreement and strategies incorporated into CHMPs. Closure planning considers how salvaged artefacts will be managed long term, however the intent for artefact material salvaged has not been determined at this point.

Although considered during landform design and planning, which includes rehabilitation designs, heritage sites may also be impacted as a result of closure implementation (i.e. footprint encroachment). As options on engineering and rehabilitation designs are narrowed approaching closure, any potential for sites to be impacted will be identified and managed in accordance with appropriate procedures. Heritage surveys, and any future assessments or clearances that are required to facilitate closure implementation will be conducted in collaboration with the Yinhawangka People in alignment with the CHMP. Post closure access requirements will be refined during mine life and changes will be communicated in updates to the closure plan.

20.10 Groundwater flow and depth

Whilst mining will leave the regional groundwater system intact, dewatering activities and borefield abstraction will impact the local aquifer system. Dewatering of below water table pits and abstraction at borefields creates a cone of depression in the water table which can extend beyond the area dewatered. Within the Paraburdoo mining footprint, it is predicted groundwater will recover in most areas to pre-mining water table levels once dewatering and water supply abstraction has ceased in the area, due to large groundwater recharge events that occur during adjacent creek flows. Post-mining, groundwater will flow back into the 4EE pit creating a pit lake. Conceptual modelling indicates the pit lake will act as a sink and groundwater recovery from dewatering activities is predicted to reach equilibrium within approximately 50 years once the pit lake level has stabilised. Groundwater levels beneath Seven Mile Creek are predicted to make a full recovery to pre-mining conditions due to large recharge from intense rainfall events and creek surface water flow interactions with the underlying hydrogeology. However localised changes around the 4EE pit lake may be present post-closure.

The semi-permanent pool, Ratty Springs, exists along the Pirraburdu Creek in proximity to the Paraburdoo mining area, approximately 2 km north-west of the existing 11W pit (AWT) and 600 m north of the proposed 20W pit (AWT). The spring is thought to occur where groundwater within the Fortescue Group discharges where Pirraburdu Creek narrows and crosses through the Marra Mamba Iron Formation. This occurs up-gradient of dewatering activities which occur within the Brockman Iron Formation. As discussed in Section 11.2.5, this pool has high biodiversity and heritage value. The hydrogeological conceptual model suggests the Springs are hydraulically disconnected from dewatering activities and monitoring since 1999 has reported no measurable impact due to mining or dewatering. As such, it is not anticipated current dewatering or proposed dewatering of the 4EE pit, will impact groundwater levels or quality in this area and therefore, the Spring will persist.

Supply water is currently abstracted from groundwater at the Southern, Channar and Turee Creek supply borefields. Recharge of the Southern borefield aquifer is primarily via infiltration from rainfall runoff and connection to adjacent alluvial aquifers of Pirraburdu and Seven Mile Creeks.

The Channar and Turee Creek supply borefields are located to the east of the Paraburdoo mine and outside of the Paraburdoo operational area. As discussed in Section 11.2.2, the deep aquifer groundwater level response after rainfall recharge is muted or non-existent; however, water level recovery is observed during periods of reduced abstraction. Groundwater monitoring and modelling is being undertaken to understand the potential interaction between the Channar and Turee Creek borefields, and the Neerambah and Mud Springs. Once the required information has been collected and analysed, a closure strategy will be developed for stakeholder consultation.

20.11 Major creek surface water flows

Flood assessments have been completed for the Paraburdoo mining area to determine the flood risk associated with the Seven Mile and Pirraburdu Creeks for a range of design rainfall events. Hydraulic models were used to assess flood behavior on the Paraburdoo post-mining landform for both non-expansion scenario (completed in 2018) and conceptual mine expansion scenario (currently ongoing). The models were used to estimate maximum flood depths and maximum velocities across the model domain. Event scenarios that were modelled include 1:100 Annual Exceedance Probability (AEP) event, 1:1,000 AEP and Probable Maximum Precipitation – Flood (PMP-F).

A map showing flood depths across the post-mining landscape at Paraburdoo (with proposed mine expansion and inclusion of some closure flood mitigation measures) resulting from a 1:1,000 AEP event scenario is presented in Figure 39. Initial results indicated that the impact of flood events on the mine landforms post-closure has been reduced with the updated mine plan. In particular some pits that previously intercepted creek flow under the 1:1,000 AEP flood event no longer intercept creek flows in the revised terrain. At the time of writing this closure plan the modelling and assessment of the post-mining landforms (with mine expansion) was still in draft format, therefore results are considered indicative only. This outcome is different from what was presented in the 2018 Paraburdoo closure plan and is attributed to closure solutions being built into the mine plan as part of the expansion. The closure solutions are described below.

Conceptual pit backfill designs have been proposed (Figure 40, Figure 41 and Figure 42) and these take into consideration minimum height to prevent creek interception, batter berm configuration for adequate buttressing, slope angle and width. Due to the proximity of these pits to large creeks, the resulting high risk of creek interception and the constructability of the structures, the partial backfills for 11W, 4W and 4E pits have been designed to raise the final landform above the estimated level of the PMP-F. The full breadth of the NLC pit will be backfilled to a height greater than creek bed height and closure measures that prevent significant scour erosion will be considered within the detailed closure designs. These designs will be refined prior to closure and factors such as geotechnical stability and type of construction material required for long term stability will be addressed. They are indicative only and subject to revision based on Rio Tinto's ongoing assessment of the merits and implications of adopting the PMP-F event scenario for final landform design for these pits.

Furthermore as discussed in Section 18.2 it is proposed 4W pit may be used to store tailings. Due to the early stage of the proposal detailed information of the storage are under evaluation, however the design for the tailings embankment will consider closure measures for flood protection.

Peak velocities across the post-mining landscape (with mine expansion) adjacent to the creek lines are presently under evaluation. However, based on the 2018 flood modelling assessment, velocities are anticipated to be moderate to high (>2 m/s) at the toe of existing waste dumps 4E_WD, 4W_WD02; and landbridges 4E_West_LB, 4W_LB and NLC_LB during the modelled scenarios. These locations are at risk of scour erosion without closure mitigation prescriptions.

The closure mitigation strategy options include possible relocation/redesign of the closure landforms such that they are outside of the 1:100 AEP flood extent boundary. Previous modelling (non-expansion scenario) has indicated the existing 4E_WD, 4E_West_LB, 4W_LB and NLC_LB are partially positioned within the 1:100 AEP flood zone. As a consequence it is anticipated waste that is located within this flood zone will be removed and placed outside of the 1:100 AEP flood zone. The post expansion topography presented in Figure 39 depicts removal of this waste. The position of the proposed 4EE_WD has been placed outside of the 1:100 year flood zone. Partial removal of landbridges adjacent to creeks and 4E_WD are considered indicative only and subject to revision based on Rio Tinto's ongoing assessment of closure flood management at Paraburdoo. Alternative closure options will consider rock armoring of these zones.

Table 22 summarises the landforms at risk of scour erosion for the 1:1,000 AEP event, and mitigation options, such as rock armoring of potential scour zones or removal of waste material.

Table 23 presents potential closure strategies to prevent pit interception.

The velocities on the engineered landforms that are is largely attributable to the steepness of the natural topography compared to the engineered post-closure landforms, and the presence of defined natural drainage lines which concentrate surface flows. Management of these erosion risks will be addressed as the final landform design is refined.

Some minor ponding of water can be expected in pit voids outside of the creek flood zones and on waste dump tops and berms during rainfall events. However, this ponding is expected to be temporary with water evaporating or infiltrating.

Assessment of flood depth on the TSF under the 1:1,000 AEP event has shown water ponding on its upper surface. It should be noted that the modelling was undertaken on the current TSF topography, and not on the end-of mining or post-closure landform, thus modelled depths are not representative of what the post-mining situation would be. The post-closure landform is expected to be a water shedding design and surface water will be considered in more detail during the detailed closure design process for this facility.

In summary, closure measures will be implemented to ensure pits do not intercept Seven Mile and Pirraburdu Creek flows, ensuring flows are maintained through the mine lease area. Closure landforms adjacent to these creek lines will have flood protection measures installed to ensure they will remain safe and stable.

Table 22: Summary of the risk of scour/erosion of the post-mining landform during an extreme rainfall event

Landform	High risk zone for scour/erosion under 1:1,000 AEP	Potential mitigation measures
4W_WD02	High energy flow from Pirraburdu Creek on western face	This dump has been rehabilitated. Review current protection measures to ensure adequate
4E_WD	High energy flow from Seven Mile Creek on western face	This dump will merge with proposed 4EE_WD. Waste dump 4E_WD was historically rehabilitated and requires rework. Review closure options for complete/partial removal or landform design options such as rock protection
4EE_WD	To be evaluated	Determine if landform design options such as rock protection is required
4W_LB	High energy flow from Seven Mile Creek on eastern face	Review closure options for complete/partial removal or landform design options such as rock protection
NLC_LB	High energy flow from Seven Mile Creek on eastern face	Review closure options for complete/partial removal or landform design options such as rock protection
4E_West_LB	High energy flow from Seven Mile Creek on north western face	Review closure options for complete/partial removal or landform design options such as rock protection
4W_WD01	High energy flow from Pirraburdu Creek on western face	Review closure options for complete/partial removal or landform design options such as rock protection

Table 23: Pits at risk of creek interception and/or overtopping under an extreme rainfall event (1:1,000 AEP)

Pit	Creek interception/overtopping under 1:1,000 AEP *	Potential mitigation measures
4EE	No interception	Partial backfill of the 4E pit on the riverine side of the 4EE pit (4EE_WD) will prevent pit interception. Detailed closure design currently under evaluation and will consider abandonment bunding
4W	No Interception	Closure design to consider bunding or partial backfill. Further investigations required
11W	No interception	Partial backfill of the riverine side of 11W pit. Detailed closure design currently under evaluation and will consider abandonment bunding
NLC	No interception	Pit not intercepted as it will be partially backfilled to above creek bed height during mine operations. Scour management may be required
18E	No interception	Incident rainfall contained within 18E pit. No mitigation required
5W	No interception	Incident rainfall contained within 5W pit. No mitigation required

Note: * Modelling was undertaken on post-expansion terrain which incorporates some flood management measures.

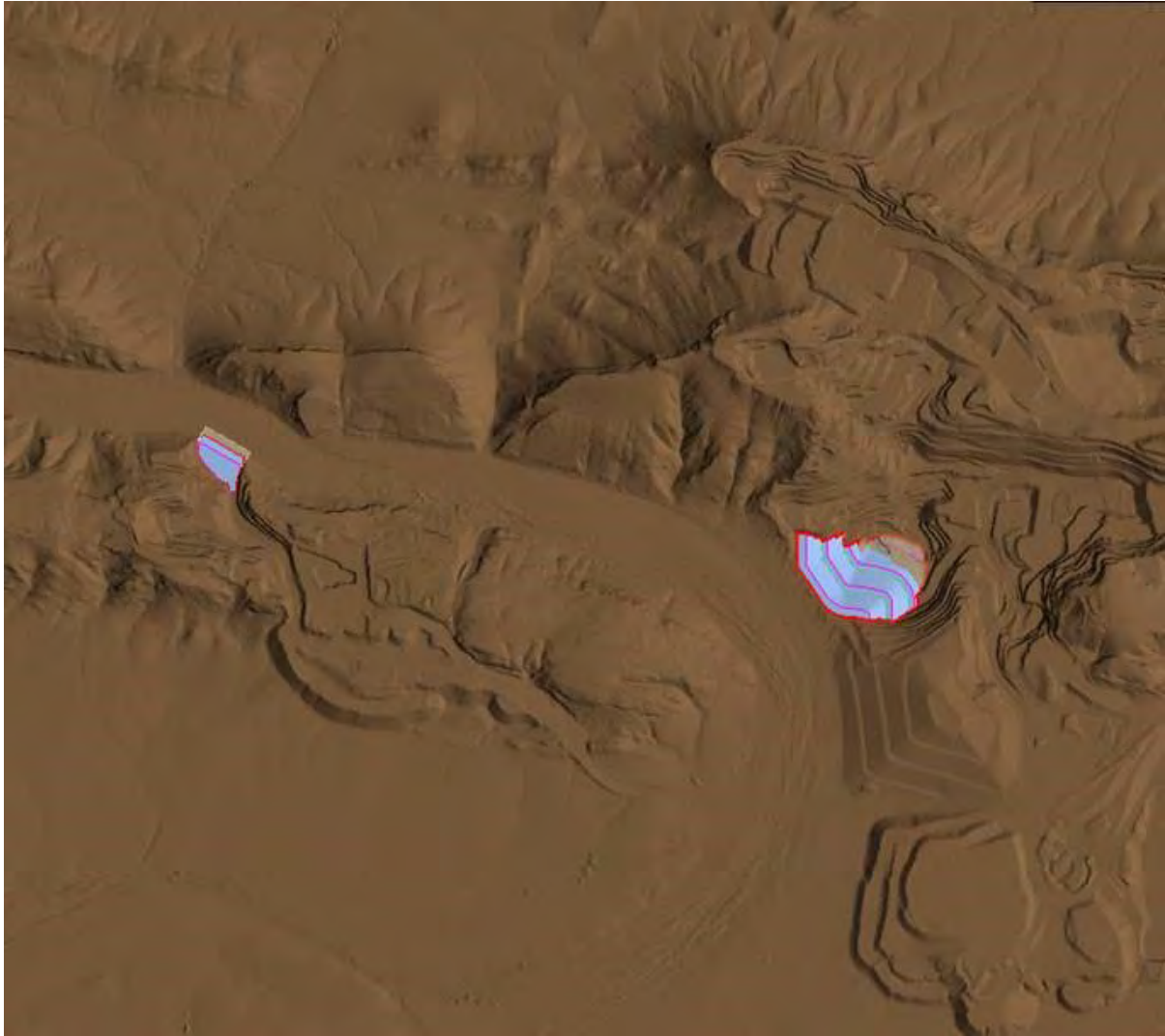


Figure 40: Conceptual partial backfill closure designs for pits 11W and 4W to prevent creek interception



Figure 41: Conceptual backfill closure design for the 4E pit to the west of the 4EE pit and surrounding mine landforms

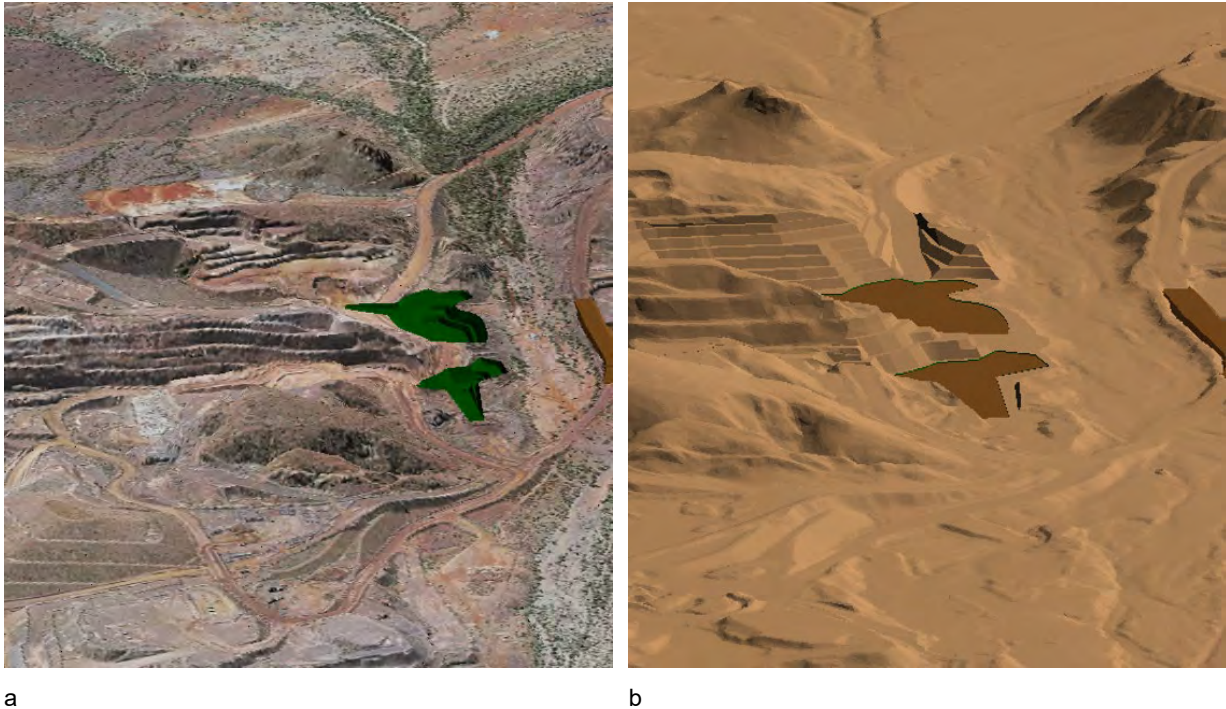


Figure 42: Conceptual partial backfill closure designs for NLC pit (a: post-mining pit shell, b: partially backfilled pit)

20.12 Community

Rio Tinto recognises the close relationship between the Paraburdoo town and the Greater Paraburdoo mining operations. A Pilbara Town Strategy is currently under development. Once finalised the strategy will inform future town planning strategies.

Communities associated with Western Range are specifically excluded from the scope of this mine closure plan. Detailed workforce planning, baseline studies and social impact assessments will be undertaken to determine potential social impact to these communities during future town planning strategies.

CLOSURE IMPLEMENTATION

21 Closure domains and implementation

Rio Tinto uses closure domains to group areas with common features, rehabilitation and decommissioning requirements at closure. Detailed closure strategies for the rehabilitation and decommissioning of individual closure domains, beyond those of current standard management practices, will be documented as the site approaches closure.

Closure domains are used to group areas with common features, rehabilitation and decommissioning requirements. Figure 43 illustrates the closure domains currently established for Paraburdoo. The broad domains at Paraburdoo mine include AWT pits, BWT pits, waste storage and infrastructure.

The domains at Paraburdoo, as presented in Figure 43, include:

- Pits (5W, 11W, 14-16W, 20W, 27W, NLC, 4EE and 18E):
 - AWT, low AMD risk, not backfilled; and
 - BWT, high AMD risk, not backfilled.
- Waste dumps:
 - free stranding, inert;
 - free standing, AMD risk;
 - in-pit, inert; and
 - in-pit, AMD risk.
- Stockpiles – low grade (used for the temporary storage of low grade iron ore);
- Landbridge (inert) - refers to elevated roads that have been constructed from inert waste;
- Waste Fine Storage Facility: a storage facility for chemically inert tailings;
- Infrastructure areas; and
- Railway: the rail spur and loop from Paraburdoo to Tom Price.

Proposed closure strategies for each of the closure domains are included in Table 24. Designs and key criteria for all major landforms are included in Appendix F.

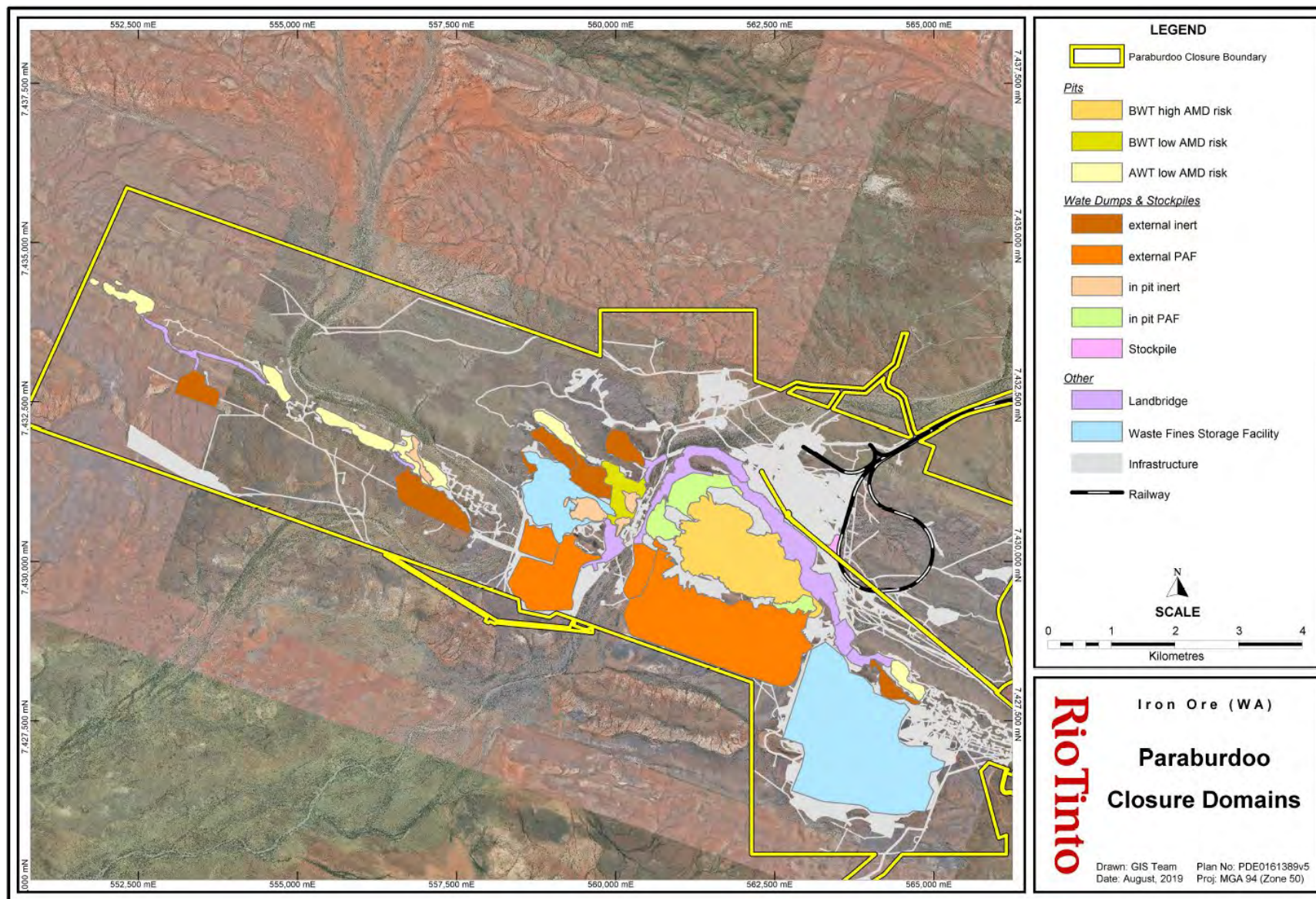


Figure 43: Paraburdoo closure domains

Table 24: Paraburdoo general area implementation strategies by closure domain

Domain	Area	Closure measures
Pits		
Pit – low AMD risk, above water table (AWT), not backfilled	5W	<ul style="list-style-type: none">11W pit will have flood management prescriptions (partial backfill or bunding) to prevent interception of creek flows. Partial backfill will create 11W_BF.NLC BWT pit will be backfilled with waste to a height greater than creek bed height, creating NLC_WD02.Pits may be partially backfilled where possible to minimise the volume of waste in free standing waste landforms.No further rehabilitation proposed within pit footprint unless the backfill level is within 10 m of the ground surface.Prior to final closure, appropriate evaluation and implementation of measures to restrict public access to remaining open voids will be undertaken.Construct abandonment bunds around pit perimeters, outside of the zone of instability.
	11W	
	14-16W	
	20W	
	27W	
	18E	
	NLC	
Pit – high AMD risk, below water table, not backfilled	4EE	<ul style="list-style-type: none">4EE pit to remain as a pit lake at closure. This closure strategy will be continually reviewed to ensure environmental impacts are acceptable.Western side of 4E pit that is adjacent to Seven Mile Creek will be backfilled with waste for flood management to prevent creek interception. This waste will create the north-western extension of waste dump 4EE_WD.Where a pit lake is retained, means to restrict public access and manage fauna ingress/egress will be identified and implemented.No rehabilitation is proposed within the pit footprint.Construct abandonment bunds around pit perimeters, outside of the zone of instability.
	(includes 4E)	
Waste Dumps and Stockpiles		
Free standing, inert waste dump	18E_WD	<ul style="list-style-type: none">Waste dump construction and rehabilitation design specifications are presented in Appendix F.18E_WD may be used to cover the TSF, thus may be removed on closure.Reshape outer slopes to appropriate angles/profiles based on design criteria suitable for the waste type.Application of topsoil or subsoil where available.Deep rip the surface on the contour and seed using appropriate native species.
	4W_Main_WD	
	5W_WD01	
	5W_WD02	
	11W_WD	
	NLC_WD01	
	27W_WD	
In-pit, inert waste dump	11W_BF	<ul style="list-style-type: none">Waste dump construction and closure design specifications are presented in Appendix F.BWT portion of NLC pit will be backfilled with waste to above creek bed height (NLC_WD02).The western (riverine facing) section of 4E pit will be backfilled with waste creating north-western finger of 4EE_WD. The eastern section of 4E pit will be backfilled with waste creating north-eastern section of 4EE_WD. Reshape outer slopes to appropriate angles/profiles based on design criteria suitable for the waste type.Additional flood protection may be required at closure for waste dumps located adjacent to creeks.No further rehabilitation proposed within pit footprint unless the backfill level is within 10 m of the ground surface
	NLC_WD02	
	4W_WD03	
	4EE_WD (in-pit sections only)	

Domain	Area	Closure measures
In-pit , AMD risk waste dump	4EX_WD	<ul style="list-style-type: none"> PAF materials have been encapsulated as described in Section 20.1.2. Reshape outer slopes to appropriate angles/profiles based on design criteria suitable for the waste type. Application of topsoil or subsoil. Deep rip the surface on the contour and seed using appropriate native species.
Free standing, AMD risk waste dump	4W_WD01 4W_WD02 4EE_WD 4E_WD	<ul style="list-style-type: none"> 4EE_WD construction and management will involve segregation and encapsulation of PAF material as described in Section 20.1.2. Installation of a store and release cover. 4W_WD01 is currently active. PAF will be fully encapsulated with inert material at closure as described in Section 20.1.3. Flood protection may be required at the toe at closure. 4W_WD02 has been rehabilitated. Additional flood protection may be required at the toe at closure. 4E_WD has been rehabilitated as described in Section 20.1.2. Rehabilitation has been unsuccessful and will require re-work. Flood protection will be required at closure and may include partial removal of waste and/or rock armouring. Reshape outer slopes to appropriate angles/profiles based on design criteria suitable for the waste type. If black shale is exposed during rehabilitation earthworks, it will be managed as per the Iron Ore (WA) SCARD Management Plan. Application of topsoil or subsoil. Deep rip the surface on the contour and seed using appropriate native species. Note: 4EX3_South_WD and 4EMX_WD will be covered by waste from 4EE pit during mine operation creating 4EE_WD. Waste dump 4E_WD will be partially covered.
Stockpiles Low Grade	4E_North	<ul style="list-style-type: none"> Process material prior to closure or otherwise reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type. Application of a topsoil or subsoil where available. Rip and seed the footprint using appropriate native species.
Landbridge-inert	18E_LB 4E_West_LB 4E_East_LB 4W_LB NLC_LB 20W_LB 11W_LB	<ul style="list-style-type: none"> Closure strategies for landbridges located adjacent to creeks (4E_West_LB, NLC_LB and 4W_LB) are under evaluation as described in Section 20.11. Designs will consider surface water flows and may involve rock wrapping, partial removal or complete removal to natural ground surface. 18E_LB may be used to cover the TSF, thus may be removed on closure. Landbridges 4E_East_LB, 20W_LB, 11W_LB will be rehabilitated in accordance with standard procedures (as per inert waste dumps). Application of subsoil/topsoil where available. Rip and seed using appropriate native species.
Other domains		
Landfill	Landfill	<ul style="list-style-type: none"> Cap landfill with a layer of inert material to a minimum thickness of 2 m. Application of topsoil or subsoil. Shallow rip the surface on the contour and seed using appropriate native species.

Domain	Area	Closure measures
Tailings storage facility	TSF 4W in-pit	<ul style="list-style-type: none"> Removal of infrastructure as detailed in Section 18. Embankment external faces and tailings surface to be shaped to closure design. The 4W in-pit TSF will have flood management prescriptions as detailed in Section 20.11. The 4W in-pit may require some further backfill at closure to cover PAF exposures on the northern wall. This will be confirmed at closure. Application of capping material. Application of topsoil or subsoil, where available. Rip the surface on the contour and seed using appropriate native species.
Infrastructure areas	Plant Maintenance Buildings Roads Laydown Conveyor Rail spur etc.	<ul style="list-style-type: none"> Retain or remove infrastructure in accordance with State Agreement requirements. Undertake contaminated sites evaluation and clean up if required. Where infrastructure requires removal, remove all structures and footings that are above surface or within 2 m of the final land surface. Drain pipelines and remove hazardous materials (from pipelines and elsewhere across the site) in accordance with Controlled Waste Regulations. Actively seek reuse and recycling opportunities for decommissioned infrastructure. Dispose of inert materials are not retained, reused or recycled in an inert landfill area (may be a used pit area) and then cap with at least 2 m of inert material. Where linear infrastructure is removed, reinstate drainage lines where appropriate. Rehabilitate final surface in accordance with standard procedures, which includes: <ul style="list-style-type: none"> deep rip the surface where required to address compaction; add a layer of topsoil and subsoil where available; and revegetate with an appropriate mix of species of local provenance.
Rail	Rail	<ul style="list-style-type: none"> Retain or remove infrastructure in accordance with State Agreement requirements. Demolish or dismantle built structures to footing level. Remove bitumen and concrete. Dispose of demolition material to an appropriate waste site. Undertake earthworks and reshaping of areas to create a compatible landform consistent with the natural relief and landforms. Natural drainage lines to be re-established where practical. If the area is very compacted deep rip prior to topsoil application. Spread topsoil/subsoil to a maximum depth of 200 mm if available, rip on the contour and seed with local provenance seed.

22 Post-mining and post-closure landform

The post-mining landform is the landform that would be generated as a result of implementation of the mine plan assuming no progressive rehabilitation activities are conducted. A conceptual image of the post-mining landform is shown Figure 44.

The post-closure landform is the final expected landform at the completion of the closure measures outlined in Table 24. A conceptual image of landforms for Paraburdoo is presented in Figure 45.

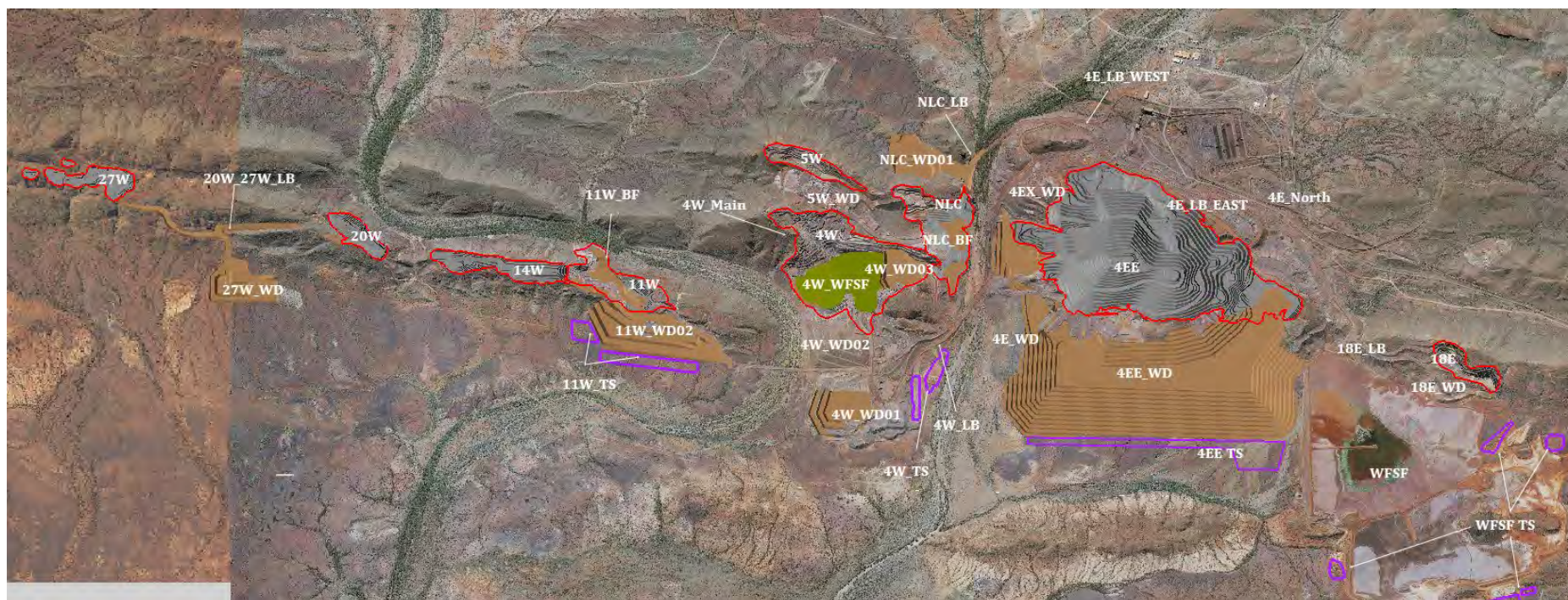


Figure 44: Conceptual layout of the site at completion of mining

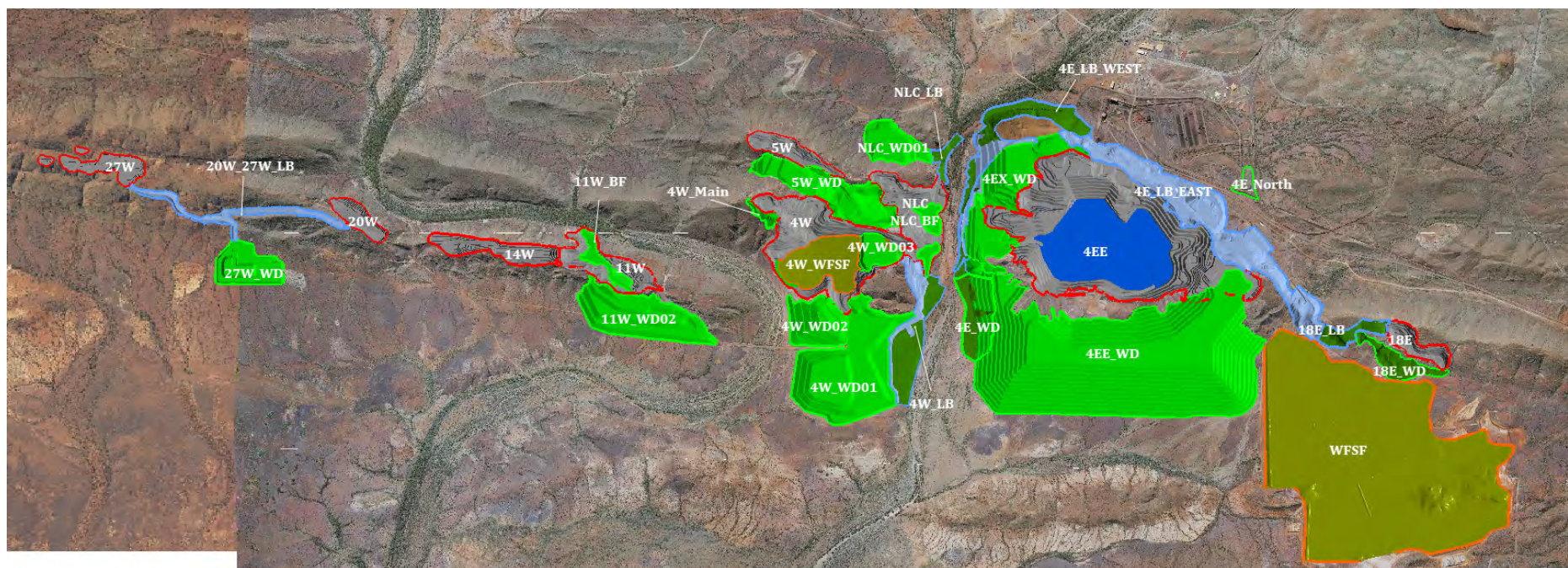


Figure 45: Conceptual layout of the site at completion of rehabilitation activities (reshaping and backfill)

23 Unexpected closure

The closure implementation schedule may be influenced by factors outside of the current mine plan. These factors include:

- suspension of operations under care and maintenance; this could occur if production costs exceed product value e.g. due to commodity price changes;
- unexpected closure; this could occur if there was major change in global demand for iron ore; and
- future proposals; these could occur if iron ore deposits of appropriate quality are identified adjacent to the existing deposits.

23.1 Temporary care and maintenance

In the event of temporary closure, measures will be undertaken to transfer the site from operations into a care and maintenance regime and relevant authorities notified. A care and maintenance plan will be developed prior to the care and maintenance period which demonstrates how on-going environmental obligations associated with the site will continue to be met during the period of care and maintenance.

23.2 Early permanent closure

Whilst Rio Tinto considers the risk of unexpected closure is expected to be minimal, there are numerous factors that could force early closure of one or several sites. Even if some level of contraction were to occur, it is reasonable to assume that the company would continue to operate in the Pilbara and that it could continue to manage closure of its sites. It should be noted that Hamersley Iron is one group within the global Rio Tinto group of companies, which further mitigates this risk.

The Paraburdoo closure plan will naturally become more detailed as time progresses, but may not be of sufficient detail to facilitate closure implementation if it were to close unexpectedly. This would be the case particularly if the proposed closure strategies rely on the full mining sequence, and need to be revised accordingly. If sudden and unexpected closure occurs, the site would effectively be placed on a period of care and maintenance whilst studies and plans are developed to facilitate effective closure implementation. Final completion criteria would also be agreed with stakeholders during this period. Closure could be expected to be delayed by several years if production ceases unexpectedly.

Notwithstanding this, the most likely early closure scenario would involve a decision to cease production made several years in advance of the event, which would provide time for the closure plan to be updated sufficiently to facilitate more timely closure implementation.

CLOSURE MONITORING AND MAINTENANCE

24 Closure monitoring program

The primary purpose of closure monitoring is to assess whether closure objectives have been met for Paraburdoo. A specific monitoring program will be finalised as the site approaches closure, and this current plan outlines the principles that will be employed rather than specific details.

24.1 Phases of monitoring

For the purposes of this plan, monitoring is assumed to be conducted in several phases including:

- Baseline monitoring, which is conducted as operations expand into new mining areas. Results that are relevant to closure are summarised in the environment knowledge base;
- Operational monitoring, which occurs throughout the life of the mine, in line with regulatory requirements and the Rio Tinto operational standards. Results that are relevant to closure are incorporated in the environment knowledge base when it is reviewed;
- Pre-closure monitoring, which occurs as the site approaches closure to underpin assessment of post-closure performance;
- Closure monitoring, which is conducted during the period of active site closure (approximately two years following the cessation of mining); and
- Post-closure monitoring, which is conducted on a regular basis until either:
 - There is a demonstration that closure objectives have been met and that the site is able to be relinquished; or
 - Parameters being monitored reach a steady state.

This plan considers pre-closure, closure and post-closure monitoring.

24.2 Indicative monitoring program

The monitoring program will be finalised during development of a Final Decommissioning Plan as the site approaches closure. Specific and appropriate monitoring will be conducted to ensure data is obtained to allow assessment of performance against completion criteria (Section 8). When agreed standards have not been met, the monitoring plan will describe remedial options available to deliver the required outcome. The monitoring program is likely to contain specific monitoring of the following key areas, as a minimum.

24.2.1 Rehabilitation monitoring

The purpose of the rehabilitation monitoring program is to evaluate successional development of rehabilitation areas and thereby provide useful feedback for the improvement of rehabilitation techniques, and to help assess progress towards long term rehabilitation objectives.

Rehabilitation monitoring also provides vital information which can be used to set realistic and achievable completion criteria. This can be achieved by examining changes in key parameters over time, and by comparing results from the rehabilitation with those from corresponding reference sites. Reference sites, also known as controls or analogues, are positioned within local areas of uncleared native vegetation.

Rehabilitation monitoring occurs on a scheduled basis, aimed at establishing trends for the locations return to self-sustaining status. The rehabilitation development is compared to the reference site values. Data analysis is undertaken to assess progress towards an acceptable outcome and a report produced to document findings.

24.2.2 Water monitoring

Water monitoring during closure will focus on confirming groundwater recovery and pit lake modelling predictions, and identification of any AMD issues. A specific program of monitoring will be developed prior to decommissioning.

24.3 Heritage surveys

Heritage assessments are undertaken prior to closure to ascertain potential cultural heritage impacts of closure implementation, and inform the development of alternative strategies if required. Assessments are also undertaken post-closure to confirm that implementation has been undertaken in an appropriate manner.

25 Post-closure maintenance

Post-closure, maintenance will continue as required until it is determined that the closure objectives have been met or it is otherwise agreed with Government to allow relinquishment of the site.

FINANCIAL PROVISION FOR CLOSURE

Rio Tinto considers specifics of the closure cost estimate to be commercially sensitive information. This section outlines the general process used to develop the closure cost estimate. Note that for commercial reasons the actual estimate is not documented in this closure plan.

26 Principles of Rio Tinto closure cost estimation

Closure cost estimates are determined based on methods outlined in the Rio Tinto Closure Standard and the Rio Tinto Accounting Policy. Closure costs are considered in two formats:

- a Present Closure Obligation (**PCO**) which is indicative of costs associated with closure of the mine given its current footprint, this accounts for the progressive development of a site over time; and
- a Total Projected Closure (**TPC**) cost, which predicts the cost (in current terms) associated with closure at the end of the mine life. The TPC includes areas that are not currently approved, but that feature within the life of mine plan and that are considered likely to be developed in the future.

The cost estimates consider the following components¹⁵:

- decommissioning (i.e. removal of infrastructure)¹⁶;
- final landform construction;
- rehabilitation and biodiversity management;
- heritage management;
- workforce management (i.e. training costs and redundancy payments)¹⁷;
- monitoring costs;
- costs associated with updating the closure plan to facilitate effective closure implementation;
- costs associated with undertaking a final shutdown of operations;
- allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas;
- assignment of indirect costs in accordance with Rio Tinto Accounting Policy; and
- a contingency factor.

27 Closure cost estimation methods

The closure cost estimation methodology is based on methods outlined in the Rio Tinto Closure Standard and Rio Tinto Accounting Policy, with the level of accuracy increasing as the site approaches closure¹⁸. The closure cost estimates are conducted based on the most recent information of mine plans and infrastructure. Closure cost estimates are generally undertaken by specialist external consultants. The PCO estimate for each site is revised on an annual basis to account for incremental mine development during the year. As part of Rio Tinto assurance processes these cost estimates are audited by external financial auditors annually to ensure adequate processes to generate the provisions are maintained. The TPC estimate is revised whenever a formal closure plan review is conducted (usually 3-yearly) to capture any changes to life of mine design.

¹⁵ Costs associated with decontamination are assessed during closure plan development but are costed separately as they are classified as operating costs, not closure costs.

¹⁶ The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. The site is sufficiently remote that deconstruction for the purposes of materials salvage and recycling is likely to be cost prohibitive. However; opportunities for salvage and recycling will be sought as the site approaches closure.

¹⁷ Workforce management costs have only been included in the TPC.

¹⁸ The level of accuracy applied to Rio Tinto estimates is as follows:

- greater than 10 years from closure: $\pm 30\%$;
- between 10 years and 5 years from closure: $\pm 20\%$; and
- less than 5 years from closure: $\pm 15\%$.

MANAGEMENT OF INFORMATION AND DATA

28 Data and information management

28.1 Iron Ore Document Management System (IODMS)

Hamersley operates a comprehensive document management system, with electronic records of all key information and data. The document system, known as Iron Ore Document Management System (**IODMS**) is linked to other business units within the Rio Tinto group of companies, and processes are in place to ensure that the data contained within this system is appropriately backed up and protected. Each document stored within this system is given a unique document number which identifies the document and enables it to be accessed. This system will continue to operate following site closure, and all relevant data will be retained according to appropriate data retention requirements.

An audit will be conducted prior to closure to ascertain whether there is any additional information stored in hard copy form at the site. Such data will be scanned and entered into IODMS to ensure that it is appropriately retained post-closure.

28.2 Closure knowledge base

The closure knowledge database is a knowledge management process designed to bring closure related research and monitoring outcomes together into one searchable location. It uses a single entry form to capture where the report is stored, and how and where the research can be applied for all new ongoing and completed closure related studies. This information is then managed by the Closure team within a secure database.

28.3 EnviroSys

EnviroSys is an environmental database that is used by Rio Tinto to manage environmental and hydrogeological data. The tool is used to store, monitor and analyse those parameters and report trends on data collections.

Data collected currently includes:

- groundwater – biological, chemical, field, levels, production;
- marine water – biological, chemical, field;
- soil chemistry;
- surface water – biological, chemical, field, levels, production;
- tonnes and moisture;
- water meters; and
- weather (rainfall, temperatures etc.).

EnviroSys is used to support the building of closure knowledge bases, as well as ensure compliance with operating licenses pertaining to data management. At closure this data would be appropriately stored to allow for review of post-closure completion criteria.

Appendix A – Register of key closure obligations

Part V Licence (License L5275/1972/12)

Condition No.	Closure conditions
15	The licensee shall ensure no waste is left within: 100 m of any surface water body at the site; and 3 m of the highest level of the water table aquifer at the putrescible landfill site.
22	The Licensee shall ensure that waste in the tipping area of the waste dump landfill is covered with a dense (at least 200 millimeters), inert and incombustible material at final landform design.
Appendix B. Fugitive emissions	Controls: The construction or operation of the new putrescible landfill expansion is not expected to generate significant dust. Existing controls which will continue to be implemented include: <ul style="list-style-type: none">- Spraying working surfaces with water using water carts;- Stockpile water sprays;- Water sprays on crushing plants;- Dust collection systems such as baghouses, covering on conveyors/transfer points and dust filters;- Sealing of working surfaces where practicable; and- Rehabilitation of disturbed areas where possible.

Iron Ore (Hamersley Range) Agreement Act 1963 incorporated through Clause 8 of the Iron Ore (Hamersley Range) Agreement Act 1968 (Paraburdoo)

Clause No.	Closure obligations
8	The provisions of clause 11 (other than paragraph (1) thereof) of the Principal Agreement shall apply to and be deemed to be incorporated in this Agreement as if: (a) all references in the said provisions to "this Agreement" and to "the mineral lease" were references to this Agreement and the mineral lease respectively; (d) in paragraph (e) of the said clause 11 the word "hereof" were deleted and the words "of the Principal Agreement as applying to this Agreement" were substituted therefor and the words "for the Company's wharf for any installation within the harbour" and the words "port or port" were deleted therefrom.
11 (e)	On the cessation or determination of any lease license or easement granted hereunder by the State to the Company or (except as otherwise agreed by the Minister) to an associated company or other assignee of the Company under clause 20 hereof of land for the Company's wharf for any installation within the harbour for the Company's railway or for housing at the port or port townsite the improvements and things erected on the relevant land and provided for in connection therewith shall remain or become the absolute property of the State without compensation and freed and discharged from all mortgages and encumbrances and the Company will do and execute such documents and things (including surrenders) as the State may reasonably require to give effect to this provision. In the event of the Company immediately prior to such expiration or determination or subsequent thereto deciding to remove its locomotives rolling stock plant equipment and removable buildings or any of them from any land it shall not do so without first notifying the State in writing of its decision and thereby granting to the State the right or option exercisable within three months thereafter to purchase at valuation in situ the said plant equipment and removable buildings or any of them. Such valuation shall be mutually agreed or in default of agreement shall be made by such competent valuer as the parties may appoint or failing agreement as to such appointment then by two competent valuers one to be appointed by each party or by an umpire appointed by such valuers should they fail to agree.

Mining Act 1978**SA Mineral Lease 246SA**

Condition No.	Closure conditions
NIL	NIL

SA General Purpose Lease 14SA – Paraburdoo Tailings

Condition No.	Closure conditions
2	The construction of the starter embankment and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled "Paraburdoo FFPP Project Tailings Dam Number 1 Works Approval Application" dated 28 October 1994 and retained on the Department of Minerals and Energy File No. 2178/94. Where a difference exists between the above document and the following conditions, then the following conditions shall prevail.
3	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the State Mining Engineer.
4	All rubbish and scrap being progressively disposed of in a suitable manner.
5	At the completion of operations or progressively where possible, all disturbed areas being rehabilitated to the satisfaction of the State Mining Engineer.
11	At the time of decommissioning of the tailings facility and prior to rehabilitation, a further review by a geotechnical/engineering specialist will be required to be submitted to the State Mining Engineer. This report should review the status of the structure and its contained tailings, examine and address the implications of the physical and chemical characteristics of the materials, and present and address the results of all environmental and stability monitoring. The rehabilitation stabilisation works proposed and any on-going remedial requirements should be addressed.
12	Should any of the above conditions not be complied with, then in addition to the provisions of the Mining Act, the provisions of Section 12 of the Paraburdoo Agreement may apply.
14	<p>The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled:-</p> <ul style="list-style-type: none">• "Paraburdoo Gas Pipeline Project Notice of Intent" (NOI 4823) dated 22 September 2004 and retained on the department of Industry and Resources File No. E190/200401• (MP Reg ID: 60720) "Tailings Storage Facility Southern Cell Expansion - Version 2 General Purpose Leases 14SA & 4SA" dated 31 October 2016 signed Fiona Hambidge, and retained on Department of Mines and Petroleum file no. EARS-MP-60720 as Doc ID 4605491. <p>Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.</p>
16	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
19	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence or be within the zone of pit instability to the satisfaction of the Executive Director, Environmental Division, DMP.

SA General Purpose Lease G4SA - Further Fines

Condition No.	Closure conditions
2	The construction of the starter embankment and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled "Paraburdoo FFPP Project Tailings Dam Number 1 Works Approval Application" dated 28 October 1994 and retained on the Department of Minerals and Energy File No. 2178/94. Where a difference exists between the above document and the following conditions, then the following conditions shall prevail.
3	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the State Mining Engineer.

Mining Act 1978

4	All rubbish and scrap being progressively disposed of in a suitable manner.
5	At the completion of operations or progressively where possible, all disturbed areas being rehabilitated to the satisfaction of the State Mining Engineer.
11	At the time of decommissioning of the tailings facility and prior to rehabilitation, a further review by a geotechnical/engineering specialist will be required to be submitted to the State Mining Engineer. This report should review the status of the structure and its contained tailings, examine and address the implications of the physical and chemical characteristics of the materials, and present and address the results of all environmental and stability monitoring. The rehabilitation stabilisation works proposed and any on-going remedial requirements should be addressed.
12	Should any of the above conditions not be complied with, then in addition to the provisions of the Mining Act, the provisions of Section 12 of the Paraburdoo Agreement may apply.
14	<p>The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled:-</p> <ul style="list-style-type: none">• "Paraburdoo Gas Pipeline Project Notice of Intent" (NOI 4823) dated 22 September 2004 and retained on the department of Industry and Resources File No. E190/200401• (MP Reg ID: 60720) "Tailings Storage Facility Southern Cell Expansion - Version 2 General Purpose Leases 14SA & 4SA" dated 31 October 2016 signed Fiona Hambidge, and retained on Department of Mines and Petroleum file no. EARS-MP-60720 as Doc ID 4605491. <p>Where a different exists between the above document(s) and the following conditions, then the following conditions shall prevail.</p>
18	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
20	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence or be within the zone of pit instability to the satisfaction of the Executive Director, Environmental Division, DMP.

SA General Purpose Lease 5SA – Kurra Kulli Camp

Condition No.	Closure conditions
2	All waste material, rubbish, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of use as a construction camp.
3	All necessary topsoil to be removed prior to the construction of camp facilities and separately stockpiled for replacement during rehabilitation of the site.

Miscellaneous License 47/00326 – Paraburdoo Landfill

Condition No.	Closure conditions
10	<p>The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled:</p> <ul style="list-style-type: none">• "Paraburdoo Landfill Extension Mining Proposal L47/326 (Reg ID28503) dated 5 October 2010 signed by Genevieve Thompson and retained on Department of Mines and Petroleum File No. E0025/200602;• (MP Reg ID 55713) "Paraburdoo Landfill Monitoring Bores" dated 10 July 2015 signed by Fiona Hambridge and retained on Department of Mines and Petroleum File No. EARS-MP-55713 as Doc ID 368218 <p>Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.</p>
13	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.

Miscellaneous License 47/00130 – Paraburdoo Gas Pipeline

Condition No.	Closure conditions
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Mining Act 1978

13	<p>On the completion of the life of mining operations in connection with this licence the holder shall:</p> <ul style="list-style-type: none">• remove all installations constructed pursuant to this licence; and• on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self supporting; unless the Warden or Minister for State Development orders or consents otherwise.
15	<p>The construction and operation of the project and measures to protect the environment being carried out generally in accordance with the document titled:</p> <ul style="list-style-type: none">• "Paraburdoo Gas Pipeline Project Notice of Intent" (NOI 4823) dated 22 September 2004 and retained on Department of Industry and Resources File No. E0190/200401 <p>Where a difference exists between the above document(s) and the following conditions, then the following conditions shall prevail.</p>
18	<p>At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Environmental Officer, Department of Industry and Resources.</p>
19	<p>All rubbish and scrap is to be progressively disposed of in a suitable manner.</p>
20	<p>At the completion of operations, or progressively where possible, all access roads and other disturbed areas being covered with topsoil, deep ripped and revegetated with local native grasses, shrubs and trees to the satisfaction of the Environmental Officer, Department of Industry and Resources.</p>

Land Administration Act 1997**Special Lease N104722 Paraburdoo Industrial Area**

Condition No.	Closure conditions
1 (8)	THAT the Company upon the determination of this lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated in the S.S Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease had never been executed and (except as provided in the S.S Agreement) the improvements and things erected on the demised premises and provided for in connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Special Lease N104723 Paraburdoo Plant Area

Condition No.	Closure conditions
1 (9)	THAT the Company upon the determination of this lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated in the S.S Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease had never been executed and (except as provided in the S.S Agreement) the improvements and things erected on the demised premises and provided for in connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Special Lease N104470 Paraburdoo Construction Camp

Condition No.	Closure conditions
1 (9)	THAT the Company upon the determination of this lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state or repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated in the S.S Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease had never been executed and (except as provided in the S.S Agreement) the improvements and things erected on the demised premises and provided for in

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connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Special Lease N104193 Paraburdoo Borefield

Condition No.	Closure conditions
1 (9)	THAT the Company upon the determination of this lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated in the S.S Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease had never been executed and (except as provided in the S.S Agreement) the improvements and things erected on the demised premises and provided for in connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Special Lease N104474 Paraburdoo Water Main

Condition No.	Closure conditions
1 (9)	THAT the Company upon the determination of this lease will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state of repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements contained or deemed to be incorporated in the S.S Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease had never been executed and (except as provided in the S.S Agreement) the improvements and things erected on the demised premises and provided for in connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Special Lease I206646 Tom Price to Paraburdoo Railway

Condition No.	Closure conditions
1 (11)	THAT the Company upon the determination of this lease or any extension thereof will yield up the demised premises and all the improvements thereon of whatsoever nature or kind in such state or repair condition order and preservation as shall be in strict accordance with the Company's covenants and agreements in the Agreement.
3 (4)	THAT upon the determination of this Lease (which may be determined only by effluxion of time under or pursuant to the provisions of the S.S. Agreement or by surrender) or upon the determination of the Principal Agreement or the S.S. Agreement then it shall be lawful for Us, Our heirs and successors (without prejudice to any right of action of any one or more of the parties hereto or the Crown in respect of any breach non-performance or non-observance of or non-compliance with any of the covenants conditions and obligations contained herein and on the part of the Company to be performed observed or complied with) into and upon the demised premises or any part thereof in the name of the whole to re-enter and the same to have again repossess and enjoy as if this lease

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had never been executed and (except as provided in the S.S. Agreement) the improvements and things erected on the demised premises and provided for in connection therewith shall then remain or become the absolute property of the Crown without compensation and freed and discharged from all mortgages and encumbrances and in such case the Company shall not have any tenant rights in such improvements or things.

Easement L478326 Turee Creek Borefield Easement

Condition No.	Closure conditions
3.1 (c)	<p>3.1 USE OF EASEMENT AREA</p> <p>The Grantee hereby covenants with the Grantor that the Grantee and Grantee's Authorised Users:</p> <p>(c) must not cause or permit any Contamination, Pollution or Environmental Harm to occur in, on or under the Easement Area or to the Surrounding Area, and if any Contamination, Pollution or Environmental Harm is caused by the Grantee or the Grantee's Authorised Users, the Grantee must minimise and remediate any resultant damage and harm to the reasonable satisfaction of the Grantor;</p>
3.1 (d)	<p>3.1 (d) must not permit or cause any damage to the Easement Area or the Surrounding Area;</p>
3.1 (g)	<p>3.1 (g) must carry out and complete any work commenced at any time and for any purpose within the Easement Area in a proper and workmanlike manner with all proper speed and:</p> <p>(i) fill in, consolidate and level off any holes or trenches made by those works within the Easement Area;</p> <p>(ii) carry away all earth and rubbish;</p> <p>(iii) reinstate and make good the surface area of the Easement Area within a reasonable period to the satisfaction of the Grantor; and</p> <p>(iv) if required by the Grantor, restore and regenerate the trees and vegetation within the Easement Area (as near as reasonably practical) to the state and condition they were in before use by the Grantee of the Easement Area pursuant to this Deed or replant with trees and vegetation of similar species as to those within the Easement Area before such use;</p>
3.1 (i)	<p>3.1 (i) must immediately fill, compact and level any part of the easement Area which may have suffered any subsidence;</p>
3.1 (j)	<p>3.1 (j) must repair or remedy any damage caused by the Grantee or the Grantee's Authorised Users to the Easement Area or the Surrounding Area, and improvements and Services in, on, under or over the Easement Area, including remediating any Contamination, Pollution, Environmental Harm, and erosion or other form of degradation;</p>
3.1 (l)	<p>3.1 (l) must not cut down or remove any standing timber unless with the prior approval in writing of the Grantor;</p>
3.1 (o)	<p>3.1 (o) must upon expiry, cancellation, termination or surrender of the Easement, remediate the Easement Area to the satisfactory of the Grantor; and</p>

NATIVE VEGETATION CLEARING PERMITS (NVCP)

Permit No.5090/3 (Paraburdoo Purpose Permit)

Condition No.	Closure conditions
1	<p>1. Land on which clearing is to be done</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, Mineral Lease 246SA (AML 70/246)</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, General Purpose Lease 4SA (AG 70/4)</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, General Purpose Lease 14SA (AG 70/14)</p>
10	<p>Retain and spread vegetative material and topsoil</p> <p>The Permit Holder shall:</p> <p>(a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.</p> <p>(b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by:</p> <p>(i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and</p> <p>(ii) laying the vegetative material and topsoil retained under Condition 10(a).</p> <p>(c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 10(b) of this Permit:</p> <p>(i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and</p> <p>(ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.</p>
11	<p>The Permit Holder must maintain the following records for activities done pursuant to this Permit:</p> <p>(b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 10 of this Permit:</p> <p>(i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;</p> <p>(ii) a description of the revegetation and rehabilitation activities undertaken; and</p> <p>(iii) the size of the area revegetated and rehabilitated (in hectares).</p>

Permit No.5153-3 (Turee Creek Pipeline Upgrade)

Condition No.	Closure conditions
1	<p>Purpose for which clearing may be done</p> <p>Clearing for the purposes of the installation of a water supply pipeline, hydrogeological drilling and associated activities.</p>
2	<p>Land on which clearing is to be done</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, Mineral Lease 246SA (AML 70/246);</p> <p>Iron Ore (Channar Joint Venture) Agreement Act 1987, Special Lease for Mining Operations 3116/11553 (Document I 163654 I), Lot 132 on Deposited Plan 243064;</p>

NATIVE VEGETATION CLEARING PERMITS (NVCP)

	Iron Ore (Hamersley Range) Agreement Act 1963, Special Lease for Mining Operations 3114/937, Easement L478326
8	<p>Retain and spread vegetative material and topsoil</p> <p>The Permit Holder shall:</p> <p>(a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.</p> <p>(b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by:</p> <p>(i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land;</p> <p>(ii) ripping the ground on the contour to remove soil compaction; and</p> <p>(iii) laying the vegetative material and topsoil retained under Condition 8(a).</p> <p>(c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 8(b) of this Permit:</p> <p>(i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and</p> <p>(ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 8(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.</p>
9	<p>Records to be kept</p> <p>The Permit Holder must maintain the following records for activities done pursuant to this Permit:</p> <p>(b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 8 of this Permit:</p> <p>(i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;</p> <p>(ii) a description of the revegetation and rehabilitation activities undertaken; and</p> <p>(iii) the size of the area revegetated and rehabilitated (in hectares).</p>
10	<p>Reporting</p> <p>(b) Prior to 31 December 2027, the Permit Holder must provide to the Director Operations, Environment, Department of Mines, Industry Regulation and Safety a written report of records required under Condition 9 of this Permit where these records have not already been provided under Condition 10(a) of this Permit.</p>

Permit No.6530/1 (Paraburdoo Haul Road Project)

Condition No.	Closure conditions
1	<p>Land on which clearing is to be done</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, Mineral Lease 4SA (AML 70/4)</p> <p>Iron Ore (Hamersley Range) Agreement Act 1963, Mineral Lease 246SA (AML 70/246)</p> <p>Iron Ore (Channar Joint Venture) Agreement Act 1987, Mining Lease 265SA (AM 70/265)</p> <p>Iron Ore (Channar Joint Venture) Agreement Act 1987, Special Lease for Mining Operations 3116/11553, Document I 163654 L, K859553 AN, Lot 132 on Deposited Plan 243064.</p>

NATIVE VEGETATION CLEARING PERMITS (NVCP)

8	<p>Retain and spread vegetative material and topsoil</p> <p>The Permit Holder shall:</p> <p>(a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.</p> <p>(b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by:</p> <p style="padding-left: 20px;">(i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and</p> <p style="padding-left: 20px;">(ii) laying the vegetative material and topsoil retained under Condition 8(a).</p> <p>(c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 8(b) of this Permit:</p> <p style="padding-left: 20px;">(i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and</p> <p style="padding-left: 20px;">(ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 8(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.</p>
9	<p>The Permit Holder must maintain the following records for activities done pursuant to this Permit:</p> <p>(b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 8 of this Permit:</p> <p style="padding-left: 20px;">(i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;</p> <p style="padding-left: 20px;">(ii) a description of the revegetation and rehabilitation activities undertaken; and</p> <p style="padding-left: 20px;">(iii) the size of the area revegetated and rehabilitated (in hectares).</p>

Permit No. 4442/5 (Purpose Permit for Railway)

Condition No.	Closure conditions
1	<p>Purpose for which clearing may be done</p> <p>Clearing for the maintenance and improvement of the existing integrated Rio Tinto Iron Ore railway and transport corridor infrastructure system to ensure the ongoing operational efficacy of this system.</p>
12	<p>Revegetation and rehabilitation</p> <p>The Permit Holder shall:</p> <p>(a) retain the vegetative material and topsoil removed by clearing authorised under the Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.</p> <p>(b) At an optimal time within 12 months following the completion of works authorised under the Permit, revegetate and rehabilitate the area (s) that are no longer required for the purpose for which they were cleared under this Permit by:</p> <p style="padding-left: 20px;">(i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and</p> <p style="padding-left: 20px;">(ii) ripping the ground on the contour to remove soil compaction; and</p> <p style="padding-left: 20px;">(iii) laying the vegetative material and topsoil retained under condition 12(a) on the cleared area(s).</p>

NATIVE VEGETATION CLEARING PERMITS (NVCP)

	<p>(c) within 24 months of laying the vegetative material and topsoil on the cleared area in accordance with condition 12(b) of this Permit:</p> <p>(i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and</p> <p>(ii) where, in the opinion of an environmental specialist, the composition structure and density determined under condition 12(c)(i) of this Permit will not result in a similar species composition, structure or density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.</p>
12	<p>(d) Where additional planting or direct seeding of native vegetation is undertaken in accordance with condition 12 (c)(ii) of this permit, the Permit Holder shall repeat condition 12(c)(i) and 12(c)(ii) within 24 months of undertaking the additional planting or direct seeding of native vegetation.</p> <p>(e) Where a determination by an environmental specialist that the composition, structure and density within areas revegetated and rehabilitated will result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, as determined in condition 12 (c) (i) and (ii) of this permit, that determination shall be submitted for the CEO's consideration. If the CEO does not agree with the determination made under condition 12(c)(ii), the CEO may require the Permit Holder to undertake additional planting and direct seeding in accordance with the requirements under condition 12(c)(ii).</p>
13	<p>13. Records must be kept</p> <p>The Permit Holder must maintain the following records for activities done pursuant to this Permit:</p> <p>(e) In relation to the revegetation and rehabilitation of areas pursuant to condition 12 of this Permit:</p> <p>(i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;</p> <p>(ii) a description of the revegetation and rehabilitation activities undertaken;</p> <p>(iii) the size of the area revegetated and rehabilitated (in hectares);</p> <p>(iv) the species composition, structure and density of revegetation and rehabilitation, and</p> <p>(v) a copy of the environmental specialist's report. (iii) the size of the area revegetated and rehabilitated (in hectares);</p>
Permit No. CPS 4032/4 (Eastern Range Project)	
Condition No.	Closure conditions
10	<p>Retain and spread vegetative material and topsoil</p> <p>The Permit Holder shall:</p> <p>(a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.</p> <p>(b) within 12 months following completion of clearing authorised under this Permit, revegetate and rehabilitate areas of temporary disturbance that are no longer required for the purpose for which they were cleared under this Permit by:</p> <p>(i) ripping the ground on the contour to remove soil compaction; and</p> <p>(ii) laying the vegetative material and topsoil retained under Condition 10(a) on the cleared area.</p> <p>(c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 10(b) of this Permit:</p> <p>(i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and</p>

NATIVE VEGETATION CLEARING PERMITS (NVCP)

	(ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
10	<p>(d) where additional planting or direct seeding of native vegetation is undertaken in accordance with Condition 10(c)(ii) of this permit, the Permit Holder shall repeat Condition 10(c)(i) and 10(c)(ii) within 24 months of undertaking the additional planting or direct seeding of native vegetation.</p> <p>(e) where a determination by an environmental specialist that the composition, structure and density within areas revegetated and rehabilitated will result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, as determined in Condition 10(c)(i) and (ii) of this permit, that determination shall be submitted for the CEO's consideration. If the CEO does not agree with the determination made under Condition 10(c)(ii), the CEO may require the Permit Holder to undertake additional planting and direct seeding in accordance with the requirements under Condition 10(c)(ii).</p>
11	<p>11. Records to be kept</p> <p>The Permit Holder must maintain the following records for activities done pursuant to this Permit:</p> <p>(b) In relation to the revegetation and rehabilitation of areas pursuant to Condition 10 of this Permit:</p> <p>(i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;</p> <p>(ii) a description of the revegetation and rehabilitation activities undertaken; and</p> <p>(iii) the size of the area revegetated and rehabilitated (in hectares).</p>

Relevant Legislation

Closure planning and implementation requires consideration of general legislative requirements beyond those that apply to a specific site. A list of potentially relevant legislation is provided below, but is not necessarily exhaustive. A comprehensive legal review will be required as closure approaches to ensure that all relevant legislative requirements are identified.

Australian Commonwealth Legislation

Environmental Protection and Biodiversity Conservation Act 1999

Native Title Act 1993

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

Workplace Relations Act 1996

Western Australian State Legislation

Environmental Protection Act 1986

Environmental Protection Regulations 1987

Environmental Protection (Controlled Waste) Regulations 2004

Environmental Protection (Unauthorised Discharges) Regulations 2004

Contaminated Sites Act 2003

Contaminated Sites Regulations 2006

Conservation and Land Management Act 1984

Mining Act 1978

Mining Regulations 1981

Parks and Reserves Act 1895

Rights in Water and Irrigation Act 1914

Biodiversity Conservation Act 2016

Aboriginal Heritage Act 1972

Aboriginal Affairs Planning Authority Act 1972

Mines Safety and Inspection Act 1994

Mines Safety and Inspection Regulations 1995

Occupiers Liability Act 1985

Criminal Code Compilation Act 1913

Relevant Guidelines and Standards

Closure planning and implementation requires consideration of relevant guidelines and standards, some of which may have regulatory consequence through being referenced in regulatory documents. A list of key guidelines and standards that are routinely considered is provided below, but is not exhaustive due to the breadth of the closure planning discipline. This closure plan has been prepared so as to be considered with relevant content of these guidelines and standards.

Guideline or Standard	Author
Guidelines for the Preparation of Mine Closure Plans (2015)	Western Australian Department of Mines and Petroleum and Environmental Protection Authority
Mine Closure: Leading Practice Sustainable Development Program for the Mining Industry (2016)	Commonwealth Department of Industry, Innovation and Science
Mine Rehabilitation Handbook (1998)	Minerals Council of Australia
Guideline for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems (2006)	Western Australian Environmental Protection Authority
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council
Mine Void Water Resource Issues in Western Australia (2003)	Western Australian Water and Rivers Commission
Contaminated Sites guideline series	Western Australian Department of Environment Regulation
Environmental Notes on Mining: Acid Mine Drainage (2009)	Western Australian Department of Mines and Petroleum
Environmental Notes on Mining: Waste Rock Dumps (2009)	Western Australian Department of Mines and Petroleum
Safety Bund Walls Around Abandoned Open Pit Mines (1997)	Western Australian Department of Industry and Resources
Global Acid Rock Drainage Guide (2014)	International Network for Acid Prevention
Australian Standard 2601: The Demolition of Structures (2001)	Standards Australia
Australian Standard 4976: The Removal of Underground Petroleum Storage Tanks (2008)	Standards Australia
Demolition Work Code of Practice (2015)	Safe Work Australia

Appendix B – Communications register

Stakeholder	Subject	Summary of discussion relevant to closure	Response
Department of Mines and Petroleum (September 2013)	Consultation with regulator (DMP) over native vegetation clearing permits (NVCP)	<p>Requirement on native vegetation clearing permits (NVCP) to return site to pre-clearing vegetation level.</p> <p>RTIO expressed concerns around the expectation inherent in the wording of the condition that requires the proponent to return the area to 'pre-cleared' vegetation levels. RTIO indicated it was concerned by lack of definition of acceptable standard of rehabilitation, and would prefer clarity on the acceptable level of deviation from the 'pre-cleared' state.</p> <p>DMP stated that the intent of the condition is to provide regulatory bodies recourse to ensure rehabilitation is undertaken to a satisfactory standard, and that nothing 'unreasonable' would be expected.</p> <p>DMP stated that end land use is taken into account and the DMP recognise that certain landforms cannot be expected to reach a level of the pre-cleared state. For the purposes of the NVCP rehabilitation conditions a Waste Dump (for example) would be viewed as still required for the purpose for which it was cleared. NVCP Rehabilitation requirements would therefore not apply in the same way as they would for areas which are no longer required such as a temporary access roads or temporary stockpile areas for example. DMP stated that it is their view that an environmental specialist within the Company (RTIO) is able to determine what is considered a 'representative' area to monitor in order to determine rehabilitation success.</p>	Noted
Office of the Environmental Protection Agency (May 2014)	General correspondence from the OEPA regarding a joint BHP Billiton and Rio Tinto rehabilitation presentation held on 20th March 2014 (our reference RTIO-HSE-0229339).	<p>Correspondence from OEPA commending BHP Billiton and Rio Tinto on their joint presentation on rehabilitation success in the Pilbara. In it's letter OEPA recognised that mine closure and rehabilitation is an important strategic issue and recognised the significant challenges remaining in this area.</p> <p>The OEPA referred to the Department of Mines and Petroleum/OEPA Joint Mine Closure Guidelines as the primary document guiding mine closure and rehabilitation across all land tenures and sought written confirmation from both companies that they would abide by any contemporary version of the guidelines, irrespective of what the current Ministerial Statement conditions required in regard to closure and rehabilitation, or similarly what State Agreement Act conditions require on the same matter. OEPA indicated its desire to discuss the updating of existing Ministerial Statements to ensure they are contemporary with respect to mine closure and rehabilitation with both parties in future.</p>	<p>Rio Tinto acknowledged the feedback form OEPA and indicated it looked forward to continued involvement with government and industry partners in developing sustainable, long term improvements for rehabilitation and closure in Western Australia. In response to the request for mine closure plans to conform to the contemporary version of the Department of Mines and Petroleum/OEPA Joint Mine Closure Guidelines, it is noted that Rio Tinto iron ore closure plans drafted to support new proposals are prepared in accordance with the Guidelines.</p> <p>For existing Ministerial Statements, closure planning is undertaken in accordance with approval conditions and Rio Tinto standards. Of particular note, compliance to the Rio Tinto standard is required irrespective of what the current Ministerial Statement conditions and State Agreement requirements are on this matter. Rio Tinto's standards require the preparation of closure plans for each aspect of an iron ore operation, and plans are revised at a frequency that is appropriate to the life and scale of the operations, and take into consideration the objectives and intended outcomes of the contemporary Guideline. RTIO will continue to undertake closure planning in accordance with its approval conditions, and Rio Tinto standards. This process will ensure that plans are progressively updated to align with contemporary Guidelines. Rio Tinto iron ore considers this a practical approach which is consistent with requirements for closure planning in Western Australia. (Our reference: RTIO-HSE-0229340).</p>
Department of Mines and Petroleum (May 2014)	Ongoing consultation with Regulators	<p>1. Rehabilitation within pit areas</p> <p>Rio Tinto has assumed that rehabilitation within pit areas will not be required except under specific scenarios. The scenarios where in-pit rehabilitation is appropriate are where:</p> <ul style="list-style-type: none"> - geochemical risks need to be managed; - backfill is at ground level or close to it; - pits drain externally; - specific visual amenity concerns; - or any other scenario that may arise on a case by case basis. <p>2. Landform stability</p> <p>The DMP recognised that historic construction of waste landforms can make it challenging to achieve stability objectives. Notwithstanding these challenges, the DMP indicated that it considers landform stability to be a critical element of rehabilitation design. It advocated that designs be based on consideration of the materials present with the landform.</p>	<p>1. This strategy has been applied by RTIO in the Paraburdoo closure plan</p> <p>2. Noted</p>
Department of Mines and Petroleum (September 2014)	Preliminary consultation on objectives and criteria applicable to the Channar closure plan	<p>Preliminary consultation on objectives and criteria applicable to the Channar closure plan</p> <p>1. Landform design needs to consider stability under maximum probable precipitation (PMP) and maximum probable flood (PMF) events</p> <p>2. Consider the pit wall zone of instability and the impact that would have on waste dump placements within the final landform.</p> <p>3. The DMP agreed that abandonment bunds around hill pits are not necessarily appropriate, and that other methods of access restriction (e.g. reducing exposure by removal of major access roads) should be considered. However, this would need to be assessed and endorsed on a case by case basis by the District Inspector.</p>	<p>1. Modelling of the PMP/PMF design flood event was undertaken to predict impacts. However, RTIO does not consider it feasible to design all landforms to withstand such events. High levels of erosion are expected to occur in both natural and man-made landforms during such periods. The 0.1% Annual Exceedance Probability (AEP) event has been used as the basis for landform design in the Paraburdoo closure plan, excluding the 4E and 4W pit flood management structures where Probable Maximum Flood (PMF) was considered.</p> <p>2. Zones of instability (derived from the conservative methodology in DMP's abandonment bund guidance material) have been defined in the Paraburdoo closure plan. These will be reviewed throughout mine life and finalised once ultimate pit geometries and face geologies are known.</p> <p>3. The Paraburdoo closure plan has adopted this approach, on the assumption that endorsement can be achieved prior to closure.</p>
Department of Mines and Petroleum (February 2015)	Correspondence from DMP Executive Director Environment to CMS (cc Manager OEPA Compliance Branch) regarding completion criteria proposed within Channar Final Study (CFS)	<p>1. The DMP supports the use of 'As Built' reports, audits, modelling and monitoring as proposed measurement tools</p> <p>2. Completion criteria should refer to all weed species, and not just declared weeds</p> <p>3. The DMP affirmed the requirement for safe, stable, non-polluting and self-sustaining landforms, and scree slopes may not achieve these basic objectives.</p>	<p>1. Noted</p> <p>2. Noted</p> <p>3. Noted. Scree slopes are proposed for select areas where alternative strategies are either precluded or made extremely challenging to implement as a result of local topography and restricted access. RTIO plans to trial rock armouring (scree slopes) at Channar mine as a means of stabilising particular waste features to make them safe, stable and non-polluting. Further information will be provided following the outcomes from this trial.</p>
Yinhawangka (April 2015)	RTIO presentation at Yinhawangka Local Implementation Committee (LIC) meeting	RTIO presented information on its mine closure planning process, general closure strategies for dumps and pits, and the stages of mine closure.	

Stakeholder	Subject	Summary of discussion relevant to closure	Response
Department of Mines and Petroleum (August 2015)	DMP Inspection report for Greater Paraburdoo	<p>DMP noted during their inspection:</p> <ol style="list-style-type: none"> 1. A large amount of decommissioned infrastructure had been left in-situ across Greater Paraburdoo sites. DMP encourages progressive removal of decommissioned infrastructure and rehabilitation is encouraged to reduce the rehabilitation and closure liabilities at site. 2. Many of the waste landforms at the sites were eroding, therefore indicating a large amount of work will be required to create long-term safe and stable landforms at closure. 3. It was pleasing to see rehabilitation works being undertaken on the 4 West Waste Dump. 4. Weeds are very common around the Greater Paraburdoo mine sites, and active management will be required to ensure weeds (in particular Ruby Dock) does not invade the undisturbed areas around Greater Paraburdoo. 	<ol style="list-style-type: none"> 1. Noted. 2. Some of the areas previously rehabilitated at Paraburdoo were undertaken for the purpose of trialling rehabilitation methods. The rehabilitation areas that have not shown success will be reviewed and re-worked in the future. 3. Noted. 4. A weed management program exists for the Greater Paraburdoo mine sites and weeds are monitored during the annual rehabilitation monitoring program. These programs will continue throughout mining operations and during rehabilitation and closure phases.
Yinhawangka (September 2015)	RTIO Life of Mine – Closure update presentation at the Yinhawangka LIC meeting	RTIO presented information on its mine closure planning process and general closure strategies.	Discussions included (but were not limited to): stakeholder consultation, cultural heritage considerations, land access, rehabilitation techniques, hydrology, environmental aspects, altered land forms and business opportunities. Yinhawangka representatives welcomed the opportunity to be involved in the closure process
Department of Mines and Petroleum (May 2016)	Ongoing consultation with regulators	<p>Public safety risk mitigation requirements for closed mine sites</p> <p>Environmental inspectors regulate safety through Mining Regulations 1981 Regulation 28 “...all holes, pits, trenches and other disturbances to the surface of the land made whilst mining which in the opinion of an environmental officer are likely to endanger the safety of any person or animal will be filled in or otherwise made safe to the satisfaction of the environmental officer”</p> <p>The DMP advised it intends to revise its abandonment bund guidance to become less prescriptive and more outcomes focused. There would not be an expectation to batter down and rehabilitate large faces – abandonment bunds to prevent inadvertent access would be more appropriate.</p> <p>Vegetation on a slope would help prevent access, but should not be relied upon as a primary control as it could be lost to fire etc. Similarly, fences should not be considered a permanent control.</p>	Noted. Placement and construction methodology for abandonment bunding will be refined as Paraburdoo mine site approaches closure.
Department of Mines and Petroleum (June 2016)	Ongoing consultation with regulators	<p>Consultation with DMP on PMP/PMF modelling for closure planning.</p> <p>DMP acknowledged that achieving stability of large waste landforms is challenging, even under current reasonable climatic conditions. DMP has observed many cases across the Pilbara and the State more broadly where rehabilitation areas have performed poorly or failed, often over a reasonably short time frame.</p> <p>Guidance is expected to be risk based and not a ‘one size fits all’ approach. It was suggested that high risk dumps (e.g. those containing designated fibrous or PAF waste) may need to be designed to withstand larger or more intense rainfall events than small, inert, low risk waste dumps.</p>	RTIO is awaiting further guidance from the DMP on their advice to design waste landforms to withstand PMP events.
Department of State Development (July 2016)	General mine closure plan discussions held with DSD.	DSD held discussions and sent various correspondence to Rio Tinto requesting that all State Agreement proponents: Prepare and submit mine closure plans in accordance with the Guidelines for Preparing Mine Closure Plans for all mine operations, including those where there is no current legal obligation to do so; and report land disturbance data consistent with Mining Rehabilitation Fund (MRF) categories in our State Agreement Annual Environmental Reports (AER).	<p>In relation to mine closure plans Rio Tinto indicated that it was willing to voluntarily provide the State with the material requested on the following basis:</p> <ul style="list-style-type: none"> • A timeframe of at least three years to progressively prepare and lodge compliant mine closure plans for operations where modern closure conditions do not currently apply. • Assurance that Mine Closure Plans will only be reviewed on a triennial basis by the Department of Mines and Petroleum (DMP) in accordance with the Guidelines; and • Confirmation that mine closure plans will not be connected in any formal way with the operation of our State Agreement mining approvals, such that changes to our mine plan will not mandate the need for revision of our mine closure plans, except at the regular triennial review period. <p>As part of this Rio Tinto provided a suggested submission schedule which was subsequently agreed to by the DSD. The Paraburdoo closure plan was proposed for provision in 2018.</p>
DER (Contaminated sites branch) (February 2017)	RTIO presentation on RTIO contaminated sites with the DER Contaminated Sites Branch	RTIO presented a PowerPoint presentation on the strategy overview and site prioritisation of RTIO contaminated sites. The presentation included an overview of the reported sites and a review of the investigations undertaken in the 2016 year. Information on the internal RTIO procedure on ‘contaminated sites assessment of statutory reporting obligations’ was provided. RTIO confirmed that sites reported under s11 of the CS Act will be identified in the Mine Closure Plan.	
Yinhawangka (March 2017)	RTIO meeting with Yinhawangka Local Implementation Committee (LIC)	<p>RTIO presented information on its mine closure planning process and general closure strategies.</p> <p>In particular, the order of magnitude closure studies being undertaken at Eastern Range and Channar was introduced to the group. Indicated that this is the first type of these studies for Rio Tinto iron ore and it involved taking the closure plan to a greater level of detail as a mine approaches closure. The Paraburdoo Closure Plan is being updated this year and will support the Paraburdoo sustaining tonnes study approval. An overview of the closure planning process was provided and it was indicated that mine closure is an expensive process with the amount of earthworks needed for reshaping the landscapes. Indicated that Rio Tinto are committed to monitoring closed mines to assure safety and stability into the future.</p> <p>Discussion in relation to the order of magnitude studies indicated that these will take a step back from standardised procedures and look at range of different options for closure, and while Rio Tinto Iron Ore (RTIO) haven’t closed in mines in the Pilbara, we have done so in other countries, so we have a good resource of knowledge across the globe to support our efforts. Indicated that the Argyle diamond mine is going through a similar closure planning process and that we are in discussions with them about common issues. Discussed the process of consultation and the importance of the Yinhawangka People providing feedback. Indicated that at this stage useful information the group can communicate on could include:</p> <ul style="list-style-type: none"> o feedback on closure strategies o visual amenity considerations – will landscape changes have cultural heritage implications? o whether closure objectives are culturally appropriate o flora species to be considered in seed mixes (i.e. bush foods) o expectations for management of salvaged artefacts o areas where post closure access is important 	<p>Feedback from LIC representatives and RTIO responses included:</p> <ul style="list-style-type: none"> • An enquiry about the economic viability of the work due to amount being spent on closure. RTIO indicated that other options (other than closure) are being explored for these areas such as tourism, training. • Statement from LIC that there a lot of examples across the globe of how not to do mine closure and the importance of learning from previous mistakes was expressed. • RTIO discussed progressive rehabilitation that has taken place at these sites already which included some black shale encapsulations. • An enquiry was raised as to whether the 100 year flood predictions are taken into account in design. RTIO indicated that yes they are as this can affect the stability of the landforms. • RTIO indicated that the landscape is not likely to be returned to its original state. • An enquiry was raised about the impacts to the landscape after mining and clarification was sought regarding what impacts are expected because Iron Ore mining doesn’t use the same process of extraction as other mining like gold. RTIO discussed acid and metalliferous materials which can cause detrimental affects and our process for managing these.

Stakeholder	Subject	Summary of discussion relevant to closure	Response
Yinhawangka (September 2017)	RTIO Life of Mine – Closure Update presentation at the Yinhawangka LIC meeting	Reiterated that the order of magnitude closure studies were still underway for Channar and Eastern Range. Reassured the group that the Paraburdoo mine will continue well beyond the closure of Eastern Range and Channar and thus the future of the township of Paraburdoo is under no immediate threat. Rio Tinto representative (Pat Knott) informed the group that we have been working on an engagement strategy, and provided a copy to the group. Indicated that the company is seeking to arrange a day long closure consult with the group in October or November. Provided an overview of the items we would like to discuss and seek Yinhawangka input on. PK provided a draft agenda for this meeting. Discussion on importance of rehabilitation, and appropriate seed collection and soil preparation raised by Yinhawangka representative. Pk discussed that there may be business opportunities for Yinhawangka with rehabilitation and environmental site works. Also indicated that YAC are welcome to invite a technical consultant to attend the consultation when it occurs.	There were no objections or concerns raised relating to the proposed Channar and Eastern Range Order of Magnitude Closure studies consultation session with Yinhawangka representatives. A forum is to be organised ideally prior to the end of 2017, involving appropriate representation from RTIO, Yinhawangka People and YAC.
Department of Mines, Industry, Regulation and Safety (October 2017)	Channar and Paraburdoo DMIRS (DMP) inspection, with summary rehabilitation and closure information provided	RT provided information on the monitoring techniques employed at GPDO and the parameters measured, statistics, species composition and comparison against reference sites. Overall DMIRS were impressed with the monitoring program, but mentioned they would like more information provided in the AER. DMIRS viewed Channar rehabilitation and were impressed - CHE3, CH Weather Station, 84E5 and the Paraburdoo Truck Training Ground. They noted RTIO need to monitor and potentially undertake remedial works on the 4WN rehabilitation due to erosion gullies and minimal native vegetation establishment. They noted that it is evident rehabilitation at GPDO is now a focus. DMIRS noted weeds across the site are an issue and need to be managed. DMIRS were impressed with RTIO initiative to identify and stockpile alternative growth media, such as detrital material, at the Sugar dump. DMIRS emphasised the importance of detailed closure planning from studies phase all the way through to closure, and the importance of stakeholder consultation. DMIRS advised that we must engage with the District Safety Inspector, particularly in regard to abandonment bunds. DMIRS noted how close the 4W Pit crest is to the Pirraburdu Creek and raised concerns about the pit intercepting the creek flows.	On completion of the Enviro Sys data cleanse of monitoring data, Rio Tinto will be in a position to consult further with DMIRS on rehabilitation monitoring results. A weed management program exists for the Greater Paraburdoo mine sites and weeds are monitored during the annual rehabilitation monitoring program. These programs will continue throughout mining operations and during rehabilitation and closure phases. With regard to the management strategies for erosion gullies at the point where rehabilitation meets natural hillslopes, RTIO would consider dumping blocky waste in such areas as an appropriate future control. DMIRS advised that BHP have a project underway investigating appropriate controls/designs for this issue. In response to the importance of stakeholder engagement, RTIO advised that increased stakeholder engagement has commenced as part of the ER and CHA OoM Closure Studies. In response to how close the 4W Pit crest is to the Pirraburdu Creek, RTIO will address this aspect in the Closure Plan.
Yinhawangka (November 2017)	Rio Tinto and Yinhawangka Eastern Range and Channar Closure Meeting	Presentation provided – reiterating Rio Tinto's procedures relating to mine closure.	Very positive feedback received from Yinhawangka People regarding the thoroughness of the closure procedures and they welcomed the proposed level of Traditional Owner consultation.
Department of Mines, Industry Regulation and Safety (October 2017)	Paraburdoo DMIRS inspection, with summary rehabilitation and closure information provided. Inspection held on the 10/11 October 2017 (print date 2 February 2018)	General comments: DMIRS were please to see an improvement in general environmental management at the project between the 2015 and 2017 inspections. Numerous challenges for rehabilitation and closure were identified around the site: 1. Some minor erosion (riling) and sparse vegetation cover on the 4W waste dump (rehabilitated in 2015) indicate this rehabilitation may not be a success. DMIRS encourages the use of small scale trials to ensure that the growth medium is suitable and to inform landform design so that future rehabilitation efforts are not hampered by a large rainfall event, if this is what caused the sparse vegetation growth on the 4W dump. 2. Close proximity of waste dumps and pits to major creek lines are likely to present challenges for achieving stable landforms that do not impact upon the natural water flows post closure. Future MCP submissions should include information on flows of all creek lines during extreme flood events, including modelling of a Probable Maximum Flood (PMF) event. This information should then be used to develop a detailed design for the waste dump/pits and any required flood protection infrastructure to demonstrate that the proposed design/s are likely to result in the landform remaining stable during a PMF event. This design/s should be presented within the MCP for review by a DMIRS Geotechnical Engineer. 3. DMIRS has recently developed a Preparedness for Closure scoresheet, to aid in the evaluation of sites against a range of criteria and provide clarity to proponents on DMIRS expectations in relation to rehabilitation and closure. It was noted the Paraburdoo Project is currently less prepared for closure than DMIRS would expect. A number of the shortcomings outlined within the closure scoresheet (e.g. post mining land use, closure objectives, knowledge gaps, completion criteria, stakeholder engagement and significant risks for closure) may be addressed once DMIRS is provided with a copy of the Mine Closure Plan for the site to review.	1. The DMIRS officers were advised that the 4WN waste dump was being monitored regularly and that remedial works will be conducted if required. Rio Tinto personnel advised that they believe the lack of vegetation cover is likely to be due to a heavy rainfall event that occurred shortly after completion seeding (i.e. the seed and topsoil were washed down the slope). 2. Surface water modelling of Pirraburdu and Seven Mile creeks and their impact on pits and waste dumps has been undertaken and will be presented in the MCP. Engineering designs of flood protection measures for pits and waste dumps are being developed. 3. Rio Tinto have welcomed the information provided in the Preparedness for Closure scoresheet, and will address any shortcomings within the MCP.
Yinhawangka (6th and 7th March 2018)	RTIO presentation of Paraburdoo Water Features with Yinhawangka Local Implementation Committee (LIC). Eastern Range and Channar closure studies, Western Range & 4EE PFS, Greater Paraburdoo water management	2 day meeting with Yinhawangka to provide an update on the Channar and Eastern Range order of magnitude closure studies, the Western Range prefeasibility study and provide an overview of hydrology and hydrogeology for Greater Paraburdoo. Included a site visit as part of the closure studies. Key discussion points of relevance to closure included closure objectives, post closure access and business opportunities presented by closure. Site visit included the 64E1 landbridge, Channar radio hill lookout, CHE3 in-pit PAF rehabilitation, 84E5 rehabilitated waste dump and 94E2 landbridge.	Key questions and responses are included below: Q: How do YAC find out about the process to establish a Pilbara Aboriginal Business? A: We have dedicated roles in the Perth team to support this. Q: There are two key bush medicines in the natural landscape. These are identified in Lola Young's Book. A: Noted, will bring book to next engagement. A: Yes this can be included. Q: Can we leave the access track in place up to Channar Radio Hill? It provides a good lookout point for tourism. A: At this stage we are leaving the tower in place and the access track would remain until the borefields are closed for maintenance i.e. when Paraburdoo closes and the radio tower is no longer needed.
Department of Water and Environmental Regulation (DWER) (8 March 2018)	RTIO meeting with Department of Water and Environmental Regulation (Eastern Range and Channar OoM studies)	Discussed that closure planning is an iterative process with increasing detail at each stage. Is driven by changes to the mine plan. Ten years from the end of the mine life formal studies commence to define how closure will be implemented. The radio communications towers at both ER and Channar and the access tracks to these are excluded from the decommissioning and rehabilitation inventories of ER and Channar at this stage, as they are associated with control of the Channar and Turee Creek borefields. These borefields are also excluded as the intent at this point of planning is for these to remain active beyond the closure of Eastern Range and Channar to continue water supply to Paraburdoo operations. The closure of these borefields will be part of the Paraburdoo mine closure.	
Environmental Protection Authority (13 March 2018)	RTIO presentation of Paraburdoo Water Features to the Environmental Protection Authority (EPA)	PowerPoint presentation on Greater Paraburdoo hydrology and hydrogeology. Information presented on borefields, Springs, pools, water usage, water balance, surface water features, monitoring and closure.	

Stakeholder	Subject	Summary of discussion relevant to closure	Response
Department of Mines, Industry Regulation and Safety (6 September 2018)	RTIO presentation of Paraburdoo Mine Closure Plan (2018) to Department of Mines, Industry, Regulation and Safety (DMIRS)	PowerPoint presentation on Paraburdoo mine closure plan. Information presented included timing of closure plan submission, indicative mining schedule, site context, historical overview, key aspects detailed within the Closure Plan such as flood management along Creeks, post closure land-use, closure objectives/completion criteria and closure domains and landforms.	<ul style="list-style-type: none"> • Discussion was held on the Paraburdoo conceptual abandonment bund locations and that areas containing natural landforms greater than 35 degrees have been assumed as a natural deterrent to access, and as such bunds have not been proposed for these areas. This proposed method was based on previous abandonment bund approaches presented to DMIRS Safety and Geotechnical branch earlier in 2018. It was noted the Paraburdoo designs have not yet been presented to the Safety Branch and that consultation will be undertaken in the future. • DMIRS queried if progressive rehabilitation of the landforms on the western side of Seven Mile Creek was planned, particularly if future mining activity in this area was to be limited. RTIO indicated progressive rehabilitation within this area was likely in the future, but there could be some access limitations to some areas should mining of deposits at Western Range be approved, and a conveyor be built. This infrastructure aspect was still in the early design phase. • RTIO asked if DMIRS had any initial comments on what was shown in the presentation. DMIRS noted a key issue for Paraburdoo was the closure of pits and dumps located along the Creeks, and impacts of surface water flow and flooding on these features, and impacts to Creek flows downstream post closure. RTIO discussed the closure designs of these pits/dumps have taken PMP flood events (pits) and 1:1000 AEP flood events (waste dumps) into consideration and design refinement is currently being undertaken by a Consultant. However it was clarified that RTIO does not typically employ this closure approach, and the design criteria proposed for these features was only for Paraburdoo pits/ dumps located in close proximity to the Creeks.
Department of Water and Environmental Regulation (25 September 2018)	RTIO presentation of Paraburdoo Mine Closure Plan (2018) to Department of Water and Environmental Regulation (DWER)	PowerPoint presentation on Paraburdoo mine closure plan. Information presented included timing of closure plan submission, indicative mining schedule, site context, historical overview, key aspects detailed within the Closure Plan such as flood management along Creeks, post closure land-use, closure objectives/completion criteria and closure domains and landforms.	<ul style="list-style-type: none"> • Discussion was held on the creek flood modelling work and likely closure outcomes of pits and waste dumps located adjacent to Paraburdoo and Pirraburdu creeks i.e. 4E and 4W pits partial backfill to Probable Maximum Precipitation – Flood (PMP-F) flood height and waste dumps designed to 1:1000 Annual Exceedance Probability (AEP) level. Further comment was made on the difficulty of designing abandonment bunds on Creeks for long term stability without affecting creek flows. • Discussion was held on topsoil deficit at Paraburdoo and that RTIO are trialling and investigating alternative growth media and no topsoil options at other nearby minesites such as Tom Price. • Currently RTIO are undertaking a number of investigations at Paraburdoo to facilitate better understanding of systems and closure outcomes. Information on these aspects will follow in future Closure Plans.
Department of Water and Environmental Regulation - Contaminated sites branch; and Department of Planning, Lands and Heritage (11 October 2018)	RTIO presentation of Paraburdoo Mine Closure Plan (2018) to Department of Water and Environmental Regulation (DWER) - Contaminated sites branch; and Department of Planning, Lands and Heritage (DPLH)	PowerPoint presentation on Paraburdoo mine closure plan. Information presented included timing of closure plan submission, indicative mining schedule, site context, historical overview, key aspects detailed within the Closure Plan such as flood management along Creeks, post closure land-use, closure objectives/completion criteria and closure domains and landforms.	<p>Key discussion points:</p> <ul style="list-style-type: none"> • The question was raised if RTIO will be able to incorporate government agency feedback on the 2018 Paraburdoo Closure Plan, into the closure plan proposed for 2019 which will accompany the Part IV approval document. It was noted that although this would be an ideal scenario, the timing may not allow for comments to be incorporated into the next update. • The question was raised if RTIO intends to progressively rehabilitate waste landforms at Paraburdoo, taking into consideration the proposed mine expansion, or if rehabilitation will be left until mine closure. RTIO noted areas will be progressively rehabilitated as they become available. The expansion is primarily associated with 4E Extension and therefore historic areas that are no longer mined and are outside of the active mining area will likely be available for progressive rehabilitation prior to mine closure. There could however be some access limitations to some areas should mining of deposits at Western Range be approved, and a conveyor be built.
Yinhawangka Aboriginal Corporation (March 2019)	Yinhawangka and Rio Tinto Local Implementation Committee Meeting	<p>PowerPoint presentation detailed information:</p> <ul style="list-style-type: none"> • review of 2019 surveys undertaken at Greater Paraburdoo and West Angelas. • proposed mine layout for Western Range and 4EE project, areas surveyed and heritage sites. • preparation of Western Range Closure Plan to support the Part IV. 	
Department of Water and Environmental Regulation (DWER); Department of Jobs, Tourism, Science and Innovation (JTSI); Environmental Protection Authority and Department of Mines, Industry, Regulation and Safety (DMIRS) (02 April 2019)	Greater Paraburdoo Hub closure update	PowerPoint presentation on the Paraburdoo, Western Range and Eastern Range closure strategies, which have been updated as part of the Part IV approval for the Greater Paraburdoo Iron Ore Hub. Key closure risks and strategies for current and future mining areas at Western Range, Paraburdoo and Eastern Range were presented. Information presented included proposed closure and rehabilitation strategies, geochemical characterisation and pit lake modelling outcomes.	No response required.

Appendix C – Closure knowledge database

The closure knowledge database is a summary of the technical reports that directly or indirectly contribute to the development of the closure plan. These documents do not form part of the report and are for indicative purposes only.

The knowledge and understanding of closure issues and management strategies evolve and improve over time, coincident with the development of the mining operation. As a result, some components of some reports and studies may be superseded by new research or studies. While the closure plan addresses the current state of understanding and strategy for closure, the closure knowledge database captures the historical development of closure knowledge, and demonstrates how experience and knowledge developed at other Rio Tinto sites has been considered during the development of the closure plan and across the life of the operation. Accordingly, some information presented in the closure knowledge database may be obsolete.

Technical reports supporting the closure of the operation will be presented as part of the last plan produced prior to the implementation of closure (also known as the Decommissioning Plan).

CONFIDENTIAL

Climate

Climate Change Adaptation Project, Rio Tinto Climate Change Impacts in the Tom Price – Paraburdoo Region of the Pilbara, Western Australia

2007

This study was undertaken to provide a future climate analysis, spanning the period from 2000 to 2060 for the inland west Pilbara region of Western Australia, with particular emphasis given to the Tom Price region.

Internal reference:
RTIO-HSE-0046946

Over the coming decades out to the year 2060, the numbers of tropical cyclones do not appear to change dramatically, with the magnitude of the inter-decadal climate variability overshadowing the slight changes in the frequency of the total numbers of tropical cyclones for this region. The modelling points to an increased likelihood of more intense tropical cyclones forming over the waters off the Pilbara coast. Extreme maximum temperatures are expected to rise by at least 4.4oC for the summer season. Annual rainfall is predicted to decline by 30% from 1970 values. The impact is likely to increase the frequency of drier years, but with further extreme heavy rainfall events. The lengthening of the return periods for the extreme rainfalls can be attributed to the predicted gradual decline in the frequency of tropical cyclone events near this location and a reduction in the frequency of the middle level cloud bands during the autumn and winter months. Potential for increased severe thunderstorm activity, particularly in the form of severe wind squalls was also identified.

Geochemical characterisation

Geochemical Characterisation of Black Shale Samples From the CHE3 Pit, Paraburdoo

2005

Geochemical assessment of exposed black shale material at the base of the Footwall Zone and the top of the Mt McRae Shale from the CHE3 Pit, Paraburdoo was investigated to provide an initial indication of the acid and metalliferous drainage potential.

Internal reference:
RTIO-PDE-0053023

Two samples were non acid forming, three potentially acid forming with a low capacity and one potentially acid forming. Materials represented by the potentially acid forming samples are expected to show no significant lag. Results indicate that the acid neutralising minerals in samples with moderate acid neutralising capacity contents are poorly reactive and not readily available. Slight enrichment in As, Be, Co, Hg, Mg and Se is found for samples. Water extracts suggest that pyrite oxidation and acid release is likely to be accompanied by the release Al, Co, Cu, Fe, Mn, Ni and Se.

Review of Waste Rock Geochemistry a) General Overview of Acid Base Accounting

2006

This report contains a general overview of acid base accounting and a summary of the geochemical test work that has been previously completed for various sites and lithologies.

Internal reference:
RTIO-PDE-0021130

There are large discrepancies in the total sulfur concentration measured using XRF and LECO machines. The XRF machine underestimates the sulfur concentration at values greater than 2%. Materials with total sulfur concentrations less than 0.1% can contain low capacity PAF material, however, it is considered only to be low additional acid and metalliferous risk if the boundary for inert material and potentially acid forming material is shifted from 0.02%S to 0.1%S. A paste pH result of less than 7 should be sent to the black shale dump and a paste pH result of greater than 7 can be sent to an inert material waste dump.

Geochemical Characterisation and ARD Assessment of Fine Tailings from Paraburdoo

2007

An acid and metalliferous drainage assessment was conducted on samples of fine tailings from Paraburdoo.

Internal reference:
RTIO-PDE-0036107

The tailings represented in by the samples are classified as non acid forming. As and Fe are enriched in soils, however, Fe is consistent with background soils and rocks and is not a concern. Water extracts indicate that the majority of metals and metalloids were at low concentrations or below detection limits. As, Se, and Sr were slightly soluble and monitoring was recommended.

Geochemical Characterisation of Paraburdoo 4 East Extension Samples

2008

Geochemical assessment of samples for Paraburdoo 4 East Extension was undertaken.

Internal reference:
RTIO-PDE-0053009

23 samples were potentially acid forming, 47 were non acid forming and 2 were classed as uncertain. The samples were either Mt McRae Shale or footwall zone banded iron formation. In at least some of the samples Ag, As, B, Bi, C, Fe, Hg, Mo, N, S, Sb, Se were enriched. Readily leachable elements included B, Ca, Co, Cu, Mg, N, Na, Ni and Zn. Of these As, Cr, Cu, F, Ni, Se, U and Zn were in excess of certain water quality standards.

Geochemical Characterisation of Paraburdoo Lens 2, Tom Price North Deposit Dales Gorge and West Angelas Samples**2008**

A geochemical assessment was undertaken on samples from Paraburdoo, Dales Gorge and West Angelas to determine acid generating potential, oxidation rates and leachable contaminants.

Internal reference:
RTIO-PDE-0034616

Samples from a range of lithologies were assessed including black shale, pyritic black shale, banded iron formation and chert. The majority of the Paraburdoo Lens 2 samples were classified as potentially acid forming. Exceptions were samples located in the top most depth intervals, in a transitional zone between deeper black shales to green and yellow/brown shales, which were classified as non-acid forming. In at least some of samples from the three mine sites C, S, As, Au, Bi, Mo, Sb, Se and Sn were enriched. Only Mo and Se were readily leachable. Three of the Paraburdoo Lens 2 samples (all black pyritic shales) were associated with the highest percentages of leached minor elements.

Mineralogical Analysis of Potentially Acid Forming Materials**2008**

Quantitative mineralogy (QEM-Scan) for samples of rock collected from Tom Price, Channar, West Angelas, Brockman, Paraburdoo (4 East Extension), Western Turner Syncline and Hope Downs 1 North was undertaken. Comparisons were made between two methodologies use to characterise potentially acid forming materials; acid base accounting and mineralogical analysis.

Internal reference:
RTIO-PDE-0053725

All samples contained elevated total sulfur concentrations and the lithologies were either shale, banded iron formation or dolomite. Pyrite was the dominant mineral contributing to acidity and the dominant sulfate secondary mineralisation consisted of alunite and jarosite.

Determination of ARD potential of Rio Tinto Iron Ore (WA) Waste Rock Samples**2008**

This report investigates the use of mineralogy to predict acid and metalliferous drainage potential. Analysis of numerous rocks was undertaken using QEM-SCAN.

Internal reference:
RTIO-PDE-0051613

Areas of waste rock which have undergone oxidation can be identified where sulfur-bearing minerals vary between samples in the form of pyrite, alunite and jarosite. The variability of gangue mineral phases suggest that some areas of composite waste rock pile may provide some neutralising potential while other areas will have no neutralising potential. Variable textural and mineralogical controls on sulfide mineral occurrence result in decreased accessibility of pyrite to oxidising fluids.

Contaminant Leaching from Non-Sulfidic Waste Material**2011**

The available leach extract data and information pertaining to the distribution of metals and metalloids in non sulfur materials at neutral pH was reviewed. Based on this review conceptual models for controls on their leaching and mobility were developed.

Internal reference:
RTIO-HSE-0145041

The review found that contaminant leaching from non-sulfidic materials was generally very limited. Usually the pH in leach tests was near-neutral (pH 6 to 8), and dissolved contaminant concentration were at or below detection limits. It is believed that a primary leachable contaminant source is the oxidation of sulfide minerals. Release from oxidising sulfides leads to release of soluble reaction products. Under neutral pH conditions, there is the potential for release of these contaminants when those products dissolve.

Environmental Status of Selenium (Se) in the Pilbara Region of Western Australia – Potential Risk from Iron Ore Mining**2011**

This report includes information about Selenium geochemistry, distribution in the environment, occurrence in rocks in the Pilbara and potential risks to the environment.

Internal reference:
RTIO-PDE-0103857

The Selenium (Se) content of shales containing significant pyrite should be recorded as part of the overall risk assessment for acid and metalliferous mine drainage. However, it should also be noted Se solubility is far less constrained by pH than in the case of metals and near neutral drainage may contain significant Se concentrations in solution. It would be most useful to study the Selenium budget of the wetlands in the Pilbara as, apart from the chance poisoning of livestock from the consumption of plants that have taken up high concentrations of Selenium, impacts are most likely to be felt in wetlands receiving mine site drainage.

Contaminant Leaching from Low-Sulphur Waste Minerals (Summary)**2011**

RTIO's Geochemical Database was reviewed and based upon this data, conceptual models for controls on the leaching and mobility of a range of metals and metalloids were developed. This summary also describes potential controls on the amount of dissolved element that may be released. This is a summary of a comprehensive report RTIO-PDE-0100104.

Internal reference:
RTIO-PDE-0090689

For most contaminants, dissolved concentrations at circum neutral pH (pH 6 to 8) were very low, typically at or below detection limit. Geochemical modelling indicates that water-rock interactions are controlled by equilibrium, for salt, carbonates and sulphates this equilibrium is often source term limited whilst hydroxyl-sulphates and hydroxides are solubility controlled. Results also indicate that sorption plays an important role in solute concentration; weak (but detectable) sorption occurred for selenium and zinc whilst the strongest sorption was evident for cobalt. The review suggested that storage waste facilities containing low-sulfur materials pose a low level of environmental risk however, there is a small risk of increased in mobility of some contaminants if acidic conditions arise. Acidic conditions can sometimes arise from the interactions between iron and aluminium hydroxyl-sulphates and hydroxides.

Geochemical Assessment of Samples From North Lobe**2012**

An acid and metalliferous drainage assessment was undertaken on samples from North Lobe, located at Paraburdoo.

Internal reference:
RTIO-PDE-0094533

All but one of the Mt Sylvia samples were classified as potentially acid forming. Seven of the McRae Shale samples were classified as non acid forming, fourteen were potentially acid forming and three had an uncertain classification. Materials represented by the calcrete, dolomite and dolerite are non acid forming. Calcrete has a significant excess of acid neutralising capacity.

Geochemical Assessment of Tailings from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J**2014**

This report presents the results from geochemical testing and saline solution extraction of tailings samples from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J deposits.

Internal reference:
RTIO-PDE-0123030

Overall the tailings from these operations are unlikely to generate acid and are not expected to leach significant levels of metals under oxidising or saline conditions.

Oxidation and solute accumulation in dewatered pit wall rocks**2014**

Dewatering and removing the water table may result in de-saturation of sulphide-bearing lithologies. This study was undertaken to review how oxygen ingress and consequent sulphide oxidation of Mount McRae Shales could impact water quality when the groundwater table rebounds after mining.

Internal reference:
RTIO-PDE-0109045

Large Scale Column Construction Procedure and Initial Chemistry**2014**

Large scale column experiments have been constructed to examine the reactivity of hot and cold black shale material in an operational environment. The memo describes the construction of the columns and the first geochemistry data collected after small rainfall events at Rhodes Ridge.

Internal reference:
RTIO-PDE-0123894

Initial results suggest that effluent water retains the chemistry of the incident rainfall. Constituents to note in the initial chemistry include nitrate and ammonia detected in the hot black shale effluent. This study provides an important comparison between laboratory characterisation studies and field reactivity of waste rock. Data from the large scale column tests can be applied to reactivity of in pit waste/talus as well as waste rock dumps. It can be used as an intermediate to predict long term reactivity of waste rock.

Paraburdoo AMD Risk Assessment**2015**

The acid and metalliferous drainage (AMD) risk assessment for the Paraburdoo area takes into account total sulfur concentrations within rock types, as well as logging data and the position of the approximate pre-mining water table to indicate whether sulfur is in the form of sulfide or sulfate minerals, and also the acid neutralising capacity of the rock type to assess the overall risk of acid generation from waste rock exposed in each mining area. The exposures of black MCS against the final pit shells for the 4 East, 4 West and North Lobe Creek areas were also assessed.

Internal reference:
RTIO-PDE-0133858

Paraburdoo drillhole data have been divided into the following mining areas: 4 East, 4 West, 11 West, North Lobe Creek, 27 West, 18 East and 5 West. It was not possible to confidently allocate waste material extracted from individual mining areas to actual external waste dumps, however, the following mining areas are deemed to pose a greater relative AMD (due to either black Mount McRae Shale (MCS) or elevated-sulfur material) risk, and therefore, precautions should be taken during closure planning associated with the related pit voids and waste dumps: 4 East, 4 West, 11 West and North Lobe Creek.

Tom Price – Historical black shale exposures in SEP Pit compared to expected black shale exposures at BS4 and HD4**2017**

The purpose of this study was to understand and compare potential surface water and groundwater quality risks from pits with areas of exposed Mount McRae Shale (MCS) at Tom Price, Brockman Syncline 4 and Hope Downs 4 operations.

Internal reference:
RTIO-PDE-0149285

The annual (approximate wet season) black MCS exposures in South East Prongs (SEP) pit at Tom Price have been modelled as part of this exercise. The maximum black MCS surface area within the SEP pit (from 2000-2010) is modelled to be 200,000 m² (2010), representing approximately 9% of the SEP pit catchment area. It is noted that acid water was first observed in a SEP groundwater bore in 2001, when total black MCS surface areas were modelled to be 68,500 m² (3% of total pit shell catchment area). Acidic water within groundwater was observed in 2001, approximately three years after dewatering of the SEP pit commenced in 1998 via a number of in-pit dewatering bores. It is possible that surface water may have been acidic earlier than 2001. The significant accumulation and pooling of water within the SEP pit during large successive rainfall events, particularly Cyclone Monty in 2004 (representing a 12 year ARI (average recurrence interval) at Tom Price), likely caused acidity within the in-pit groundwater bores. In subsequent years, the pH had an increasing trend in many of the bores, however groundwater remained acidic for at least four years following Cyclone Monty.

Inspection of historical Paraburdoo waste dumps for the presence of black shale**2017**

This memo documents the outcomes of the Paraburdoo waste dumps desktop and field verification assessment for presence of black shale. The 2007 report undertaken by the Paraburdoo Mine Geology team identified waste dumps that may contain black shale and was the starting point for the desktop review. The desktop assessment involved a review of the locations identified in the 2007 report including discussions with long term team members of the Paraburdoo Operations to provide anecdotal evidence of black shale waste dumps, review of the latest aerial photography and a field verification inspection.

Internal reference:
RTIO-PDE-0153336

There appears to be no black shale located on the surface of Paraburdoo waste dumps. It should be noted that whilst no black shale was identified on surface, there is still a risk that during rehabilitation works that black shale may be exposed if there is a requirement to "cut into" the waste dump as part of reshaping. Provisions should be made to ensure that in the event that black shale is encountered, exposures will be managed according to the RTIO Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan.

Geochemical Characterisation of mine waste from Tom Price, Hope Downs 1 and Hope Downs 4**2018**

The purpose of this work was to investigate the leaching kinetics of six low-sulfur waste rock samples collected from Tom Price, Hope Downs 1 and Hope Downs 4. Static testing was conducted to provide a 'snapshot' of the geochemical characteristics of each waste rock sample. These tests were completed to screen all samples before commencing more detailed leach column tests. The geochemical test program was designed to assess the degree of risk from the presence of reactive sulfides, acid generation and leaching of soluble metals/metalloids and salts in accordance with relevant mine waste geochemistry and mine closure guidelines.

Internal reference:
RTIO-PDE-0159203

The results from the geochemical assessment indicate the samples have negligible to low-sulfur content, low but generally sufficient ANC and are generally classified as non-acid forming. The amount of potential acidity that could be generated from the samples is expected to be negligible to low, with all samples having low reactivity; there is a high factor of safety and low risk of any significant acid generation from these materials. Waste rock materials represented by these samples are likely to generate pH neutral surface runoff and seepage with low salinity and generally low concentrations of dissolved metals(oids) (excluding the Tom Price black MCS sample where elevated manganese was measured in the leachate).

Paraburdoo Historic Black Shale Waste Dump Reconciliation**2018**

Black shale was mined historically from pits 4 West (4W), 4 East Northwest (4ENW) and 4 East North (4EN). The black shale exposures have been mapped within those pit shells, however limited data was recorded to indicate where black shale was dumped. This reconciliation involved review of historical aerial imagery and survey data to assess each location and assign an AMD risk rating based on estimated volumes and spatial location of black shale.

Internal reference:
RTIO-PDE-0161201

Black shale was mined between 1989 and 1996 from 4W pit, and is likely located in waste dumps 4W_WD01 or 4W_WD02. Black shale was mined prior to 1989 and up to 2004 in 4E pit, and is likely located in waste dumps 4E_WD, 4EX_WD and 4EX3_SOUTH_WD. These dumps are considered to pose a low acid and metalliferous (AMD) risk based on the low volume of black shale likely to have been placed within the dumps, as well as considering the majority of black shale would likely be encapsulated by sufficient (i.e., greater than 5 m) inert waste.

AMD and Geochemical Summary for 2018 Paraburdoo Closure Plan**2018**

The purpose of this document is to support the 2018 update for the Paraburdoo Closure Plan. The Closure plan aligns with the 2017 Life of Mine Plan (LoM) and covers the 4 West (4W), 4 East (4E), 5 West (5W), 11 West (11W), 18 East (18E) and the North Lobe Creek (NLC) mining areas, the associated waste dumps, and the tailing storage facility. Discussion has also been made for 14 West (14W) and 16 West (16W) approved deposits (14W and 16W represent part of the 27 West (27W) deposit, as referenced in this work). Brief comment has been made on the 36 West (36W) deposit, as well as the below the water table mining of NLC, even though they are not in the current LoM, and still to be investigated. The results of this assessment are superseded by content in RTIO-PDE-0133858 (2019).

Internal reference:
RTIO-PDE-0161216

Rio Tinto Iron Ore (WA) has undertaken an extensive program of geochemical testing to understand the potential for acid and metalliferous drainage (AMD) to occur within the range of waste types common to mining operations in the Pilbara. Mining activities at Paraburdoo include the disturbance of PAF material (i.e. black MCS) and site-specific ABA test work began in 2005. The Paraburdoo AMD assessment concludes that the 4E, 4W and NLC pits pose a moderate AMD risk mainly based on the historic (i.e., at 4E and 4W) and expected (i.e., at NLC, mainly BWT but possibly also AWT) exposure of black MCS. The 11W area is also noted as posing a moderate AMD risk, however if black MCS is avoided in that area during future mining (black shale is currently not exposed), the AMD risk rating may be downgraded to low. Likewise, the AMD risk ratings for the 18E, 5W, 27W and 36W areas are also classified as low.

Physical characterisation**Net solute load response to the installation of infiltration limiting dry cover systems over acid forming waste piles****2014**

This work was conducted to verify the central design concept of store-and-release covers over sulfidic above water table waste dumps that is, whether limiting net percolation volume through the cover results in a lesser sulfate and acidity load being realised generated and passing through the dump.

Internal reference:
RTIO-PDE-0128431

The results from this thesis project confirm that the central aim of store-and-release covers to reduce net percolation volume is a valid measure for reducing the net loading of sulfate and acidity. The mechanism through which decreasing net percolation (applied water volume) results in a lesser sulfate and acidity load was identified, however further work in a site context is needed to assess how this relationship between percolation volume and loading persists in the real-world environment.

Growth Media Characterisation**2018**

This report provides an interpretation of material characterisation data for a total of 53 potential growth media samples made up of 34 samples for which data has been previously collected by Outback Ecology Services on behalf of Rio Tinto, 11 samples for which data has been previously collected by Landloch on behalf of Rio Tinto as part of previous erosion studies and 8 additional samples collected and analysed as part of this project. Based on this characterisation, each material was classified as either suitable or not suitable for use as a growth medium.

Internal reference:
RTIO-HSE-0324326

Properties tested for included pH1:5 (water), salinity (EC1:5, EC1:2), exchangeable cations (K⁺, Ca²⁺, Mg²⁺, Na⁺, Al³⁺), effective cation exchange capacity (ECEC), exchangeable sodium percentage (ESP), particle size distribution (fine fraction < 2mm), coarse fraction (> 2mm), particle size distribution (all material), texture, emerson class, dispersion potential rating, rock particle density, rock water absorption and rock cover of rain-armoured surface. A classification scheme for key parameters was then developed to classify a material as suitable or unsuitable. Several materials have properties that were invariably suitable. In some cases, materials have some properties that are suitable and others unsuitable. In others, several of the properties are problematic. Suitable materials represent those that have base properties that are not likely to impede vegetation. Marginal materials are those that are likely to support vegetation but that have some properties that may limit establishment and growth. Unsuitable materials are those that have properties that are likely to significantly impact on vegetation growth either through being saline, prone to dispersion, and having pH values quite different to those typically observed. Of the 53 samples, 21 were recommended as suitable growth media, 25 were assessed as marginal growth media and 8 were not recommended as growth media. Samples which were recommended were sourced from Yandicoogina, Channar, Mesa J, Mesa K, Eastern Range, Paraburdoo and Parker Point. Marginal samples were sourced from Brockman 4, Brockman 2/Nammuldi, Mesa A, Mesa J, Channar, Eastern Range, Paraburdoo, Yandicoogina and Hope Downs 4. Samples which were not recommended were sourced from areas at Greater Paraburdoo (Paraburdoo and Eastern Range), West Angelas, Western Turner Syncline and Parker Point.

Groundwater**Final Voids Modelling Paraburdoo 4 West/4 East****1998**

This report provides predictive modelling of the likely long term pit water levels and the impacts of evaporative losses from the final voids on local/regional groundwater flows and pit water/groundwater salinity.

Internal reference:
RTIO-HSE-0016072

The predictive modelling results indicate final pit water levels will recover to around RL329 at 4 West, some 11m below the pre-mining groundwater level in the area, and to around RL307m at 4 East, some 33 m below the pre-mining levels. Pit water salinity will increase, in 100 years time frame, from approximately 1,000mg/L to approximately 4,200 mg/L in 4 West and up to approximately 9,400mg/L in 4 East. Both pits are predicted to become groundwater sinks.

Surface water**2016 review of Existing Water Quality Data Greater Paraburdoo****2017**

This report evaluates historical and current geochemical data from surface water and groundwater monitoring locations in the Greater Paraburdoo region, including at the Paraburdoo, Eastern Ranges and Channar mine sites. The aim of the report is to monitor for signs of acid and metalliferous drainage (AMD) development or changes in water quality associated with dewatering or other mining activities. Groundwater quality has been reviewed from production and monitoring bores regionally and within the Paraburdoo and Channar mine sites, with a focus on areas with AMD risk. The Eastern Range mining area is AWT and there are no groundwater bores due to its high elevation. Surface water quality was evaluated from monitoring sites in pools and creeks, within the Seven Mile Creek and Turee Creek catchments. The previous water quality review for Greater Paraburdoo was conducted in 2011 and therefore, the focus is on water quality data between 2012 and 2016.

Internal reference:
RTIO-PDE-0154092

Groundwater at Greater Paraburdoo was circum-neutral in 2012-2016 and ranged from 7.3 to 8.6 pH. Excluding the groundwater surrounding the Paraburdoo tailings dam, groundwater was fresh and TDS ranged between 150 and 1800 mg/L, with a median of 870 mg/L. CHE3, 4E and 4W pits pose moderate to high potential AMD risk due to PAF exposures and PAF waste storage in-pit. Ratty Springs bores were monitored during 2011-2013 and displayed generally low salinity (median TDS = 680 mg/L). Regular monitoring is recommended across the site to make it easier to identify changes in water quality. Surface water within the Greater Paraburdoo region was fresh to brackish (TDS: 32 to 3900 mg/L) and neutral to mildly alkaline, with pH ranging from 6.8 to 9.2 for the 2012-2016 period. In general, surface water quality is relatively stable over time within the Greater Paraburdoo region, although there are some gaps in water quality data. This is partially due to the ephemeral nature of many of the water bodies, such as Howie's Hole and Python Pool, where the pools were dry when monitoring was undertaken.

Water interactions and pit lakes**Impact of final voids on Groundwater Flows and Quality****2002**

A preliminary assessment of the potential impacts of final voids (if left open) on long-term groundwater flow and water quality has been carried out for the Paraburdoo and Tom Price pits.

Internal reference:
RTIO-PDE-0035871

It was concluded that at Paraburdoo lakes in 4 West, 4 East, North Lobe and 64 East pits are not likely to become acidic but will eventually become saline. The lakes are predicted to be mostly total sinks or partial throughflow pits. The exception is at 64 East where surface water runoff to the pit is predicted to fill the pit to the pre-mining water table. Under these conditions the water would establish a throughflow system. However, no significant impacts on regional water quality are predicted for any of the pits. In the case of North Lobe, the lake is likely to convey water into the 7 Mile Creek system. 4 West, 4 East and 64 East, have been classified with a low risk for potential environmental impacts, whereas, North Lobe has a high risk.

Testing hay as an in situ remediation option for acidic pit lakes in the Pilbara**2017**

A field experiment was conducted at the Tom Price mine in two small temporary pit lakes ('West' and 'East' Lakes). Water-damaged hay produced by Rio Tinto Iron Ore in the Pilbara was used to treat the West Lake, with the East Lake kept untreated. A laboratory-based microcosm experiment was conducted in order to determine if bio-physical processes that occur in microcosms (a classic method in mine water treatment experiments) represent field conditions. A laboratory-based microcosm pilot experiment containing acidic lake water was conducted for 60 days. Results from the pilot demonstrated that (relative to controls) microcosms containing hay become more neutral to pH >6. Review of the pilot experiment resulted in a range of improvements in the design and execution of the microcosm experiment in order to better mimic conditions in the field trial.

Internal reference:
RTIO-PDE-0159196

The West Lake controls exhibited a slight improvement in pH over the course of the experiment, whereas the East Lake controls did not. The likely contamination of the water and sediment by hay prior to the experiment (due to collection of in situ water after the field experiment commenced) indicates that the carbon that leached from the hay may have been sufficient to increase pH in the microcosms. The main observable effect of lake water source appeared to be that chemical composition of West Lake was such that the hay - while effective at reducing dissolved oxygen concentrations - was not as effective in driving oxidation reduction potential to levels that classically are considered necessary to support sulphate reducing bacteria. A seasonal algal bloom in East Lake indicated that pit lakes are subject to the same processes as natural lakes; the specific cause of the bloom is currently unclear but likely seasonal. The main risk associated with the use of organic matter to treat acidity in pit lakes is the potential for release of problematic quantities of gases such as methane, carbon dioxide or hydrogen sulphide. Due to a lack of within-lake replication the effect of hay on microbial assemblages could not be determined for the field trial. Further research is needed on gas flux and the microbes responsible associated with organic matter treatments in pit lakes to better understand potential risks associated with gas flux on closure.

Paraburdoo 4E pit lake water quality assessment**2018**

This memo provides a high level assessment of the future water quality of the Paraburdoo 4 East (4E) pit lake and presents the assumptions, methodology and results of the assessment.

Internal reference:
RTIO-PDE-0161335

Based on the high level assessment it was predicted the risk of developing an acidic lake in the Paraburdoo 4E pit is considered low. Under circum-neutral conditions parameters such as metals, TDS and sulfate are expected to remain low. Additionally some parameters such as TDS or salinity will inevitably evapoconcentrate in the long term if the pit lake becomes a sink. It was recommended additional modelling be undertaken to refine the model further.

Flora**Monitoring of unmined hillslope vegetation at Tom Price, Paraburdoo and Marandoo****2001**

This study obtained baseline information on various parameters from unmined hillslopes in the West Pilbara areas of Marandoo, Tom Price and Paraburdoo, to facilitate comparison of vegetation established on sloping rehabilitation areas.

Internal reference:
RTIO-HSE-0016088

Vegetation on hillslopes fell into three broad structural groups: slopes dominated by a spinifex hummock grassland with an open cover of scattered shrubs; slopes supporting a relatively dense shrubland over a moderate amount of spinifex; or slopes supporting a tall shrubland (usually dominated by Mulga) over large amounts of annual grasses with little or no spinifex. There was considerable variability in the floristic composition of unmined hillslope vegetation, with none of the transects showing any particular trend. Fire appears to be the dominant influence, with unburnt transects grouping out as dissimilar from burnt transects.

Paraburdoo Gas Pipeline Rare Flora Survey**2003**

This report describes the flora of the Paraburdoo Gas Pipeline route from September 2003, with the focus to record locations of any rare or unknown flora specimens (and take voucher specimens). Biological Survey IDs: 2003-105 and 2003-540.

Internal reference:
RTIO-HSE-0011107

Nine general vegetation types identified. Over 150 taxa of vascular flora were recorded, but the focus of the study was on rare or unusual flora. No Declared Rare Flora (DRF) were recorded, including no evidence of *Lepidium catapycnon*. A single Priority flora species was recorded: *Ptilotus trichocephalus* (P1), which is a small annual herb found in small patches of up to 25 individuals. Six introduced weed species were recorded from the pipeline corridor: *Acetosa vesicaria* (Ruby Dock), *Aerva javanica* (Kapok), *Cenchrus ciliaris* (Buffel Grass), *Cenchrus setigerus* (Birdwood Grass), *Malvastrum americanum* (Spiked Malvastrum) and *Solanum nigrum* (Black Berry Nightshade).

Paraburdoo Gas Pipeline Re-alignment Rare Flora Survey - Botanical Survey Advice**2005**

This report extends the biological survey coverage for the gas pipeline at Paraburdoo. Biological Survey ID: 2005-254

Internal reference:
RTIO-HSE-0014251

No Declared Rare Flora or Priority flora were found on this additional survey.

Regional Survey for Ptilotus sp. Brockman, Aluta quadrata and Geijera aff. Salicifolia**2007**

A regional survey was conducted, targeting three flora species, namely Aluta quadrata, Ptilotus subspinescens (formerly Ptilotus sp. Brockman) and Geijera salicifolia (formerly Geijera aff. salicifolia).

Internal reference:
RTIO-HSE-0039999

The survey proved successful for two of the target species (Ptilotus sp. Brockman and Geijera aff. Salicifolia), as well as a number of other Priority flora. In reference to Aluta quadrata, no new populations were identified and one erroneous species record was removed from the dataset – reducing its known range.

Flora and Vegetation Surveys for the Paraburdoo Magazine and the Tom Price Powerline Infrastructure Areas**2011**

This report describes the flora and vegetation for the Paraburdoo Magazine, including the tailings dam stage 3 and the access track to Stony Creek. Biological Survey ID: 2011-1365

Internal reference:
RTIO-HSE-0109585

144 taxa from 40 families were identified at Stony Creek, across seven vegetation types. No DRF or Priority Flora were identified. Four introduced weed species were identified. 77 taxa from 27 families were identified on the access track to Stony Creek, across eight vegetation types. No DRF or Priority Flora were identified, although confirmation is required for a sighting of Eremophila coacta (P1). Four introduced weed species were identified.

Aluta quadrata (P1) Seed Phenology & Collection Program**2011**

Western Botanical implemented an Aluta quadrata seed collection program from August to October 2011. Primary objectives were to gain an understanding of the phenology and seed development of Aluta quadrata, to collect seed from known populations and to determine and implement a seed cleaning method.

Internal reference:

Conclusions recommended that initial seed collection should be undertaken from exposed, north-facing areas, as these plants were first to shed their fruit. The week up to the 30th September 2011 was an optimum time for seed collection at Howie's Hole. By the 4th October optimum seed collection time at Western Range appeared to have passed.

Paraburdoo Botanical & Vertebrate Fauna Survey (2012)**2012**

This survey, commissioned to support a new clearing permit, combined background research with a detailed field survey, provides: an inventory of species of biological and conservation significance, vegetation types and flora species, vertebrate fauna, vegetation types, fauna habitats and a review of previous surveys.

Internal reference:
RTIO-HSE-0133972

Two priority flora species were recorded: Aluta quadrata (P1) and Ptilotus trichocephalus (P3). 22 vegetation units were described. 284 terrestrial vertebrate fauna species potentially occur area, including: 33 native and seven introduced mammal species, 140 bird species, 100 reptile species and four amphibian species. There are 23 fauna species of conservation significance. A roost cave for the Pilbara Leaf-nosed Bat was identified.

Flora and Vegetation Assessment - Turee Creek Water Pipeline Upgrade and Paraburdoo Town Feeder One Line Replacement**2012**

This flora and vegetation assessment was conducted for the Turee Creek pipeline upgrade (TCPU) and the town feeder one line (TFOR) locations near Paraburdoo. Biological Survey IDs: 2012-2061; 2012-2062

Internal reference:
RTIO-HSE-0147662

The vegetation and flora of the study area is considered to be represented in nearby areas. There are no TECs within the study area. Families with the highest amount of taxa include Fabaceae, Poaceae, Malvaceae and Scrophulariaceae. No threatened species were recorded. Two species of priority flora were recorded from TCPU: Hibiscus sp. (P1) and Goodenia sp. (P3). Restriction zones will be placed around the location of these species. Five introduced (weed) species were recorded in TFOR; seven weeds in TCPU. Desktop assessment shows the study area may provide habitat to 15 conservation significant terrestrial vertebrate fauna species. The fauna habitats of TFOR are common and widespread and does not include significant fauna habitat (eg. caves, rock piles, waterholes, termite mounds, sandy banks or tree hollows). Whereas TCPU contains a water body likely to provide important habitat for native fauna, but there are no other significant fauna habitats.

Propagation of Aluta quadrata via cuttings**2012**

Nuts about Natives were commissioned to investigate propagation of Aluta quadrata via cuttings. Three separate trials were conducted, each employing standard nursery propagation techniques and prior learnings.

Internal reference:

Trials showed that propagation of Aluta quadrata via cuttings was possible using standard nursery techniques, but success rates were extremely low. Over the entire trial period only 6 out of the 896 (0.7%) cuttings showed positive root development. As a result, use and/or application of these propagation techniques in a field based capacity was not viewed as a viable option; and further small-scale laboratory trials would be required to develop/improve methodologies.

Seed testing of Aluta quadrata seed lots**2012**

Western Botanical's SeedLab (WBSL) was engaged by Rio Tinto Iron Ore (RTIO) to investigate seed quality and germination biology of Aluta quadrata. Seed lots were collected in 2011, from the Howie's Hole, Western Range and Pirraburdoo Creek populations.

Internal reference:

On the whole, all seed lots were considered to have a high purity, ranging 96.50% to 99.92%. Viability of seed lots ranged from 9% to 25% and results were considered to be within the expected range for this genus. Germination trials found that the application of certain pre-treatments can increase the germination of A. quadrata seeds. Maximum germination was recorded from manually excising seed out of the indehiscent fruit, though this treatment is not recommended due to the high labour intensity and abnormal seedlings with poor survival rates. The current recommended pre-treatment for germination of A. quadrata seeds is Smoke

Knowledge Review and Predictive Species Habitat Modelling**2012**

To further the understanding of Aluta quadrata a literature review on the biology and distribution was conducted. The objective of this work was to enhance understanding of known and potential habitat distributions, with a view to utilising outcomes to guide future targeted survey efforts.

Internal reference:

Outcomes of the predictive models identified the following potential relationships with known Aluta quadrata locations: mid to high elevations of moderately rugged terrain; low to mid topographic positions of gullies and mid-slopes; low average annual rainfall (approx. 270 mm); vegetation classified as Triodia open hummock grassland; and land system types of hills and ranges.

Marandoo Native Pivot Trial Harvesting and Monitoring 2015**2016**

The primary objective was to determine whether native plants required in mine site rehabilitation could be established and grown under large-scale irrigation pivots; for the purpose of producing harvestable quantities of seeds. Trials were located within two irrigation pivots at the Hamersley Agricultural Project (HAP) near Rio Tinto's Marandoo Mine.

Internal reference:

Twelve native species were planted and grown in the pivot trials. Of these species, Aluta quadrata seedlings from the seed propagation trials were translocated and incorporated into the study in May 2013. Aluta quadrata showed low survival rates in the pivots, with only 10% remaining by the end of the first year's trial period. Low survival rates more than likely reflected atypical substrate conditions, competition from invasive species and accidental clearing by machinery. It is noted that seed for this translocation trial was collected prior to Aluta quadrata being listed as Declared Rare Flora; therefore no approved translocation program was required.

Greater Paraburdoo Detailed Flora and Vegetation Survey**2018**

Astron Environmental Services were commissioned to undertake a detailed two phase flora and vegetation assessment of the Greater Paraburdoo Development Envelope, covering a survey area of 11,203 hectares.

Internal reference:

RTIO-HSE-0330744

Twenty-one vegetation units were recorded in the survey area, none of which represent a threatened ecological community or priority ecological community. All vegetation units are considered well represented beyond the survey area and do not support assemblages of species that are unique, located on restricted landforms, or of high conservation significance. Vegetation condition ranged from Excellent to Completely Degraded. An estimated 41.1% of the survey area was rated between Very Good and Excellent, 17.9% was rated as Good and 10.4% was rated between Poor and Degraded. An estimated 30.6% of the survey area was cleared and rated as Completely Degraded. When combined with the previous site data from within the survey area a total of 470 taxa have been recorded. Twenty-two introduced flora species (weeds) were recorded during the current survey, none of which are listed as Weeds of National Significance or as declared pests.

Fauna**Turee Syncline Bat Monitoring 2009****2010**

To collect data on presence and levels of activity of the two bat species in the Turee Syncline project area in order to define the type of usage of particular habitats, and from this make assumptions about the importance of such habitats to the species. The design approximates a Before-After-Control-Impact, and includes sites for comparison from the Eastern Ranges and near Channar where the Pilbara leaf-nosed bat has been recorded previously.

Internal reference:

RTIO-HSE-0206241

The Pilbara leaf-nosed bat was present at four sites in the Turee Syncline (TS) area and one site in the Eastern Ranges (ER) on the present survey. Activity levels were greatest at the two sites with pools of water: ER1 (32E pools) and TS5. The latter site was discovered and added during the present survey based on observations of activity over the pool of ER1 (32E Pools) part way through the survey. Pools of water, rather than roost sites, might be the most important resource to the Pilbara leaf-nosed bat in the Eastern Ranges, Channar, and Turee Syncline areas. This is supported by observations of the greatest activity over pools, and the virtual absence of activity at cave entrances and areas where pools have disappeared in the past few years (Channar, HH1). However, roost sites are likely to be somewhere within the range system. The presence of the Pilbara leaf-nosed bat consistently over two surveys in 2009 in a gorge in the Eastern Ranges was a significant observation given its close proximity to mining infrastructure since 2004.

Summary of Pilbara Leaf Nosed Bat occurrences at Eastern Range and surrounds**2010**

To summarise data on presence of the Pilbara Leaf Nosed Bat at Eastern Range and surrounds. Summary of efforts conducted to find the PLNB roost.

Internal reference:
RTIO-HSE-0206242

Area 1 (32E pools) appears to provide some kind of important, possibly limited resource to the PLNB. This site demonstrates the persistence of the species despite nearby mining and habitat degradation. Pools and suitable roost sites are important, and possibly limited resources in the area around Paraburdoo. The Eastern Ranges area has been searched extensively on several occasions for roosts of the Pilbara leaf-nosed bat and ghost bat between May 1997 and July 1999. None were found. Pilbara leaf-nosed bats have been noted as present in Area 1 (32E pools) during every visit made between June 1998 and November 2009.

Presence and activity of Pilbara Leaf nosed bat at Eastern Ranges**2013**

To determine whether the Pilbara leaf-nosed bat continues to use the Eastern Ranges project area during mining, and assess the level and types of mining activity that might have detectable effects on the species in comparison to natural environmental factors.

Internal reference:
RTIO-HSE-0206244

The continued presence of the species in the gorge within which 32E Site 3 ('ER1' on previous surveys) is located has been recorded. Access to this gorge is somewhat restricted by a rock face upstream and infill to create the haul roads downstream, and the pool was completely dry during the survey, however the Pilbara leaf-nosed bat was still present. No unambiguous calls of this species were detected. There have been no reliable records of the ghost bat in the Eastern Ranges and no roost sites have been located.

OEPA Level 1 and Targeted Conservation Significant Fauna Assessment**2018**

Astron Environmental Services were commissioned to undertake a Level 1 and targeted conservation significant fauna assessment of the Channar Development Envelope which is 7,305 hectares in size.

Internal reference:
RTIO-HSE-0326666

There were 74 vertebrate fauna species recorded within the survey area, comprising one amphibian, eight reptiles, 49 birds and 16 mammals (including three introduced species). The fauna species assemblage recorded during the survey was considered typical of the Hamersley Range subregion. One vertebrate species of conservation significance: the Pilbara Leaf-nosed Bat was recorded within the survey area during the current survey, with the majority of the survey area (65%) considered suitable foraging habitat. This species was recorded at five locations within the survey area, with one location Howie's Hole recording 'very high' activity (approximately 2,500 calls), which is expected given the presence of water. However, the timing of calls also indicated that at least one Pilbara Leaf-nosed Bat roosted overnight in a satellite cave close to Howie's Hole. An additional seven conservation significant fauna species have been assessed as highly likely to occur given previous records in the vicinity and suitable habitat within the survey area: Pilbara Olive Python, Grey Falcon (*Falco hypoleucos*) (Vulnerable), Peregrine Falcon (*Falco peregrinus*) (Other Specially Protected Fauna), Northern Quoll, Long-tailed Dunnart (*Sminthopsis longicaudata*) (Priority 4), Ghost Bat and Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4). The Night Parrot (*Pezoporus occidentalis*) (Endangered; Critically Endangered) was considered unlikely to occur within the survey area due to a lack of potential shelter and foraging habitat and no calls being recorded during the current survey.

Greater Paraburdoo Level 2 Fauna Survey April 2018**2018**

Astron Environmental Services were commissioned to undertake a Level 2 fauna and Short Range Endemic assessment of the Greater Paraburdoo Development Envelope which is 11,203.4 hectares in size.

Internal reference:
RTIO-HSE-0328335

Seven broad fauna habitat types were recorded in the survey area: Riverine, Drainage Line, Gorge, Breakaway, Rocky Hill, Low Hill, and Stony Plain. Areas of cleared habitat were prevalent throughout the central portion of the survey area where mining infrastructure and operations are concentrated. The Gorge, Riverine and Breakaway habitats in the survey area are considered important for fauna due to the microhabitats they provide such as caves and permanent water pools. The Gorges and Breakaways in particular contain a high diversity of microhabitats. There were 154 vertebrate fauna species recorded within the survey area, comprising two amphibians, 34 reptiles, 94 birds and 24 mammals (including four introduced species). The fauna species assemblage recorded during the survey is considered typical of the Hamersley Range subregion. Four of the seven recorded conservation listed species are classified under the Environment Protection and Biodiversity Act 1999 as 'Matters of National Environmental Significance' species: the Pilbara Olive Python, Northern Quoll, Ghost Bat and Pilbara Leaf-nosed Bat. The Pilbara Olive Python has been previously recorded in the Riverine habitat of the survey area at Seven Mile Creek. The Northern Quoll was recorded twice during the first phase of the current survey in the form of individual scats in the Breakaway and Gorge habitats. The Pilbara Leaf-nosed Bat was recorded at seven of the 16 bat detector locations; all were deemed to be at low activity levels. The Pilbara Leaf Nosed Bat records were from foraging individuals in Breakaway, Drainage Line and Riverine habitats. One previously identified roost within the survey area that is close to Ratty Springs is a confirmed permanent diurnal/maternal roost. The Ghost Bat was recorded once (two possible calls) during the current survey through an acoustic recording in the Breakaway habitat. A targeted fauna survey, specifically to assess the presence of the Northern Quoll, was undertaken within certain gorges in the Eastern Ranges portion of the survey area. No conservation significant fauna were recorded as part of this targeted fauna survey.

Greater Paraburdoo Subterranean Fauna Survey**2019**

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned to undertake a survey and assessment for subterranean fauna (troglifauna and stygofauna) throughout a Study Area encompassing the Greater Paraburdoo Iron Ore Hub.

Internal reference:
RTIO-HSE-0334994

The 2018 survey sampled a total of 312 bores and drill holes throughout the Study Area. A total of 1510 subterranean fauna specimens were recorded comprising 165 troglifauna and 1345 stygofauna specimens. In combination with previous records, a total of 171 troglifauna specimens representing 40 species/ species level taxa and nine higher level indeterminate taxa are known to occur within the Study Area. In combination with previous records, a total of 1355 stygofauna specimens representing 72 species/ morphospecies and nine higher level indeterminate taxa are known to occur within the Study Area.

Biodiversity improvement studies**Evaluation of mine waste materials as alternative rehabilitation growth medium****2010**

This study reviewed the physical and chemical properties of soil, tailing and mineral waste from select Pilbara mining operations, to identify waste material and material combinations for use as a topsoil substitute or supplement.

Internal reference:
RTIO-HSE-0109961

The study showed plant-available nutrients held within the waste materials, although variable, was characteristically low and comparable to natural soils in the region. The majority of the waste materials had macro and micro nutrient concentrations within the range or above the levels measured in benchmark Pilbara topsoil and rehabilitated soils. The pH and phosphorus buffering index of most waste materials were also comparable to that of the benchmark topsoil materials. However, some of the waste types and tailings may need to be mixed with rocky material due to poor physical / erodibility characteristics.

Genetic diversity in Eucalyptus leucophloia across the Pilbara: Provenance zone implications**2011**

This study was undertaken to define the provenance seed collection zones for a common species of the Pilbara, Eucalyptus leucophloia (Snappy Gum). This report details information on genetic analysis conducted on E. leucophloia. Collections of E. leucophloia were made from 20 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Internal reference:
RTIO-HSE-0108843

Genetic diversity in E. leucophloia was high and was typical of that found in other eucalypt species with wide spread distributions. Across the species the level of population differentiation was low and the majority of the diversity was maintained within populations with only 6% of variation partitioned between populations. Genetic variation in E. leucophloia showed little structure across the Pilbara with no clustering of populations based on any geographical proximity or in association with obvious topographical, physiogeographical or geological features such as the Hamersley or Chichester Ranges. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within E. leucophloia implies that seed resources for rehabilitation can be selected from a wide range within the Pilbara.

Genetic diversity in Acacia ancistrocarpa across the Pilbara: Provenance zone implications**2011**

This study was undertaken to define the provenance seed collection zones for Acacia ancistrocarpa (Fitzroy Wattle). This report details information on genetic analysis conducted on Acacia ancistrocarpa. Collections were made from 24 populations across the Pilbara bioregion and genetic analysis was conducted on 16 populations using microsatellite markers.

Internal reference:
RTIO-HSE-0119260

Genetic diversity in A. ancistrocarpa was high but lower than that in E. leucophloia, another widespread species in the Pilbara. Across the species Pilbara range the level of population differentiation was low and the majority of the diversity was maintained within populations with only 3% of variation partitioned between populations. Genetic variation in A. ancistrocarpa showed little structure across the Pilbara with no clustering of populations based on geographical proximity or in association with obvious topographical, physiogeographical or geological features. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within A. ancistrocarpa implies that seed resources for land rehabilitation and mine-site revegetation programs can be selected from a wide range within the Pilbara

Root hydraulic conductance and aquaporin abundance respond rapidly to partial root-zone drying events in a riparian Melaleuca species**2011**

This study examined partial root zone drying (PRD) responses of Melaleuca argentea.

Internal reference:
RTIO-HSE-0252171

The results demonstrate that PRD can induce rapid changes in root hydraulic conductance and aquaporin expression in roots, which may play a role in short-term water uptake adjustments, particularly in species adapted to heterogeneous water availability.

Baseline Terrestrial Fauna Assessment of Pilbara Rehabilitation Areas**2012**

In 2011 a fauna survey was conducted within established rehabilitation areas at Brockman 2 and Tom Price mine sites, with the aim of identifying whether fauna is recolonising rehabilitation sites in assemblages comparable to reference sites.

Internal reference:
RTIO-HSE-0134168

The study found that at least 85 species of native vertebrate fauna, as well as representatives from each of six major groups of invertebrate fauna, are using rehabilitation areas at Brockman 2 and Tom Price, with species compositions that were broadly similar to reference sites. Ant collections were typical of the Pilbara bioregion, with an absence of invasive ant species. The study found greater data correlation between monitoring sites at a particular mine site (Tom Price or Brockman 2) than between rehabilitation and reference sites, indicating the importance of selecting local reference sites. The study concluded that the best candidates for bio-indicators are ants and reptiles.

Hay Project – Native Seed Orchard**2012**

Commencing in 2011 (and still ongoing), a trial irrigated seed orchard was established at the Hamersley Agriculture Project (Marandoo). The purpose of the trial was to identify an alternate method of addressing seed deficits. If successful, the project may be implemented at other Rio Tinto operations, such as the Nammuldi agriculture project.

Internal reference:
RTIO-HSE-0141263

Genetic diversity in *Aluta quadrata*: Implication for management and provenance zone**2012**

*This study was undertaken to define the provenance seed collection zones for *Aluta quadrata*. This report details information on genetic analysis conducted on *Aluta quadrata*. Collections were made from 8 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.*

Internal reference:
RTIO-HSE-0156732

Genetic diversity in *A. quadrata* was moderate and lower than in the other two more widespread Pilbara species, *E. leucophloia* and *A. ancistrocarpa*. The findings suggest that its populations may have fluctuated significantly in size over time with genetic drift and possibly inbreeding resulting in a reduction in genetic variability, particularly in rare alleles. Despite the narrow geographic range, the level of population differentiation in *A. quadrata* was relatively high with 25% of the genetic variation maintained between populations and 19% due to differences between the three different locations. This significant genetic structure indicates that *A. quadrata* consists of three conservation or management units, Western Ranges, Pirraburdoo and Howie's Hole.

Genetic diversity in *Acacia atkinsiana* across the Pilbara: Provenance zone implications**2012**

*This study was undertaken to define the provenance seed collection zones for *Acacia atkinsiana* (Atkins wattle). This report details information on genetic analysis conducted on *Aluta quadrata*. Collections were made from 16 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.*

Internal reference:
RTIO-HSE-0187256

Genetic diversity in *A. atkinsiana* was low and lower than that observed in its congener *Acacia ancistrocarpa*, a widespread species across northern Australia. The level of population differentiation was high and 30% of the diversity was partitioned between populations across the range of *A. atkinsiana*. Genetic variation in *A. atkinsiana* showed some structure across the Pilbara with clustering of populations in the western part of the distribution and from the Hamersley Range, along with other populations that were divergent from these groups. The low levels of genetic diversity and high levels of differentiation within *A. atkinsiana* implies that seed for land rehabilitation and mine-site revegetation programs should be restricted to specific zones. For rehabilitation of sites within the Hamersley Range we recommend seed collections be restricted to that region. Similarly, for rehabilitation in the part of the distribution west of Pannawonica, seed collections should be restricted to that area.

Rehabilitation Quality Metric (RQM) Project**2012**

Western Australia has no formal process to measure habitat quality and as such RTIO has needed to design its own customised metrics. Vegetation condition scoring has previously been developed by RTIO through a Biodiversity Net Positive Impact Assessment, but a more precise metric was needed. The Rehabilitation Quality Metric (RQM) project was developed to provide a repeatable method to assess rehabilitation quality against pre-determined reference sites, on a site by site basis, to predict rehabilitation ecosystem quality at the time of relinquishment.

Internal reference:
RTIO-HSE-0164020

The RQM methodology employs seventeen parameters to characterise the landscape, including vegetation, fauna habitat, fauna presence, erosion, and ecosystem function. Parameters are tailored to be an applicable measure for both rehabilitation and native vegetation (reference sites). Parameters are scored, based on measured or observed characteristics, with a value between 0 and 1, with 1 being functional (terrestrial ecosystem is functioning for the maintenance of biodiversity values at a local or property scale) and 0 being dysfunctional (terrestrial ecosystem is failing; indicators of ecosystem function have scored below acceptable levels). Both rehabilitation areas and reference sites are scored. Scores are subsequently determined for the entire mine lease, based on the condition of the land before mining (extrapolated from the reference sites, area weighted) and the likely post-mining conditions (extrapolated from the rehabilitation areas and expected closure domain distribution, area weighted, ie pits with no rehabilitation score 0). The difference between the pre-mining and post-mining scores represents the residual impact of mining.

Propagation of Pilbara spinifex (Triodia sp.)**2012**

Triodia has often been observed to have very poor establishment from broadcast seed. This project investigated alternatives to growing *Triodia* (spinifex) from seed, focussing on ways to propagate seedlings from wild harvested material.

Internal reference:
RTIO-HSE-0169744

The project found the most successful propagating material was stolons. Greatest propagation success was achieved when *Triodia* were collected when semi to fully dormant (mid Winter-Spring). The 'Moist Root Induction Method' recommended by previous researchers was less successful than the standard propagation techniques employed in this project. Success varied notably between populations. Consequently, any future collections of propagating material should target multiple populations to maximise potential for success.

Pilbara Seed Science Project, Part 2 Final Report Jan 2012**2013**

Undertaken between 2009-2012, this seed research investigated germination, biology, dormancy classification and treatments for dormancy alleviation for a range of species from the Pilbara.

Internal reference:
RTIO-HSE-0174944

The *Acacia atkinsiana*, *Indigofera monophylla* and *Sida echinocarpa* seed lots have physical dormancy. Heat treatments and mechanical scarification improved germination on dormant seeds, however, heat treatments killed non-dormant seeds. The treatments used for *Goodenia stobbsiana* seeds failed to overcome dormancy, suggesting deep physiological dormancy. The *Hakea lorea/chordophylla* seed lots were found to be non-dormant, with very high germination results in the controls. As such, they will not require any pre-treatments prior to direct seeding. The florets surrounding the *Triodia pungens* and *T. wiseana* seeds were found to restrict germination, however, many of the freshly extracted seeds out of the florets were found to be physiologically dormant. Treatments for dormancy include mechanical scarifier to rupture seed coat, hot water (noting potential damage to immature or non-dormant seeds) and increases to germination through wet / dry cycling and / or temperature cycling.

Morphological variation in the western rainbowfish (Melanotaenia australis) among habitats of the Pilbara region of northwest Australia.**2013**

The aim of this honours thesis was to determine and quantify the extent of morphological variation present in *M. australis* and relate this to environmental variables, which will provide the first step to understanding how the species copes with environmental change.

Internal reference:
RTIO-HSE-0252169

This results of this thesis found that there was limited evidence that fish morphology correlated with environmental variables

Patterns of water use by the riparian tree Melaleuca argentea in semi-arid northwest Australia**2013**

This thesis examines the water use physiology of the riparian tree *Melaleuca argentea*, and the ways in which this species may respond to anthropogenic disturbances to hydrologic processes.

Internal reference:
RTIO-HSE-0249538

M. argentea displays highly plastic root-level responses to heterogeneous water availability and to waterlogging, facilitating high rates of water use and growth in the riparian wetland habitats of the Pilbara. Mature *M. argentea* trees appear to tolerate groundwater drawdown of at least several metres, most likely by employing the same plastic root strategies to access deeper water. *M. argentea* can also withstand short periods of severe drought, by adopting a 'waiting' strategy of ceasing growth and shedding leaves to avoid moisture loss, a state from which they can then recover. *M. argentea* populations are unlikely to thrive under large and prolonged reductions in water availability.

Priority Species Seed Quality and Germination Final Report**2013**

This study investigated the quality and germination biology of a range of priority and keystone (*Triodia*) plant species from the Pilbara.

Internal reference:
RTIO-HSE-0207487

Eremophila magnifica subsp. *Magnifica* has physical & physiological dormancy. Propagation methods other than seed may be more successful. *Geijera salicifolia* and *Olearia mucronata* has physiological dormancy. Temperature cycling may be required to stimulate germination. *Indigofera ixiocarpa* and *Indigofera* sp. Bungaroo Creek has physical dormancy or is non-dormant. Mechanical scarification may be required. *Ptilotus subspinescens* is non-dormant and will germinate easily without removal from the perianth sheath. However, seed is likely to lose viability with a few years. *Sida echinocarpa* and *Sida* sp. Barlee Range has physical dormancy. Seeds should be removed from the mericarp and then scarified in order to germinate. *Triodia pungens* has *T. wiseana* non-deep or deep physiological dormancy. Germination of de-husked seeds can be improved by applying gibberellic acid or 1% smoke water and wet/dry cycling.

Early physiological flood-tolerance and extensive morphological changes are followed by slow post-flooding root recovery in the dryland tree Eucalyptus camaldulensis subsp. Refulgens**2014**

This study investigated physiological and morphological response to flooding and recovery in *Eucalyptus camaldulensis* subsp. *Refulgens*, a riparian tree species from a dryland region prone to intense episodic flood events.

Internal reference:
RTIO-HSE-0252170

E. camaldulensis subsp. *Refulgens* underwent considerable morphological changes during flooding, including extensive adventitious root production, increased root porosity and stem hypertrophy. Physiologically, net photosynthesis and stomatal conductance were maintained for at least 2 weeks of flooding before declining gradually. Despite moderate flood-tolerance during flooding and presumably high environmental selection pressure, recovery of reduced root mass after flooding was poor.

Priority Species Project Progress Report 2013**2014**

The Priority Species Project, initiated in 2012, aims to improve knowledge of priority plant species and develop methods to successfully germinate and establish priority species, to enable priority plant species to be integrated into Rio Tinto rehabilitation programmes. This work is being undertaken in conjunction with the Department of Parks and Wildlife.

Internal reference:
RTIO-HSE-0207486

13 plant species were selected as being potentially suitable for establishment in rehabilitation: *Eremophila magnifica* subsp. *magnifica*, *Indigofera* sp. Bungaroo Creek, *Indigofera* sp. gilesii, *Acacia bromilowiana*, *Sida* sp. Barlee Range, *Ptilotus subspinescens*, *Ptilotus mollis*, *Acacia subtiliformis*, *Isotropis parviflora*, *Grevillea* sp. Turee, *Hibiscus* sp. Canga, *Themeda* sp. Hamersley Station, and *Aluta quadrata*. *Indigofera* sp. Bungaroo Creek and *Ptilotus subspinescens* were found to readily germinate in laboratory conditions, and a field trial was established at Brockman 4 late in 2013.

Regional Variation in Metal Concentrations of Pilbara Fish in Relation to Concentrations in Water and Sediments**2014**

This study aimed to characterise and document natural, background metal concentrations in freshwater fishes from different locations across the Pilbara in order to understand how local geology may affect baseline metal levels in fish tissues and surface waters. Metal concentrations were analysed from water, sediment and muscle and liver tissues from fish collected from up to 13 sites as yet unimpacted by mining across the Pilbara during October (dry season) of 2012.

Internal reference:
RTIO-HSE-0216967

Levels of dissolved metals from water samples were generally low. However, some elevated concentrations of Boron, Copper and Zinc were recorded. Concentrations of heavy metals in sediments were variable across the Pilbara. Generally, sediment concentrations were well below the Interim Sediment Quality Guidelines (ISQG). However, metal concentrations in excess of ISQG TVs were recorded for Chromium and Copper at some sites. There was no relationship between metal concentrations in sediment and those in water. Metal concentrations in fish tissue (muscle and liver) varied between species with some significantly higher in some particular species. The study concluded that variation in metal concentrations in water, sediment and fish across pools in the Pilbara was likely to be mainly dictated by the local geological setting in which the pool occurs.

Progress Report 2014, Ecological responses of native fishes to dynamic water flows in northwest arid Australia**2014**

This three year Australian Research Council linkage Project commenced in 2013 and aims to increase understanding of the effects of altered stream flows on the Pilbara freshwater aquatic environment. Project aims: 1. Quantifying fish biodiversity and population structure in relation to hydrological and environmental parameters to identify thresholds of ecological concern for water management; 2. Determine the fundamental physiological, morphological and behavioural adaptations of fishes to variations in water quality using experimental manipulations; and 3. Examine spatial scales of gene flow to determine if increased flows increase genetic connectivity relative to natural-flow sites.

Internal reference:
RTIO-HSE-0246021

To date work has focuses on characterisation of baseline physicochemical parameters across aquatic habitats within the Fortescue River catchment (Aim 1), analysis of variation in rainbow fish morphometrics and mechanosensory lateral line systems in response to geographic region and water management regime (Aim 2), and extraction of DNA samples from 17 populations across the Fortescue River catchment (Aim 3). The project will culminate in the development of a predictive model for stream restoration relevant to future closure scenarios for above and below-groundwater mines. Results from an honours thesis indicate that rainbow fish body shape varies according to geographic region but fish from a dewatered site (WW Ck) were more streamlined than other populations from the upper Fortescue catchment. This statement of results has been superseded by the results of the actual thesis report RTIO-HSE-0252169.

Rehabilitation Close Out Report: CHE3 AMD Encapsulation**2017**

This report outlines the process followed to implement rehabilitation of potentially acid forming material at the Channar CHE3 pit at Greater Paraburdoo, which was identified as not meeting the SCARD Management Plan requirements. Natural occurring Black Shale (BS) exposures were identified in the floor of the pit and on areas of the wall. Also BS exposures were visible in the surface of the 'ready for rehabilitation' waste dumps, suggesting inadequate encapsulation during dump construction.

Internal reference:
RTIO-HSE-0315087

Rehabilitation earthworks took place between March and November 2016. The total footprint area rehabilitated was 33.75 Ha over the project, which includes the CHE3 dumps, inert areas and CHE1 rework area. The project was significant in scale; in order to achieve the required rehabilitation design that would leave an encapsulated, safe and stable landform, approximately 2.2 million cubic meters of material was moved by a load and haul operation. Topsoil (~63,000 m³) was hauled from CH64E5 stockpiles, but only applied to the encapsulated waste dumps, not inert areas. Two native seed mixes were created for the project; one for the encapsulation dumps which contained predominantly shallow rooted species, and a second mix for the inert areas which reflected a normal format seed mix. The seed was sown on the same pass as ripping using a mechanical seeder. The project involved an estimated 50,650 manhours with no recorded Lost Time Injuries. Instrumentation has been installed on the dumps containing encapsulated BS to monitor for any changes to water quality.

Landform design**Results of flume investigations of the stability of rock mulches****1998**

This study assessed the potential for rock mulches to be stripped from the soil surface by overland flows.

Internal reference:

RTIO-HSE-0109221

Although 150-300mm diameter BIF was not removed by simulated overland flows, even for 100mm/hr simulated runoff on 55% gradients, considerable scour of the spoil between the rocks was observed, indicating potential for long-term development of rills or gullies if the level of rock cover was less than 100%. Large reductions in sediment concentrations were observed when finer rocks were mixed with BIF. The data indicate that it is crucial for any rock mulch to cover a wide range of particle diameters, including a component of finer rocks. The resulting mixed rock created a framework of large rocks that resist movement by flows, while the smaller rocks reduce erosion being anchored within the larger (framework) rock. For rock mulches with a mixture of rock diameters, 80% cover produced acceptable erosion rates. Sediment loads were slightly higher for 40% cover by rock of mixed diameters, and it was speculated that this may also achieve acceptable erosion rates with the addition of vegetation.

Final Landform Design Criteria for Use During Mine Planning**2012**

Rio Tinto Iron Ore WA have historically designed closure landforms for waste materials with berms ~10 m, lifts ~20 m and ad hoc alterations to batter gradients where erosion rates have been perceived to be unacceptably high. This report integrates recent advances in characterisation and modelling of materials, climate and erosion processes to provide appropriate final landform batter characteristics for key Pilbara mineral wastes and soils.

Internal reference:

RTIO-PDE-0159989

Material properties of mineral wastes were assessed and classified for the range of mineral wastes found across Rio Tinto Pilbara sites. Climate sequences were used to model and test potential erosion rates for a range of batter configurations (shapes (linear, concave), heights, gradients, berm capacity) and validated against existing slopes for which material and climate data were available. This information was used to develop a searchable waste dump batter database for all major mineral wastes and soils, intended for use during mine planning design.

Rehabilitation close out report 4WN and 4WR waste dumps**2016**

The 4 West North (4WN) and 4 West Road (4WR) Waste Dumps at the Paraburdoo mine were rehabilitated in 2016. This report documents the process and implementation of the project.

Internal reference:

RTIO-HSE-0273177

The 4WN and 4WR waste dumps rehabilitation project was significant in scale; some 2.9 million cubic meters of material to be moved by a load and haul operation. Earthworks took place between October 2014 and October 2015. Earthworks were performed in a two stage process; the 'tip to' designs were pushed out into the 'final' designs i.e. batters pushed out to 17-20 linear degrees; with 20 m lift heights and 10 m back sloping berms for the final design. An unmanned aerial vehicle (UAV) was used to survey the dump and ensure it was conforming to the designs with a tolerance of + 200mm. Topsoil was spread on the surface to a depth of 100 mm. Deep ripping on the contour took place in December 2015 and a native seed mix, which was based on similar topographic sites, was sown on the same pass as ripping. A trial was established on 4WN to test the effectiveness of Bactivate on soil conditions and plant growth success.

Assessment of 1000 and 2000 year return interval storms on a rehabilitated landform batter profile shape, berm size and crest size for Greater Paraburdoo materials**2018**

This report details the results of the assessment of the impact of 1000 year and 2000 year return interval storms (24-hour duration) on rehabilitated landform batter profile shapes, berm sizes and crest bund sizes for materials at Greater Paraburdoo. The assessment involved creating 1000 and 2000 year water erosion prediction project (WEPP) climate sequences for Greater Paraburdoo and using this information to undertake erosion simulations and assessment of runoff predictions in order to develop landform design parameter recommendations for materials found at Greater Paraburdoo operations that would deliver an acceptable rate of erosion in these larger rainfall events.

Internal reference:

RTIO-HSE-0324327

Seven materials were included in the assessment including Dales Gorge, Joffre, Footwall Zone, Whaleback Shale, Hydrated Zone, Calcrete and McRae Shale. A range of design options were recommended. For low erodibility materials (Dales Gorge, Joffre and Footwall Zone) it was determined that the current parameters recommended for 1 in 100 year ARI events remain appropriate for these larger events due to conservancy built into the existing design tool.

Contamination**Greater Paraburdoo Dumped Black Shale Inventory****2007**

Early mining and dumping strategies at Greater Paraburdoo did not consider acid rock drainage from black shale. This report attempts to quantify the amount of black shale mined in Greater Paraburdoo through block model queries and suggest likely locations for the dumping of this material, thus actioning one issue flagged in the Environmental Audit conducted in October 2006.

Internal reference:

RTIO-PDE-0047348

Geological models did not represent in situ reactive black shale distribution and mining records do not account for the dump locations of the majority of black shale that was mined in the Greater Paraburdoo. The historical management of both in situ and dumped black shale (reactive and non-reactive) was not carried out in an auditable manner, and only limited quantitative records can be located to assess the ARD risk associated with dumped black shale inventory. The data can be considered a general guide at best, and is not reliable.

Impact of Nitrogen from Explosives on Mine Site Water Quality**2008**

The likely issues associated with the use of nitrogen based explosives on mineral waste and any leachate water are explored in this report. The amounts of explosives used on site are described, along with nitrogen chemistry and toxicity. Nitrogen concentrations for various mine sites and specific lithologies are presented which includes concentration in rock assays and liquid extracts.

Internal reference:
RTIO-PDE-0054638

It was concluded that the largest risk of nitrogen contamination is likely to arise from the discharge of surface waters that have been in contact with blasted materials and are discharged off site into creeks or waterways. This becomes a more significant issue if the water is also acidic. Algae (ie cyanobacteria) plumes have been identified in acidic water at Tom Price

Control Measures for Potentially Acid Forming Pit Wall Rocks**2010**

Desktop study of potential strategies to manage exposed sulfidic materials and find viable options for management was conducted with a focus on the Hope Downs 1 and Tom Price sites.

Internal reference:
RTIO-PDE-0079541

Chemical treatments have the potential to be effective only in the short-term and only for minor water quality issues. Grouting of the pit walls is expected to have limited applicability, although grout curtains behind the wall may have success (untested). Cover technologies have the greatest potential to be effective over the long term, but would need to be resistant to puncture by underlying rocks, resistant to weathering and UV damage ie shotcrete, geomembranes. For long term performance the exposed surface need to be as stable and free of loose material as possible. Treatment effectiveness will also depend on the site conditions, eg chemical less effective at Tom Price.

Paraburdoo Detailed Contaminated Site Investigation – Underground Diesel Pipeline**2011**

This soil investigation was undertaken in the vicinity of the underground diesel dispensing pipeline at the Paraburdoo 1480 Facility. The report assesses the magnitude and extent of potential soil impact. A total of 22 primary samples were submitted for analysis of TPH, TPH aromatic/aliphatic speciation, BTEX, PAH compounds and lead.

Internal reference:
RTIO-HSE-0142458

The spill is concentrated with the highest concentrations of TPH C10 – C36 observed within Bay 1. The maximum depth of impact within this area is approximately 10 m below ground level. Some PAH and BTEX were identified above (Limit of Reporting) LOR levels but below the Ecological Investigation Levels (EILs) in the high concentration zones. The total volume of impacted soil has been estimated to be 2320 m3.

Paraburdoo Bulk Fuel Depot Final Environmental Site Assessment Report - URS November 2011**2011**

The objective of this work was to undertake an Environmental Site Assessment at the Paraburdoo Bulk Fuel Depot. The objectives of this assessment were to establish the magnitude and extent of potential soil impacts associated with the bulk fuel storage tanks and to assess soil quality in the vicinity of the tank bund.

Internal reference:
RTIO-HSE-0128514

Laboratory analysed soil and groundwater samples contained total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylene, polycyclic aromatic hydrocarbons and lead. An observed leak of fuel oil within the tank bund was responsible for critical levels of contamination of the soil. This soil was excavated. Anecdotal evidence of historical spills at the Mine Train Refuelling/Load Out Area suggested this area was also of concern. It was recommended that future monitoring be performed at this site to confirm the extent of remaining contamination.

Paraburdoo 1480 Facility Final Environmental Site Assessment Report - URS November 2011**2011**

The scope of this work was to assess, where possible, the magnitude and extent of potential soil impacts associated with an observed leak of an underground diesel dispensing line.

Internal reference:
RTIO-HSE-0128513

Laboratory analysed samples return positive results for total petroleum hydrocarbons, total petroleum hydrocarbons aromatic/aliphatic speciation, benzene, toluene, ethylbenzene, xylenes, polycyclic aromatic hydrocarbon compounds and lead. Findings of the investigation indicate that the spill is concentrated in the centre of the site. The total volume of impacted soil has been estimated to be 2,220m3.

Workshop Summary and Desktop Review: Dewatering and Sulfate Accumulation**2012**

This is a summary of a workshop held to determine the risks of dewatering sulphides within the pit wall. The outcomes from this workshop will be used to develop models to estimate the mass of sulfate produced as a consequence of dewatering activities.

Internal reference:
RTIO-PDE-0101903

There are many processes that contribute to poor pit water quality. Most of these processes are known and accounted for in existing models. However, the science of fluid flow in fractured rock is not well developed and this lack of knowledge restricts the outcomes of studies on pit water quality. There is a general lack of empirical data for estimating parameters used in models, creating a large degree of uncertainty in predictive models. Sensitivity analysis can be used to overcome some of these challenges.

Development of a conceptual model: Sulfate accumulation as a consequence of pit dewatering activities, memo**2012**

Mine dewatering and the consequent lowering of the water table may result in desaturation of sulfide bearing lithologies. The objective of this work was to develop a conceptual model of the associated processes: where sulphide bearing rock intersects the pit walls, and where the sulphide bearing rock is located behind the pit walls but not directly exposed on the pit wall face.

Internal reference:
RTIO-PDE-0101903

The conceptual model developed estimates the mass of sulfate produced as a consequence of dewatering activities, considering processes during operations and after operations cease, and using sensitivity analysis where parameter inputs are uncertain. The model output provides the basis for an assessment of potential impacts on water quality for general risk assessment applications. Further work was identified to improve parameterisation of the model, including the collection of additional empirical data for pit wall fracturing, saturation of pit wall fractures and sulfide oxidation rates in talus and on pit walls.

Ethnographic or archaeological values**Water and Indigenous People in the Pilbara: A Preliminary Study, CSIRO: Water for a Healthy Country****2011**

Water resources are vital to Indigenous identities, beliefs, environmental philosophies and livelihoods. This report provides a broad-scale scoping study of Indigenous relationships to water in the Pilbara and considers the potential impacts of Indigenous water values.

Internal reference:
RTIO-HSE-0218222

Indigenous belief systems perceive water as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Water sources were derived during the Dreaming and are the most important features in the Pilbara cultural landscape. Interviews raised issues of long term drying, obstruction of water flow, over-extraction, inappropriate discharge from de-watering and access restrictions.

Appendix D – Closure risk assessment

Risk Description				Risk Manager	
Evaluated 19 of 20 risks (1)					
Threat Title	Causes (Triggers / Indicators)	Existing Controls	Evaluation Rationale		
Environmental					
Non AMD contaminated site(s) lead(s) to a social, environmental or financial impact.	<ul style="list-style-type: none">• Poor use or uncontrolled use of chemicals and hydrocarbons during operations.• Inadequate housekeeping practice and maintenance of work areas and equipment.• Contaminated sites have not been identified.• Inadequate clean-up of contamination.• Potential contamination source has not been addressed.• The full nature and extent of reportable contaminated sites have not been adequately determined.• Lag contamination events from historical waste disposal practices.• Changes in regulatory expectations and continually developing regulatory understanding of emerging contaminants of concern.	<ul style="list-style-type: none">• Regular maintenance / inspection / audit of work place procedures.• Spill management kits readily available.• Sites are reviewed annually and areas of potential environmental concern are captured on the Rio Tinto Iron Ore internal Potentially Contaminated Sites Register, which represents potentially contaminating activities and sites which are assessed in accordance with the Contaminated Sites Act 2003 requirements.• Prescribed premises and appropriate operation of licenced facilities.• Water treatment facilities for sewerage and oily water prior to discharge to defined areas.• Management system and operational control procedures (i.e. the management system).	A reportable contaminated site is found during the closure phase that requires remediation or management. Assumption: Clean up and low level ongoing management required (e.g. pumping of bores).	II	<p>PDO-16 Undertake detailed contaminated site investigation prior to closure to identify, assess and classify potentially contaminated sites.</p> <p>PDO-17 Ensure end land use planning considers the impacts of any known or suspected contaminated sites.</p>
Acid, metalliferous or neutral mine drainage creates a contaminated site.	<ul style="list-style-type: none">• Interaction of water and mineral waste could generate acid / alkaline levels that leach metals / salts from the mineral waste or local environment.• Presence of temporary or permanent open water bodies, enabling evapoconcentration to occur with creation of alkaline / hypersaline water quality.• Ability of metals / salts to move through environment to impact a sensitive receptor, to meet definitions in Contaminated Sites Act 2003.• Poor management of PAF material in waste dumps.• Leaching from Waste Fines Storage Facilities (WFSF).	<ul style="list-style-type: none">• Geochemical characterisation of waste material.• Mineral Waste Management Plan in place to guide ongoing identification, management and monitoring of mineral waste risks throughout studies and operations.• SCARD management plan in place governing the presentation of PAF material should it present during operations.• Groundwater operating management plan in place governing the monitoring of groundwater quality.	An AMD/NMD plume develops leading to corrective actions being required during the post-closure phase. Assumption: the site can not be relinquished.	III	<p>PDO-02 Characterise the geology underlying the locations of potential black shale in waste dumps. Pending the outcomes of this assessment, an assessment of transport pathways and receiving environments may be required to predict potential drainage impacts related to AMD.</p> <p>PDO-03 Refine the 4EE water balance and geochemical pit lake model. The model predicts how the pit lake and its water quality will evolve over time and simulates the inputs, outputs and reactions that occur in a pit lake.</p> <p>PDO-18 Investigate suspected PAF areas on the waste dumps 4EX3_South_WD, 4W_WD01 and 4E_WD to determine if these areas contain PAF exposures.</p> <p>PDO-41 Review additional resource/hydro drilling results as they become available for the 4EE pit to refine the understanding of PAF material geochemistry and modelled exposures/volumes expected.</p>
Resource					
Closure strategy prevents or limits future access to resources.	<ul style="list-style-type: none">• Backfill or waste dumping strategies sterilise ore resources.• Access is cut off to remaining ore resources as a result of rehabilitation strategy.• Infrastructure is removed or tenure is relinquished which could have been used to access other nearby deposits.	<ul style="list-style-type: none">• Economic review of ore reserves prior to backfill.	Future resource is sterilised through pit backfill completed as part of closure works Assumption: Future change in grade cut-off or ore price results in some minor reserves being deemed economic, had backfill not occurred.	I	Class 1 do not require any specific actions but should be monitored for changes which result in change in rating of such risks.
Geotechnical					
Pit wall stability compromises closure outcomes.	<ul style="list-style-type: none">• Influence of erosion, subsidence, seismicity, wall slip.• Influence of groundwater recovery and surface water flows on stability.• Creek system neighbouring or within zone of instability, potential stream capture.• Geotechnical assessment incorrectly defines the zone of instability.• Built landforms (waste dumps/landbridges) within potentially unstable pit edge zone.	<ul style="list-style-type: none">• Geotechnical assessments for wall stability and zone of collapse undertaken as part of mine design reviews, as required.• Pit walls design factor of safety 1.3, geotechnical assessment show zone of collapse for high risk locations (near creeks, infrastructure etc.)• Landforms not to be constructed within the zone of instability	Pit wall collapses. Waste dump or other constructed feature, positioned inside the zone of instability fails.	II	PDO-21 Review geotechnical potentially unstable zones around final pit crests prior to closure and undertake a risk assessment to determine which (if any) waste dumps and other structures need to be removed from within these zone.

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Risk Description				Risk Manager	
Evaluated 19 of 20 risks					
(1)					
Threat Title					
Causes (Triggers / Indicators)					
Existing Controls					
Evaluation Rationale					
Waste disposal					
Waste fines storage facility is not closed effectively.	<ul style="list-style-type: none">• Inappropriate design leads to deterioration of WFSF wall.• Engineering solutions are not effective post-closure.• WFSF not operated in accordance with design intent resulting in compromised structure.	<ul style="list-style-type: none">• Specific closure design considerations to be built into the design of WFSFs.• Local hydrology management addressed in design and construction phases i.e. run on from adjacent natural landforms.• Landform design guidelines to be implemented i.e. physical characterisation of the mineral waste on the outer surface.• Internal tailings closure guideline has been developed.• Independent and internal reviews of closure design.• D5 standard requiring design for large rainfall events and Maximum Credible Earthquake seismic event.• Operational Maintenance Manual provided by the design engineer to ensure facility is operated as per design. Reviews undertaken annually by the design engineer to ensure the facility is being operated in accordance with the design intent.	<p>Unable to demonstrate a stable closure landform, which may impact relinquishment of facilities.</p> <p>Assumption: Forced to retain site for an additional 10 years, rework required to align with stakeholder expectations.</p>	III	<p>PDO-22 Closure requirements to be incorporated into the next WFSF designs.</p> <p>PDO-40 Re-evaluate the waste fine storage facility closure design as the site approaches closure</p> <p>PDO-42 Review the site groundwater and surface water monitoring program to ensure data for closure planning purposes is being collected.</p> <p>PDO-43 Revise the models developed for the WFSF groundwater salinity plume assessment based on updated data.</p>
Health & safety					
Human health impacts arise from fibrous material exposures.	<ul style="list-style-type: none">• Hazardous fibres exposed in situ by mining, mined and moved to encapsulation areas or naturally present in soils disturbed by mining / rehabilitation activities.• Erosion of materials containing hazardous fibres post-closure.• Inadequate encapsulation of fibrous material.• Historic buildings may contain fibrous materials and/or paints which require disposal.	<ul style="list-style-type: none">• Physical materials characterisation - sampling regime has determined a small volume of fibres are present in mineral waste materials and has quantified anticipated sources and volumes.• Fibrous Materials Management Plan enacted.	<p>The risk is evaluated on the assumption that there is a single occurrence of fibrous materials within a building that was not identified. MRC is assumed as a single exposure where a person is affected.</p>	III	<p>PDO-19 Review the decommissioning infrastructure inventory of buildings containing fibrous building materials and ensure decommissioning controls and appropriate disposal methods are in place.</p>
Access to the area post-closure poses a public safety/liability risk.	<ul style="list-style-type: none">• Post-closure access / land-use requirements, e.g. for stock/pastoralism, people, heritage, environmental monitoring, adjacent mining activities.• Potential for general public to create their own access if appropriate access not provided.• Long term integrity of abandonment bunds.• Decommissioning of infrastructure not implemented effectively.• Some roads will be retained for post-closure access.	<ul style="list-style-type: none">• Complete removal of infrastructure excluding buried services below 1m depth.• Abandonment bunds where appropriate.	<p>Closure fails to prevent inadvertent access to unsafe or unstable areas.</p> <p>Assumption: Single fatality or impairment</p>	III	<p>PDO-36 Define and confirm final locations for abandonment bunding.</p> <p>PDO-37 Determine construction methodology for abandonment bunds.</p> <p>PDO-38 Review and acceptance of abandonment bund placement and design by regulator.</p> <p>PDO-39 Propose and agree safe access routes to traditional owner sites, and monitoring areas.</p>
Other environment					
Inability to achieve closure strategy (objectives and criteria) due to impacts from third parties.	<ul style="list-style-type: none">• Regional approach not taken.• No forum currently available for sharing information with other mining companies.• Assumptions may be incorrect about closure outcomes for adjacent mines.• Adjacent land uses have potential to impact on closure outcomes i.e. weed management, fire, grazing.	<ul style="list-style-type: none">• Development of a business policy is underway to allow Rio Tinto to discuss rehabilitation and closure with third parties.	<p>Not assessed - not considered a serious credible threat</p>		
Cost estimation					
Closure costs are not adequately estimated or provisioned.	<ul style="list-style-type: none">• Costs are underestimated due to risks not being identified.• Costs are underestimated because closure strategies fail and require rework.• Stakeholder expectations evolve over time.	<ul style="list-style-type: none">• Annual process for generation of provisions.• Closure risk identification process (risk assessment) with key subject matter experts should identify any key gaps in knowledge or process.• Closure process within Rio Tinto calls for OoM, PFS and FS studies as the site approaches closure, which go to increasing levels of details and ensures confirmation that appropriate provisions are allowed for.	<p>Closure costs exceed closure provisions.</p>	II	
Closure Vision					
Closure outcomes as contained in the final closure plan are not achieved.	<ul style="list-style-type: none">• Water recovery and/or quality (in BWT pits/springs/pools) is different to what was predicted.• Material characterisation assumptions are incorrect.• Monitoring results are not as expected or reflective of prior modelling.• Incorrect assumptions or understanding of technical aspects underpinning the closure strategy.• Climatic conditions or changes impact outcomes.	<ul style="list-style-type: none">• Integration of closure plan with Life of Mine Plan.• Involvement of a broad range of internal stakeholders in the development of the closure plan.	<p>Evaluated assuming that there are minor variations between the mine plans and closure plans within the 5 year review period.</p>	II	<p>PDO-29 Engage with stakeholders regarding post closure land use objectives and expectations.</p> <p>PDO-30 Refine site closure objectives, completion criteria and measurement tools in consultation with key stakeholders.</p>

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Commercial in Confidence

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Risk Description Evaluated 19 of 20 risks <div>(1)</div>				Risk Manager	
Threat Title	Causes (Triggers / Indicators)	Existing Controls	Evaluation Rationale		
Land use					
Adverse environmental impacts to offsite areas or loss of land for beneficial uses offsite.	<ul style="list-style-type: none"> Unplanned post-closure impacts occur as a result of migration of a contaminant (e.g. sediment, AMD) off-site. Diversion or catchment of important surface water flows on-site, impacting on downstream areas off-site. Regional groundwater impacts not well understood. Failure to understand or consider cumulative impacts on off-site areas. Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation. 	<ul style="list-style-type: none"> Physical materials characterisation completed for common waste types. Multi-disciplinary pit and waste dump design sign-off process exists (MDAS), considers landform design guidelines and provides rehabilitation designs where appropriate. Rehabilitation design criteria are based on landform stability without vegetation cover (cover provides additional stability). Areas of potential environmental concern are captured on the RTIO internal Potentially Contaminated Sites Register, which represents potentially contaminating activities and sites, and will be assessed in time taking into account a risk based approach. 	Downstream surface water flows reduced due to creek interception, impacting downstream pastoral value. Assumption: Detailed closure flood protection landform designs will be implemented (suitable construction material is available locally)	II	PDO-20 Develop detailed closure flood management designs for voids and landforms located adjacent to major creek lines and ensure they address geotechnical risks. PDO-26 Investigate and collect more information on the Springs hydrology to develop hydrogeological conceptualisation.
Hydro-geological / hydrology					
Pit lake has undesirable environmental impacts.	<ul style="list-style-type: none"> Open water bodies in Pilbara naturally attract fauna (feral and native species) for food/ water/ refuge, safe access to water required. Concentration of natural groundwater or mineral waste derived salts through evapoconcentration in open water bodies. Release of metals from natural geology or mineral waste into water (infiltration or groundwater flow). Water provides opportunity for plant /weed growth, good and bad (toxic algal blooms, noxious weeds). Certain plant / animal species bio-accumulate / magnify toxic metals. Instability associated with saturated, unconsolidated ground can be increased by high traffic volumes. Groundwater flow through pit lake or mineral waste with connection to regional aquifer. Density driven saline groundwater flow from groundwater sink-style pit lakes. Downstream groundwater users (people, plants or animals). 	<ul style="list-style-type: none"> Rio Tinto Iron Ore Void Closure Management Guidance. Environmental surveys include regional groundwater dependent ecosystem. Geochemical waste characterisation, good understanding of water chemistry / reaction chemistry. Physical waste characterisation. Rio Tinto Iron Ore Rehabilitation handbook. Rio Tinto Iron Ore Landform design guidance. 	4EE pit void requires additional management at closure to prevent unacceptable impacts from occurring.	IV	PDO-42 Review the site groundwater and surface water monitoring program to ensure data for closure planning purposes is being collected. PDO-03 Refine the 4EE water balance and geochemical pit lake model. The model predicts how the pit lake and its water quality will evolve over time and simulates the inputs, outputs and reactions that occur in a pit lake. PDO-44 Validate hydrogeological model with further groundwater data over time. PDO-45 Undertake surveys to determine if there are any off-tenure receptors - pastoral, heritage and environmental.

Risk Description				Risk Manager	
Evaluated 19 of 20 risks (1)					
Threat Title	Causes (Triggers / Indicators)	Existing Controls	Evaluation Rationale		
Flora & fauna					
Vegetation on rehabilitated areas does not meet completion criteria.	<ul style="list-style-type: none">• Vegetation established, but does not re-seed in same abundance.• Weed competition.• Species selection / insufficient species diversity.• Animal interference i.e. feral animals eating new growth.• Changes to soil water conditions e.g. salinity, water logging.• Vegetation does not provide suitable habitat for local fauna.• Availability of top soil/poor stockpile management/failure to collect soils during ground disturbing activities.• Low moisture retention i.e. hydrophobic soils development, very rocky materials.• Chemical properties of materials on waste dump / rehab surface e.g. salt circulation, alkalinity.• Limited experience in revegetation of riparian areas as required for the Caves Creek realignment.• Completion criteria are currently indicative only and therefore final requirements/ expectations are not yet understood or agreed.• The entire area has not yet been subject to environmental surveys.	<ul style="list-style-type: none">• Physical and geochemical materials characterisation complete.• Rehabilitation handbook provides direction on surface treatment options and provides guidance on seed selection for appropriate diversity.• Annual stockpile reconciliation of top soil and sub soil stockpiles conducted.• Soil resource management procedure governing the planning and recovery of soil resources during ground disturbance.• Top soil stockpiles provide seed bank.• Seeds tested for germination as per standard. Seeds sourced from reliable suppliers.• Seeds research and development programs carried out.• Rehabilitation monitoring carried out to determine progress of rehabilitation towards completion criteria.	Vegetation fails to meet criteria at a site level (not at a single dump), requires remediation.	III	<p>PDO-11 Investigate optimal species selection for post-closure landforms.</p> <p>PDO-24 Investigate alternative growth media for Paraburdoo.</p> <p>PDO-25 Forecast closure seed requirements and reconcile against present stocks based on final landform knowledge. Develop strategy to address any predicted shortfall in seed availability.</p> <p>PDO-46 Review fleet requirements to recover topsoil/subsoil.</p>
Closure strategy implementation results in adverse impact to flora or fauna with conservation status or wider regional impact to high value environment.	<ul style="list-style-type: none">• Scheduled, listed or declared rare and / or threatened species of flora or fauna present in/adjacent to site.• Downstream regional area of high value.• Regional groundwater impacts not well understood.• Environmental conditions post-closure differ significantly from pre-mining conditions.• Post-mining land use differs from pre-mining land use.• Failure to understand or consider cumulative impacts on off-site areas.• Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation.	<ul style="list-style-type: none">• Baseline biological / ecosystem and groundwater monitoring used to evaluate post-mining impacts.	Aluta quadrata individuals are impacted by implementation of the closure strategy.	II	No specific actions.
Biodiversity & ecosystems					
Void has undesirable impacts on downstream ecosystem function.	<ul style="list-style-type: none">• Capture of surface water flows.• Overtopping of pits causing unplanned discharges of poor quality water.• Diversion or catchment of important surface water flows on-site, impacting on downstream areas off-site.	<ul style="list-style-type: none">• Multi-discipline review of new pit and dump designs (MDAS), includes review by surface water team• Approvals request process includes review and sign off by biodiversity/environmental disciplines.	<p>A void terminates creek flows reducing the volume of surface water reaching downstream ecosystems.</p> <p>Assumption: Detailed closure flood protection landform designs will be implemented.</p>	III	<p>PDO-20 Develop detailed closure flood management designs for voids and landforms located adjacent to major creek lines and ensure they address geotechnical risks.</p> <p>PDO-47 Investigate suitable sources of waste materials required for construction of flood management landforms/controls.</p> <p>PDO-48 Ensure suitable waste material required for construction of flood management landforms/controls are included in the 5 yr. Mine Plan</p> <p>PDO-45 Undertake surveys to determine if there are any off-tenure receptors - pastoral, heritage and environmental.</p>
Geology & soil					
Built landforms (excluding mine void areas) erode and/or collapse.	<ul style="list-style-type: none">• Physical material properties not adequately considered in design.• Poor drainage and erosion management.• Landforms including waste dumps, landbridges, diversions not constructed to contemporary closure design requirements.• Design does not consider significant rainfall events.	<ul style="list-style-type: none">• Multi-disciplinary pit and waste dump design sign-off processes, considers landform design guidelines and provides rehabilitation designs where appropriate.• Rio Tinto Iron Ore Rehabilitation handbook used for general rehabilitation activities.• Rehabilitation designed to be stable without vegetation.	<p>Closure landform located adjacent to major creek line is significantly eroded by creek flows.</p> <p>Assumption: Detailed closure flood protection landform designs will be implemented (suitable construction material is available locally)</p>	II	<p>PDO-20 Develop detailed closure flood management designs for voids and landforms located adjacent to major creek lines and ensure they address geotechnical risks.</p> <p>PDO-47 Investigate suitable sources of waste materials required for construction of flood management landforms/controls.</p> <p>PDO-48 Ensure suitable waste material required for construction of flood management landforms/controls are included in the 5 yr. Mine Plan.</p>

Risk Description				Risk Manager		
Evaluated 19 of 20 risks (1)						
Threat Title	Causes (Triggers / Indicators)	Existing Controls	Evaluation Rationale			
Heritage						
Heritage site / cultural value is degraded as a result of implementing the closure strategy.	<ul style="list-style-type: none">Previously unidentified heritage sites or cultural heritage values, not considered in existing assessment, discussions, agreements or with no authority to disturb.Changes to landforms at closure have potential to alter conditions at downstream sites, e.g. consider drainage, landform footprint, erosion implications.Cessation of maintenance of / access to heritage site.Cultural values not considered in rehabilitation strategies.The presence of several heritage sites in close proximity to mining areas.Plans for repatriation of salvaged artefacts not well understood.Downstream regional area of high value to multiple Traditional Owner groups.Changes to environmental conditions due to cessation of operational or artificial support / mitigation activities, e.g. dewatering, water supplementation.Unplanned impact to known heritage site from machinery activity/material movement.	<ul style="list-style-type: none">Internal ground disturbance approval request system.GIS system includes results from heritage surveys.Heritage sites within mine area subject to appropriate approvals prior to disturbance.Ongoing consultation with Traditional Owners.Mine plan (pit shells, dump locations) have been designed to avoid direct disturbance of several heritage sites.Cultural Heritage Management Plan (in draft).Environmental and groundwater monitoring regime in place during operations.RTIO Heritage procedures and protocols and relationship with Yinhawangka.Yinhawangka and RTIO Claim Wide Participation Agreement.Yinhawangka and RTIO - Paraburdoo land Access protocol.	The closure strategy for Springs as agreed with Stakeholders is not effective.	III	<p>PDO-26 Investigate and collect more information on the Springs hydrology to develop hydrogeological conceptualisation.</p> <p>PDO-27 Develop an agreed closure strategy for the Springs in consultation with Stakeholders.</p>	
Socio-economic						
A stakeholder's expectations do not align with that of another stakeholder, causing delays to plan approval and / or closure implementation.	<ul style="list-style-type: none">Conflicting stakeholder expectations or areas of authority e.g. different regulators for environment, heritage, health, economic, tourism.Conflicting legal obligations e.g. State Agreement and EPA.Interactions between catchment land uses, including mining developments, at different points in time.	<ul style="list-style-type: none">Rio Tinto Iron Ore stakeholder engagement practice with key stakeholders.	Stakeholder requirements for environmental management conflict, and one stakeholders needs can't be met.	II		
Closure outcomes do not meet stakeholder(s) expectations.	<ul style="list-style-type: none">Absence of rehabilitation trial or data to support predicted outcomes, closure activities fail to achieve completion criteria.Communication of anticipated closure outcomes and post-closure land use needs i.e. wrong plant species established.Unrealistic expectations for economic potential opportunities / post-closure land use capability.Consultation fails to identify stakeholder concerns.Large number of stakeholders in the project.Clarity of explanation / prediction of closure outcomes, communication styles, long term engagement of agreed outcomes through generational change.Stakeholder expectations change over time, due to changing global benchmarks for mine rehabilitation success, intergenerational change, regulatory changes etc.Stakeholders do not endorse site closure as their issues / concerns were not addressed.Post closure access expectations not met e.g. safe access to key heritage sites/springs.Final landform design (e.g. location of abandonment bunds, aesthetics, pit lakes) deemed unacceptable.Stakeholder expectations not met e.g. the condition of the localised catchment (surface flow) and ground water level at closure.	<ul style="list-style-type: none">RTIO stakeholder engagement with key stakeholders.Monitoring established for water and rehabilitation areas.Annual environmental reporting.	<p>Relinquishment is delayed because agreed completion criteria no longer meet stakeholder expectations.</p> <p>Assumption: Forced to retain site for an additional 20 years, rework required to align with stakeholder expectations.</p>	III	<p>PDO-28 Develop stakeholder engagement plan and strategy.</p> <p>PDO-29 Engage with stakeholders regarding post closure land use objectives and expectations.</p> <p>PDO-30 Refine site closure objectives, completion criteria and measurement tools in agreement with key stakeholders.</p> <p>PDO-31 Agree completion criteria with appropriate regulators.</p>	
Mine closure has an unacceptable impact on local communities.	<ul style="list-style-type: none">Local communities receive support for some basic community services e.g. water, power, waste services, community support services.Significant proportion of community are directly or indirectly employed by operation.Inadequate stakeholder engagement.	<ul style="list-style-type: none">Planning for closure considers impacts on local community.	<p>Reputational damage as a result of community outrage associated with impact to local business and services.</p> <p>Assumption: Town closure will be dealt with in a separate Town Closure Plan.</p>	II	<p>PDO-28 Develop Stakeholder Engagement plan and strategy.</p> <p>PDO-32 Develop Human Resources Strategy for closure.</p> <p>PDO-33 Actively pursue development of TO business development and growth opportunities.</p>	
End of record						

Appendix E – Task, research and trial activities schedule

Reference	Task	Completion Date
PDO-02	Characterise the geology underlying the locations of potential black shale in waste dumps. Pending the outcomes of this assessment, an assessment of transport pathways and receiving environments may be required to predict potential drainage impacts related to AMD.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-03	Refine the 4EE water balance and geochemical pit lake model. The model predicts how the pit lake and its water quality will evolve over time and simulates the inputs, outputs and reactions that occur in a pit lake.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-11	Investigate optimal species selection for post-closure landforms.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-16	Undertake detailed contaminated site investigation prior to closure to identify, assess and classify potentially contaminated sites.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-17	Ensure end land use planning considers the impacts of any known or suspected contaminated sites.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-18	Investigate suspected PAF areas on the waste dumps 4EX3_South_WD, 4W_WD01 and 4E_WD to determine if these areas contain PAF exposures.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-19	Review the decommissioning infrastructure inventory of buildings containing fibrous building materials and ensure decommissioning controls and appropriate disposal methods are in place.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-20	Develop detailed closure flood management designs for voids and landforms located adjacent to major creek lines and ensure they address geotechnical risks.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-21	Review geotechnical potentially unstable zones around final pit crests prior to closure and undertake risk assessment to determine which (if any) waste dumps and other structures need to be removed from within the zone.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-22	Closure requirements to be incorporated into the next TSF designs	Prior to next Closure Plan update
PDO-23 [COMPLETE]	Investigate the TSF groundwater salinity plume.	[COMPLETE 2018] During and/or prior to decommissioning study (5 years prior to closure)
PDO-24	Investigate alternative growth media for Paraburdoo.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-25	Forecast closure seed requirements and reconcile against present stocks based on final landform knowledge. Develop strategy to address any predicted shortfall in seed availability.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-26	Investigate and collect more information on the Springs hydrology to develop hydrological conceptualisation.	Post completion of monitoring
PDO-27	Develop an agreed closure strategy for the Springs in consultation with Stakeholders.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-28	Develop stakeholder engagement plan and strategy.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-29	Engage with stakeholders regarding post-closure land use objectives and expectations.	On-going
PDO-30	Refine site closure objectives, completion criteria and measurement tools in consultation with key stakeholders.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-31	Agree completion criteria with appropriate regulators.	During and/or prior to decommissioning study (5 years prior to closure)

Reference	Task	Completion Date
PDO-32	Develop Human Resources Strategy for closure.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-33	Actively pursue development of TO business development and growth opportunities.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-34	Review opportunities to backfill pits during life of operations.	On-going
PDO-35	Develop a progressive rehabilitation and closure timing strategy for Paraburdoo.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-36	Define and confirm final locations for abandonment bunding.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-37	Determine construction methodology for abandonment bunds.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-38	Review and acceptance of abandonment bund placement and design by regulator.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-39	Propose and agree safe access routes to traditional owner sites, and monitoring areas.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-40	Re-evaluate the waste fine storage facility closure design as the site approaches closure	During and/or prior to decommissioning study (5 years prior to closure)
PDO-41	Review additional resource/hydro drilling results as they become available for the 4EE pit to refine the understanding of PAF material geochemistry and modelled exposures/volumes expected.	On-going
PDO-42	Review the site groundwater and surface water monitoring program to ensure data for closure planning purposes is being collected.	Prior to the next Closure Plan update
PDO-43	Revise the models developed for the TSF groundwater salinity plume assessment based on updated data.	Upon finalisation of required groundwater data
PDO-44	Validate the hydrogeological model with further groundwater data over time.	Post completion of groundwater monitoring
PDO-45	Undertake surveys to determine if there are any off-tenure receptors – pastoral, heritage and environmental.	Prior to next closure plan update
PDO-46	Review fleet requirements to recover topsoil/subsoil.	Prior to next closure plan update
PDO-47	Investigate suitable sources of waste materials required for construction of flood management landforms/controls.	During and/or prior to decommissioning study (5 years prior to closure)
PDO-48	Ensure suitable waste material required for construction of flood management landforms/controls are included in the 5 yr. Mine Plan	Post identification of suitable waste sources for flood management landforms

Appendix F – Landform design criteria

18E Waste Dump

Waste volume	1,816,689 m3	
Erodibility ranking	High	
	Low	38%
	Medium	35%
	High	27%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure: N/A
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	48	
Topsoil required (m³)	30,763	

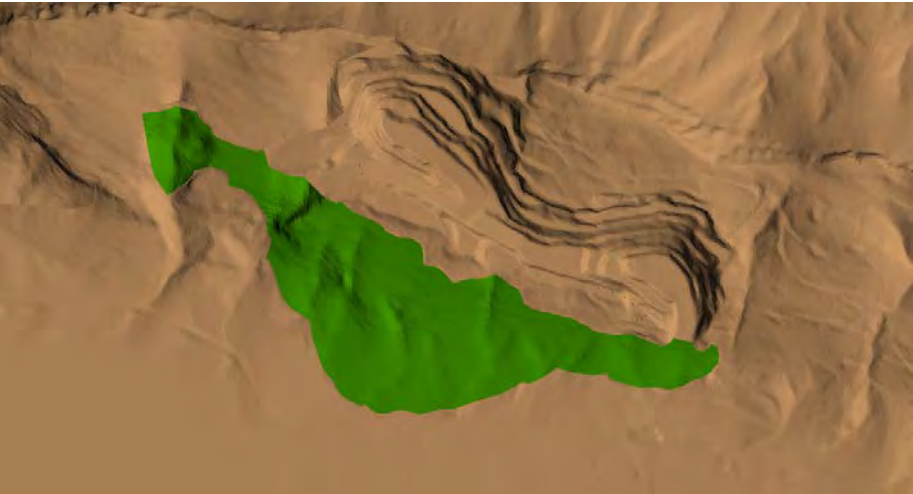
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	36°	N/A
Lift height (m)	48	N/A
Berm width (m)	20	N/A
Berm slope (deg)	0°	N/A
Footprint (ha)	15.4	

Comments
18E waste dump is neighbouring to the WFSF. This waste material will be considered for use in capping on the upper surface of the WFSF at closure.

Construction Design



Rehabilitation Design
Dump Reclaimed as capping for tailings storage facility



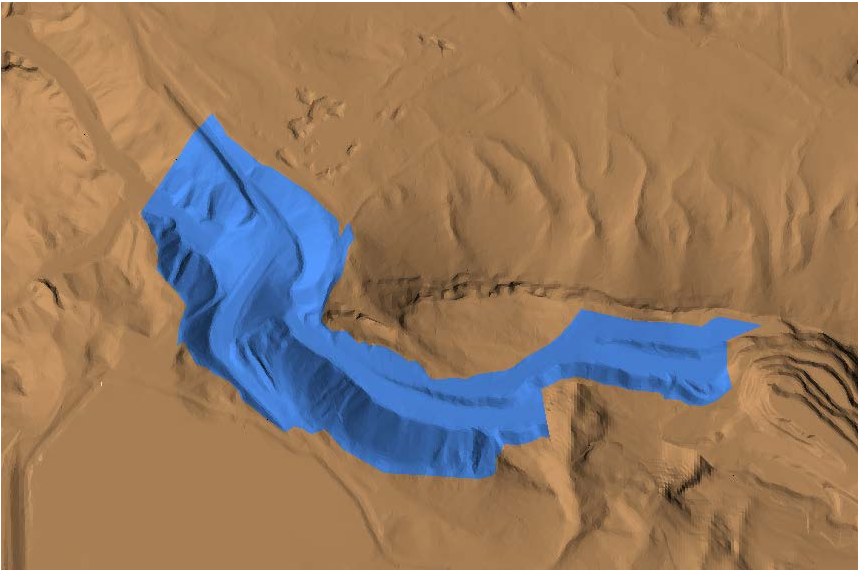
18E Landbridge

Waste volume	1,816,689 m3	
Erodibility ranking	Medium	
	Low	54%
	Medium	30%
	High	16%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	110	
Topsoil required (m³)	48,000	

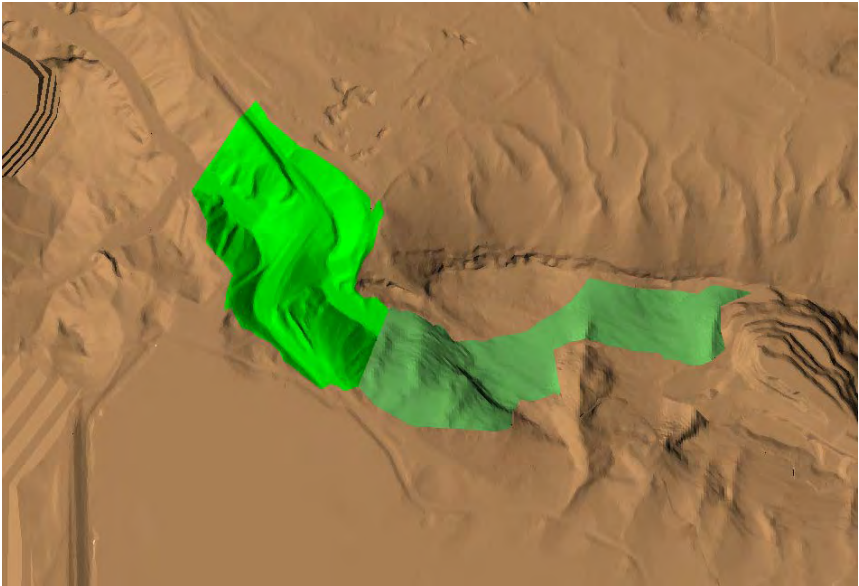
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	36°	TBC
Lift height (m)	60 m	TBC
Berm width (m)	NA	TBC
Berm slope (deg)	NA	TBC
Footprint (ha)	24.4	TBC

Comments
Waste material from 18E landbridge could be partially reclaimed for use as capping on the WFSF, with the western half of the landbridge left in situ (and battered down) to ensure local water flows around the WFSF are controlled. Battered down rehabilitation design to be determined. It has been assumed 18E_Landbridge was constructed from 4E waste - therefore generic pit waste ratio utilised.

Construction Design



Rehabilitation Design



4EX Waste Dump

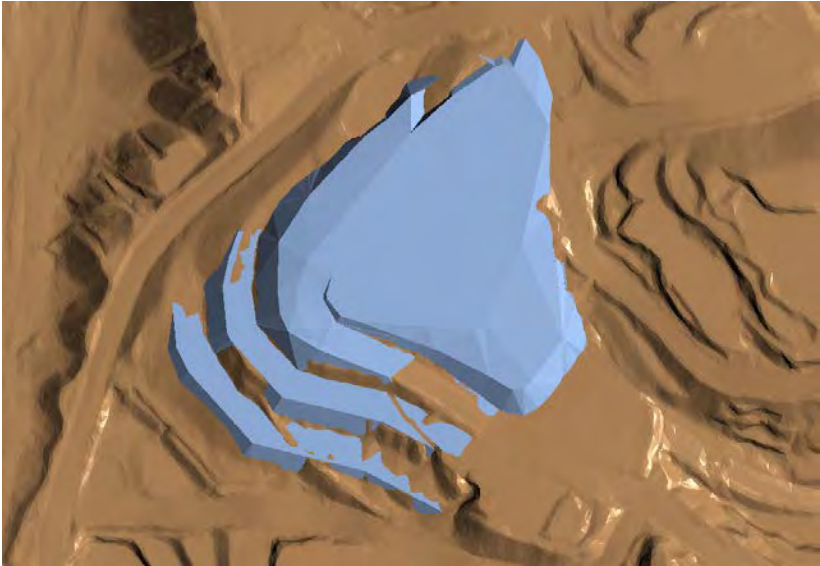
Waste volume	10,488,857m3	
Erodibility ranking	Medium	
	Low	54%
	Medium	30%
	High	16%
Classification	Inert <input type="checkbox"/>	Capping required at closure:
	PAF <input checked="" type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	75	
Topsoil required (m³)	70,000	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	37°	20°
Lift height (m)	24	20
Berm width (m)	20	20
Berm slope (deg)	0°	3
Footprint (ha)	21.6	35.7

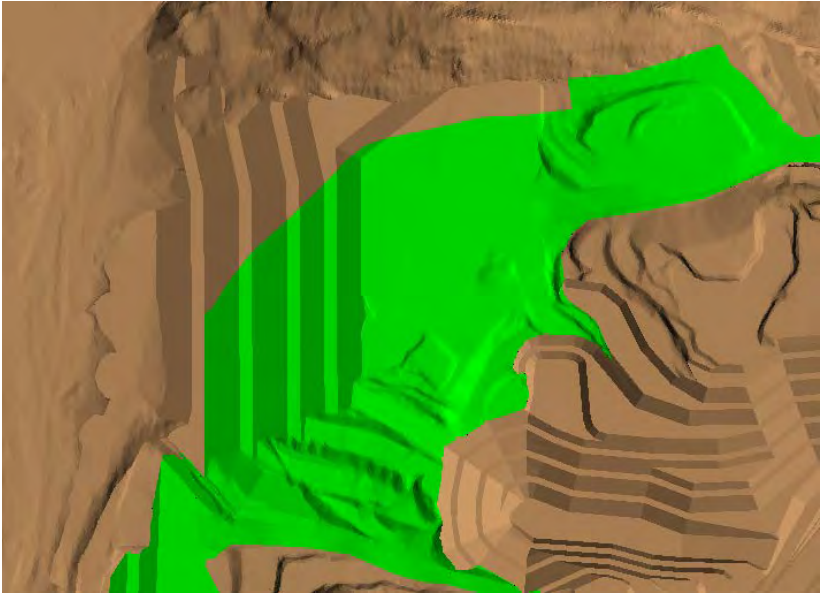
Comments

Low AMD risk.
Mining in the north western section of 4E pit is complete, and historic exposures located in this area have been covered with approximately 35m of backfilled waste. This in-pit waste dump is known as 4EX_WD.
Assumed 4EX_WD will be partially reclaimed by 4EE pit and will also be modified by the 4EE waste dump / ROM pad construction. May need to be partially reclaimed to sit outside zone of instability.
Rehabilitation design of riverine side of waste dump is under review and the final landform design is still unknown.

Construction Design



Rehabilitation Design



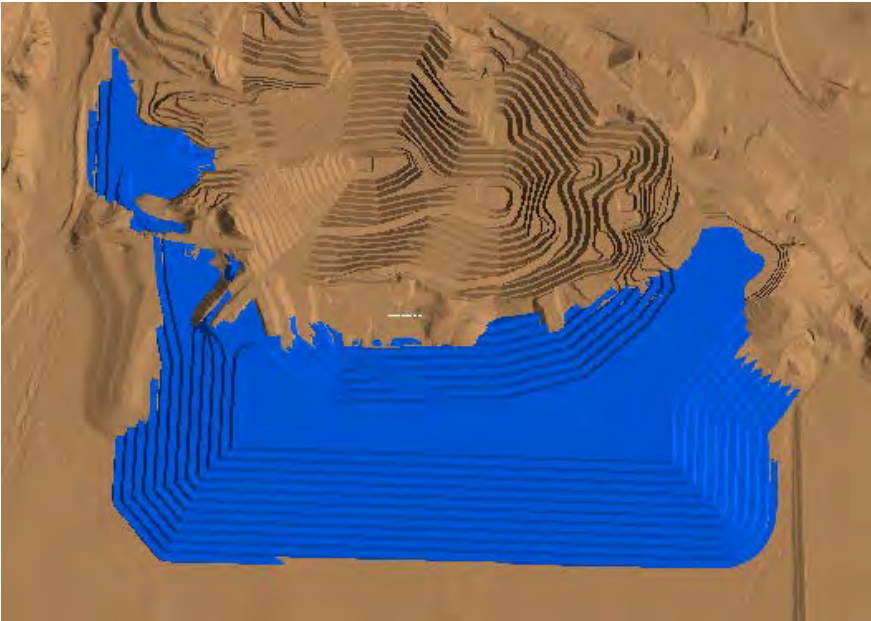
4EE Waste Dump

Waste volume	165Mm3	
Erodibility ranking	Medium	
	Low	67%
	Medium	12%
	High	20%
Classification	Inert <input type="checkbox"/>	Capping required at closure
	PAF <input checked="" type="checkbox"/>	20 Mm³
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	110	
Topsoil required (m³)	698,400	

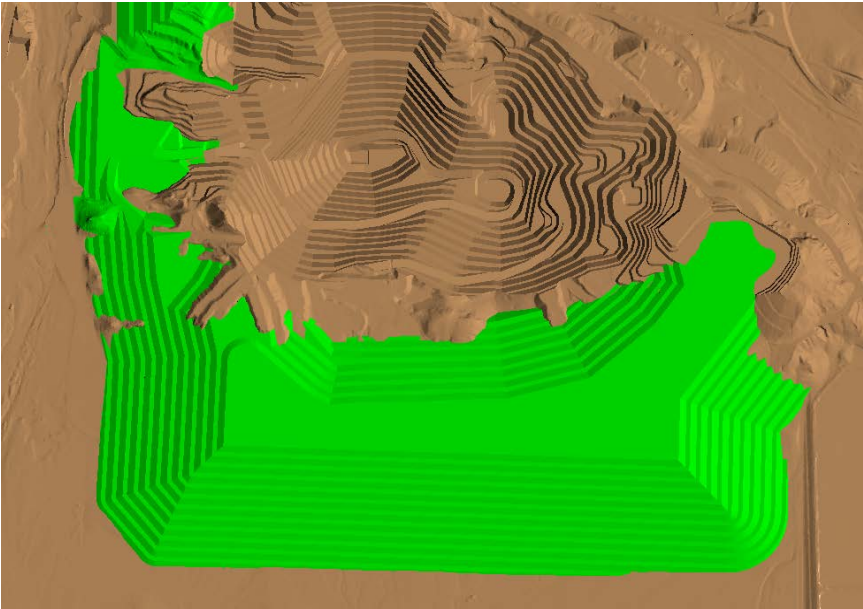
Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	10	10
Berm width (m)	32	19m (15m back slope face)
Berm slope (deg)	0°	3°
Footprint (ha)	315	341

Comments
Conceptual design. 4EE_WD will cover existing/historic waste dumps (4E_WD, 4EMX_WD and 4EX3_South_WD). PAF material to be dumped and stored according to RTIO SCARD document.

Construction Design



Rehabilitation Design



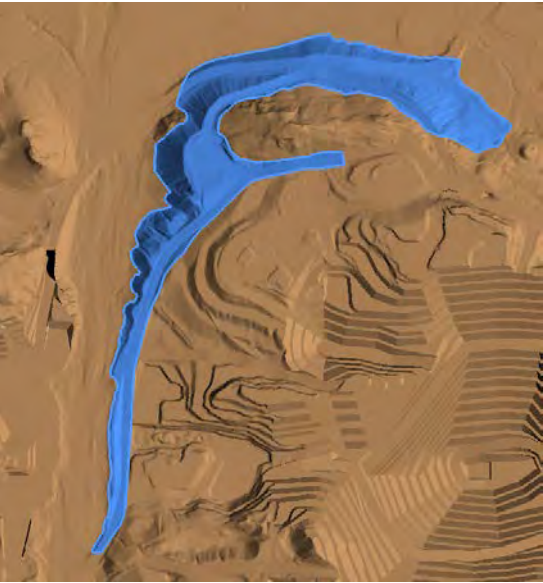
4E West Landbridge

Waste volume	5,543,434 m3	
Erodibility ranking	Medium	
	Low	54%
	Medium	30%
	High	16%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	90	
Topsoil required (m³)	27,000	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	70	20
Berm width (m)	NA	20
Berm slope (deg)	NA	3°
Footprint (ha)	40.2	40.2

Comments
Breakdown of material type is assumed due to limited records and the age of landbridge. Assumed to be constructed from 4E waste - generic pit waste ratio utilised.
Conceptual closure strategy is to reclaim waste to outside of the 100yr flood plain, with the remaining slope tying in with the 4EX_WD closure design.

Construction Design



Rehabilitation Design



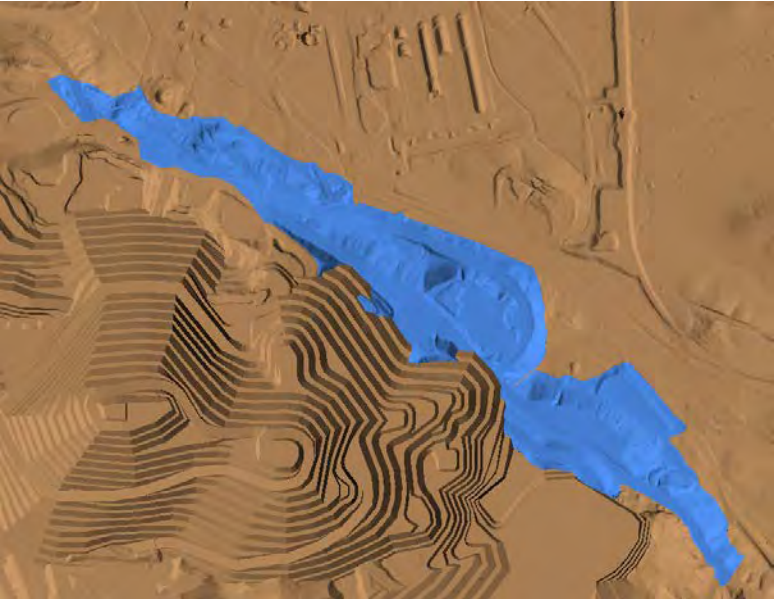
4E East Landbridge

Waste volume	16,511,544 m³	
Erodibility ranking	Medium	
	Low	54%
	Medium	30%
	High	16%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	97	
Topsoil required (m³)	159,700	

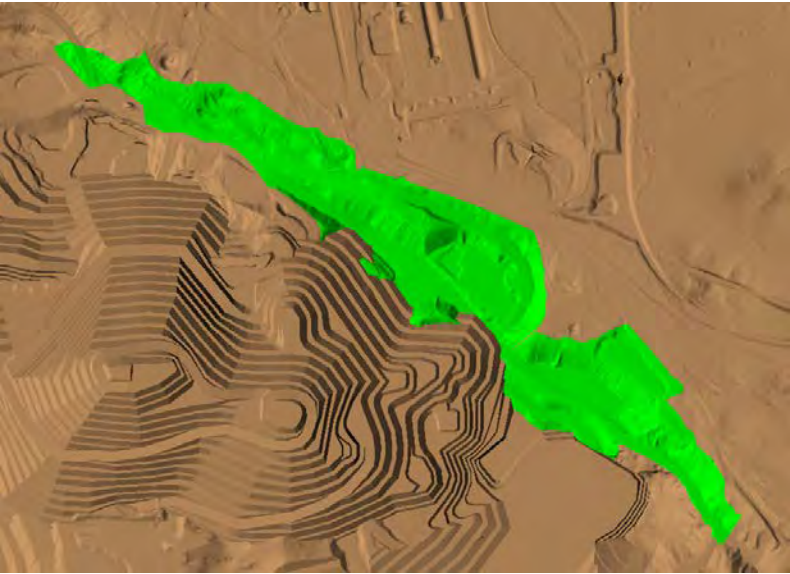
Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	37°	TBC°
Lift height (m)	62	TBC
Berm width (m)	NA	TBC
Berm slope (deg)	NA	TBC°
Footprint (ha)	76.8	TBC

Comments
Rehabilitation design to be determined. Breakdown of material type is assumed due to limited records and the age of landbridge. Assumed to be constructed from 4E waste - generic pit waste ratio utilised.

Construction Design



Rehabilitation Design



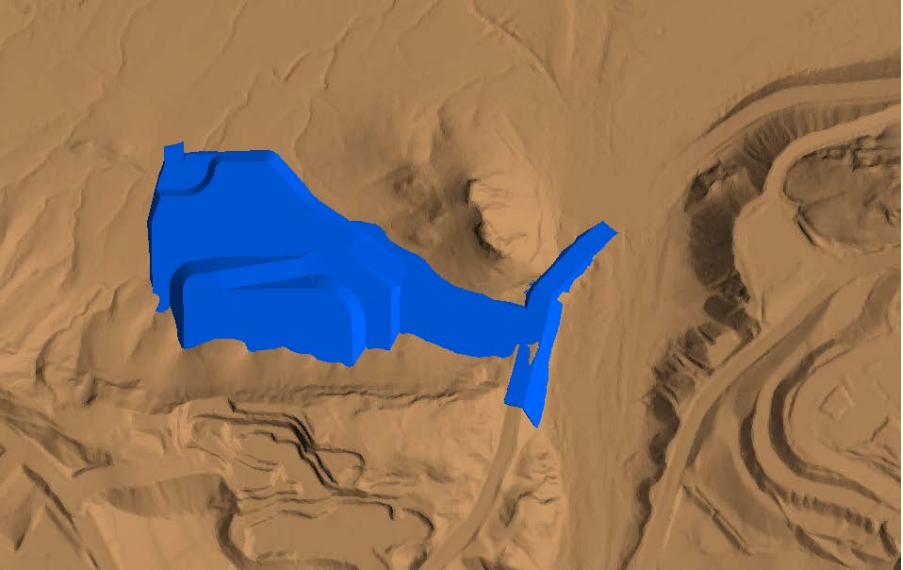
NLC Waste Dump 1

Waste volume	3,352,419m3	
Erodibility ranking	High	
	Low	32%
	Medium	39%
	High	29%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	38	
Topsoil required (m³)	43,600	

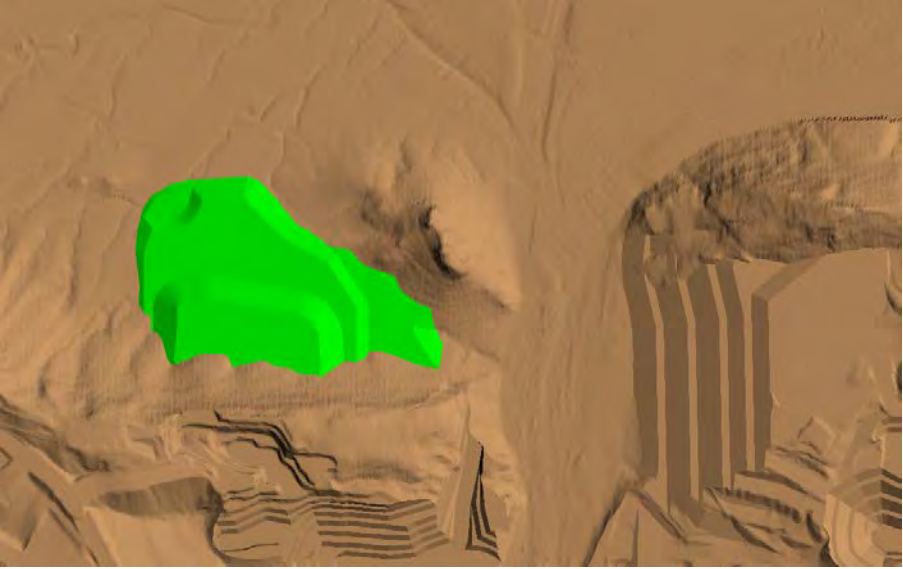
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	20	20
Berm width (m)	52	22
Berm slope (deg)	0°	11°
Footprint (ha)	24.7	21.1

Comments
Waste dump has been identified as a possible stockpile for capping material for the landfill area. Conceptual closure strategy is to reclaim waste to outside of the 100yr flood plain (overlap with NLC LB). Rehabilitation design of riverine side of waste dump is under review.

Construction Design



Rehabilitation Design



NLC Landbridge

Waste volume		
Erodibility ranking	Low	
	Low	%
	Medium	%
	High	%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)		
Topsoil required (m³)		

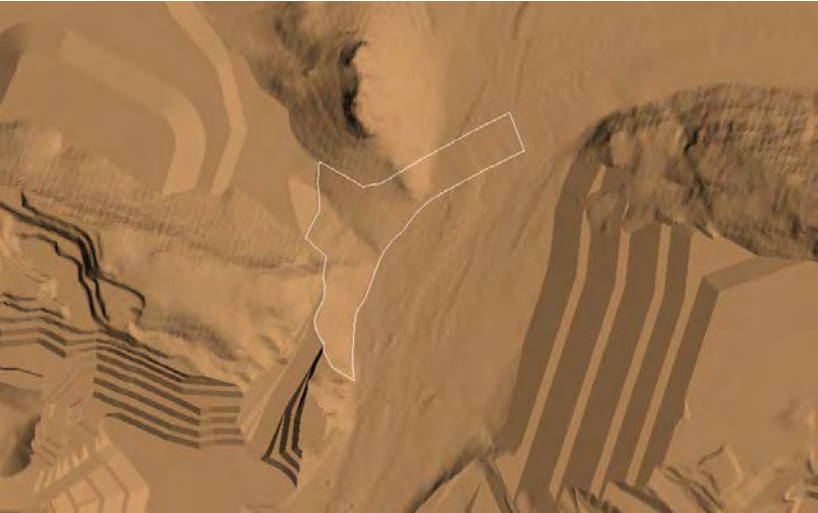
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	°	°
Lift height (m)		
Berm width (m)		
Berm slope (deg)	°	°
Footprint (ha)		

Comments
Located within the 1:100 yr floodplain. Conceptual closure strategy is to reclaim waste to outside of the 100yr flood plain – captured under NLC_WD.

Construction Design



Rehabilitation Design



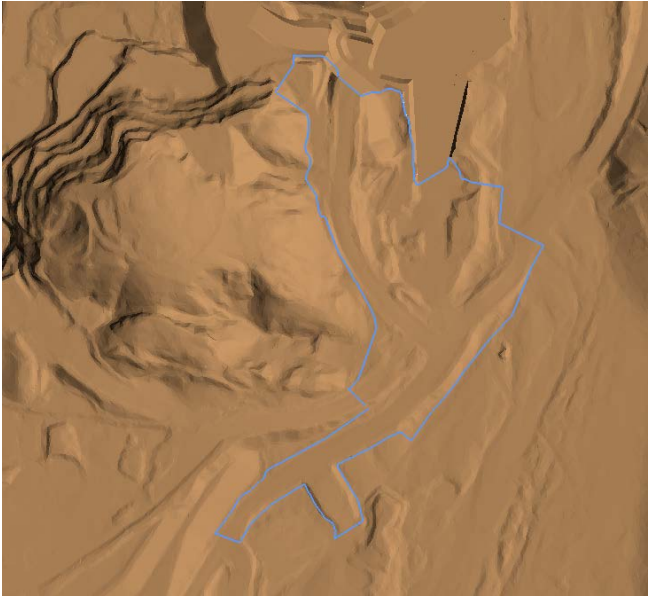
4W Landbridge

Waste volume	1,201,686 m³	
Erodibility ranking	TBC	
	Low	Unknown
	Medium	Unknown
	High	Unknown
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	45	
Topsoil required (m³)	22,800	

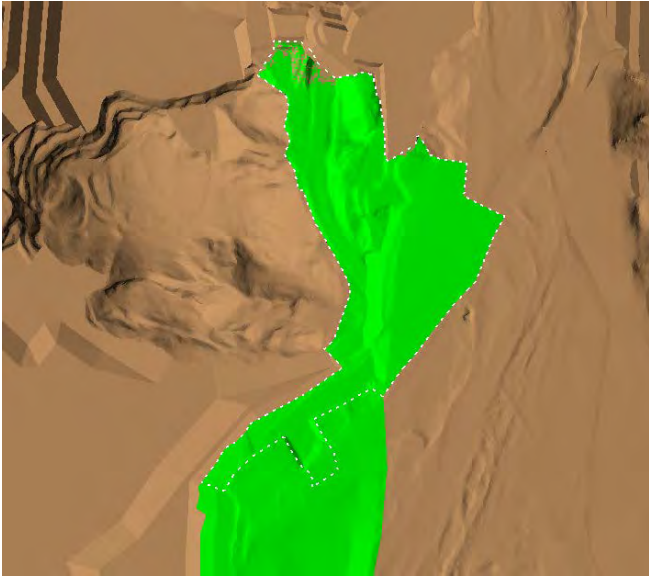
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	TBC
Lift height (m)	45	TBC
Berm width (m)	0	TBC
Berm slope (deg)	0°	TBC
Footprint (ha)	17	TBC

Comments
Unknown construction material – early 1970’s construction. Design assumption is that landbridge is partially reclaimed such that the final landform sits outside of the 100 yr flood plain. Rehabilitation design to be determined.

Construction Design



Rehabilitation Design



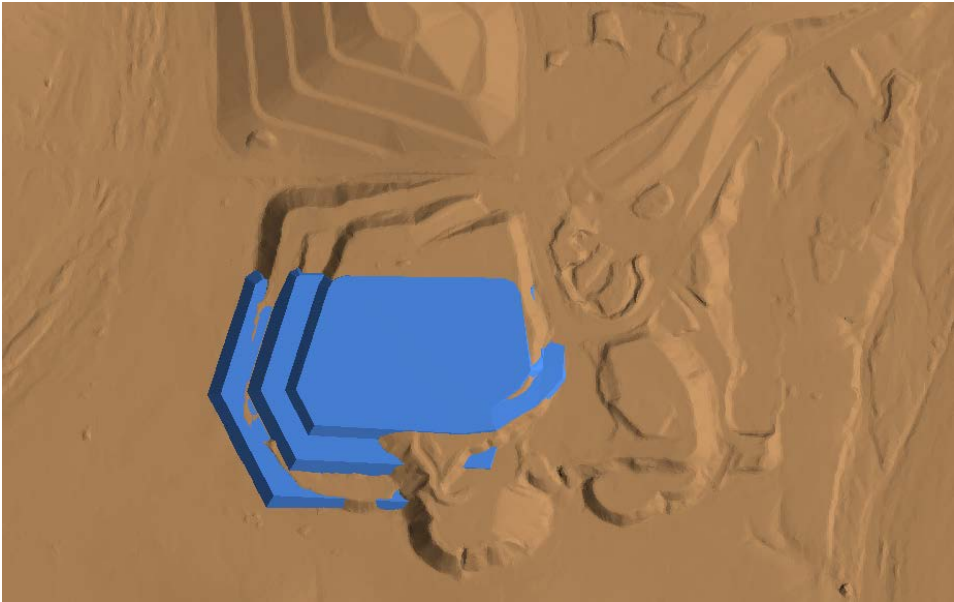
4W Waste Dump 01

Waste volume	25,166,219 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	11%
	High	19%
Classification	Inert <input type="checkbox"/>	Capping required at closure:
	PAF <input checked="" type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	54	
Topsoil required (Mm³)	185,000	

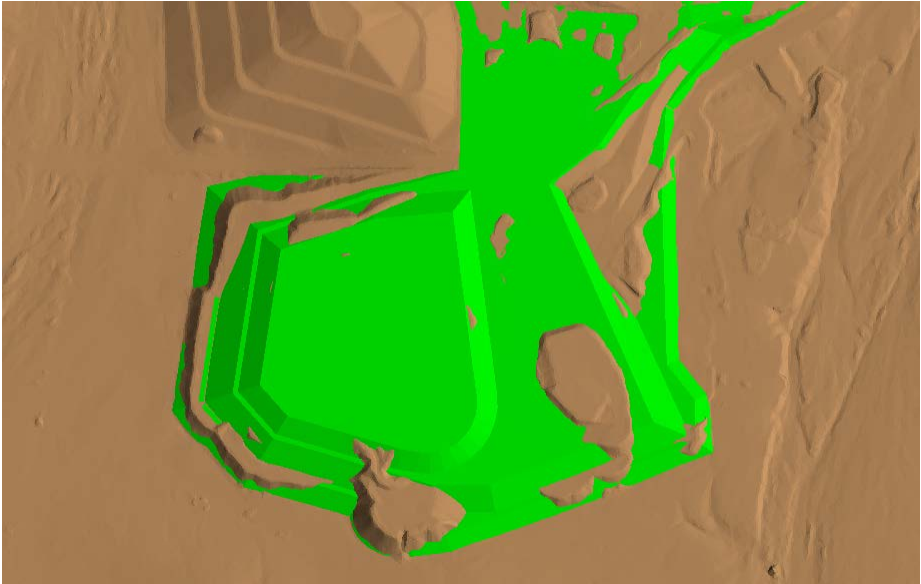
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	20	20
Berm width (m)	30	10
Berm slope (deg)	0°	11°
Footprint (ha)	90.4	90.6

Comments
Low AMD risk Due to the low volume of black shale mined over time, and the high likelihood that an adequate volume of inert waste has already been dumped over black shale, the construction of a store and release cover system is not required. If black shale is exposed during rehabilitation earthworks on 4W_WD01, a minimum of 5 m inert waste will be placed over the exposure and if it the exposure is on the batters a store and release cover will be installed, as per the <i>Iron Ore (WA) SCARD Management Plan</i> . Also known as 4W Rubber Dump

Construction Design



Rehabilitation Design



4W Waste Dump 02

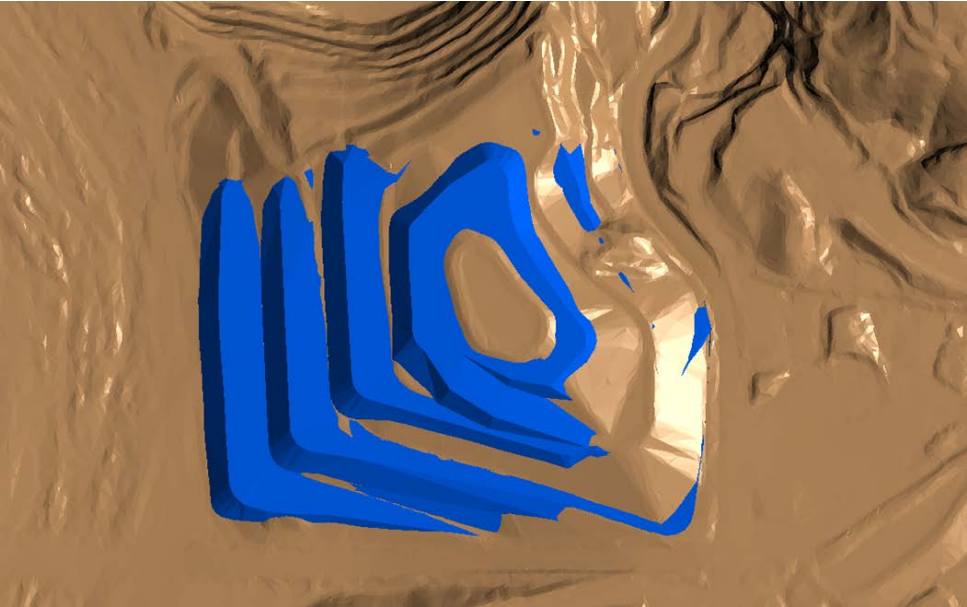
Waste volume	6,732,982 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	11%
	High	19%
Classification	Inert <input type="checkbox"/>	Capping required at closure:
	PAF <input checked="" type="checkbox"/>	0m³
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	80	
Topsoil required (Mm³)	n/a	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	37°	17°
Lift height (m)	20	20
Berm width (m)	28	10
Berm slope (deg)	0°	11°
Footprint (ha)	27.3	27.5

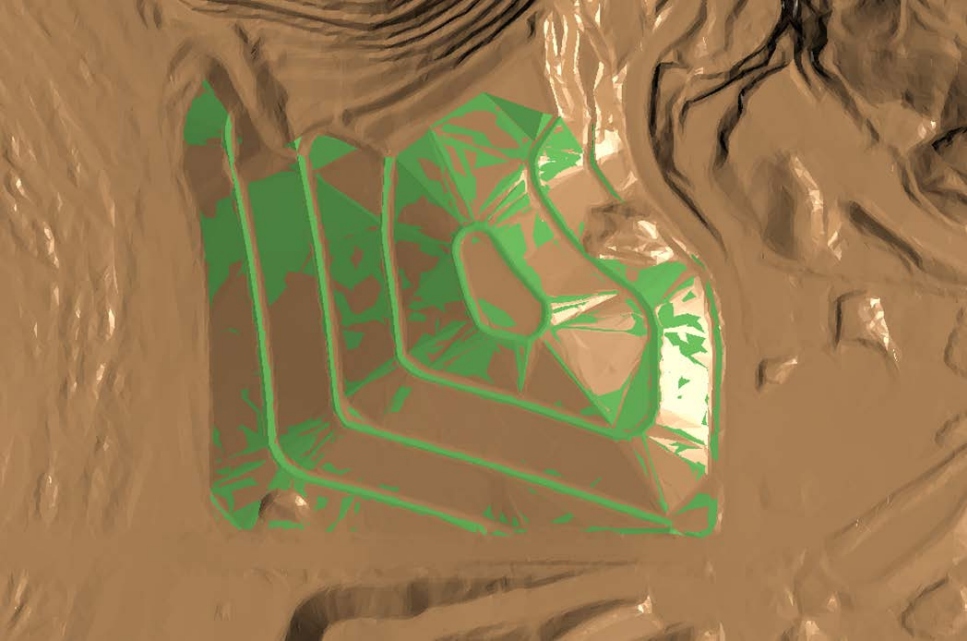
Comments

Waste dump 4W_WD02 was rehabilitated in 2016.
Also known as 4WN.

Construction Design



Rehabilitation Design



4W Waste Dump 03 (In-pit)

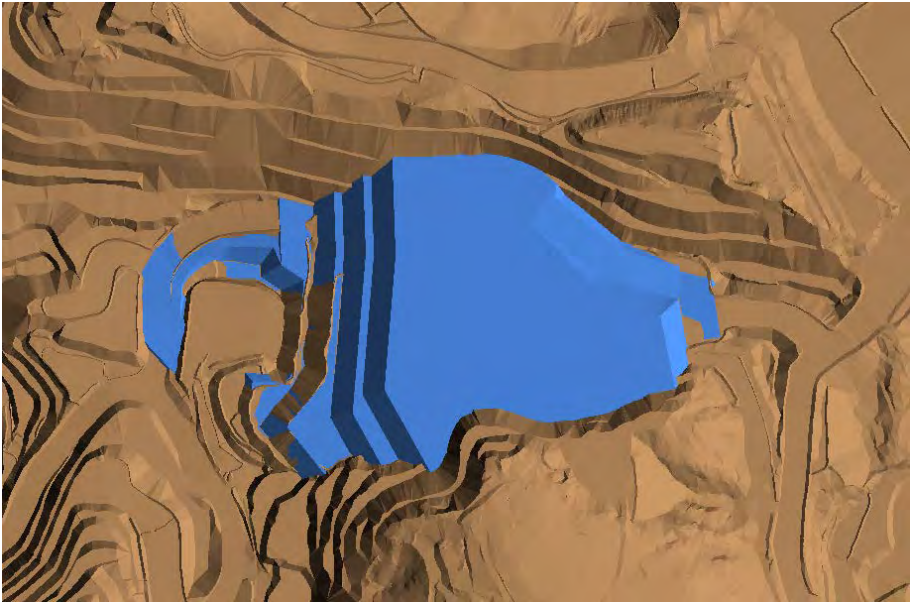
Waste volume	4,313,665 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	11%
	High	19%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)		
Topsoil required (Mm³)		

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	35°/20°
Lift height (m)	20	20
Berm width (m)	10	10
Berm slope (deg)	0°	0°
Footprint (ha)	17	17

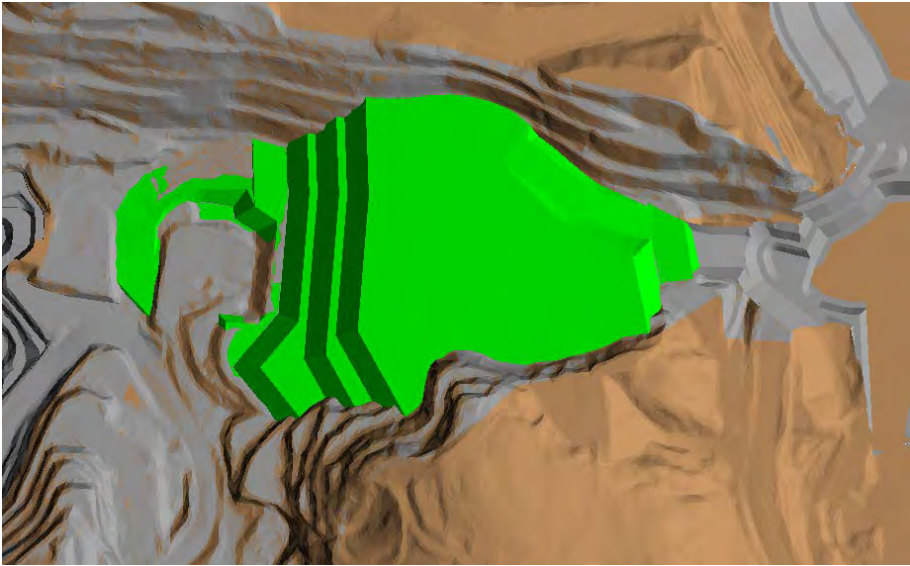
Comments

Eastern limit to be battered down at 20 deg.
4W_WD03 is an in-pit waste dump that covers black shale exposures on the 4W pit wall.
If fibrous material is encountered during operations, segregation and encapsulation of this material will be undertaken in accordance with fibrous minerals management practices, and placed within this dump.
Waste dump is internally draining (to west).

Construction Design



Rehabilitation Design



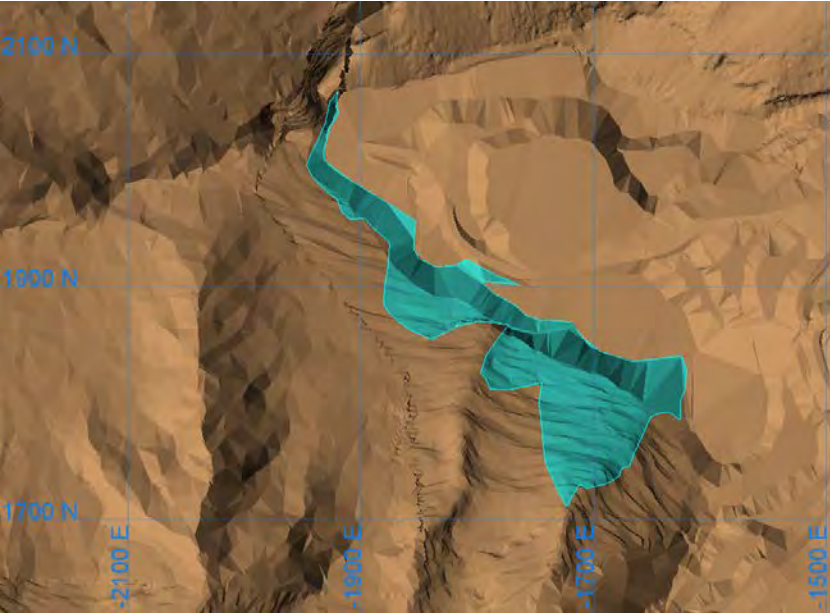
4W_Main Waste Dump

Waste volume	195,798 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	11%
	High	19%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure: tbc
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	132	
Topsoil required (Mm³)	TBC	

Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	36°	TBC
Lift height (m)	90	TBC
Berm width (m)	NA	TBC
Berm slope (deg)	NA	TBC
Footprint (ha)	3.9	TBC

Comments
Historic legacy.
Rehabilitation design to be undertaken.

Construction Design



Rehabilitation Design

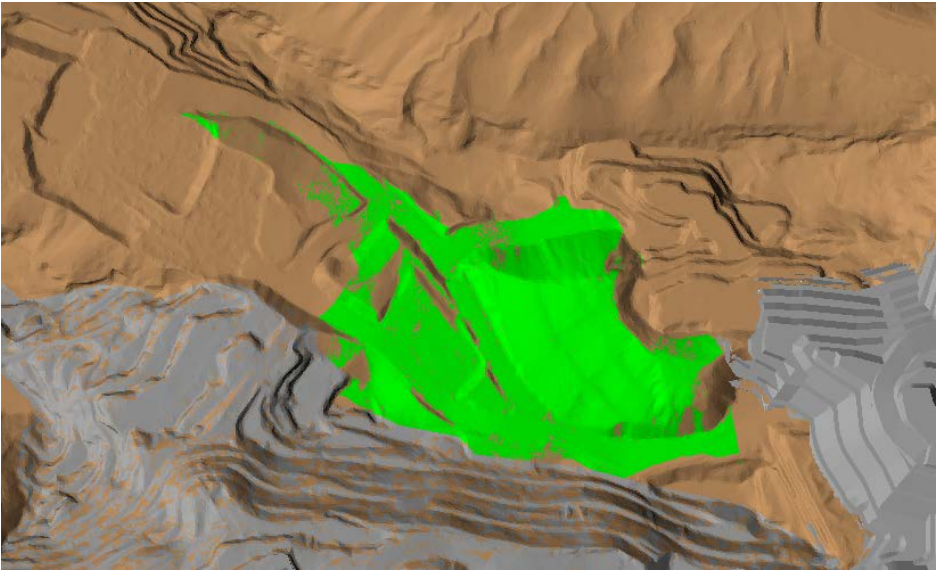
5W_Waste Dump 01

Waste volume	7,064,738 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	11%
	High	19%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	80	
Topsoil required (m³)	25,766	

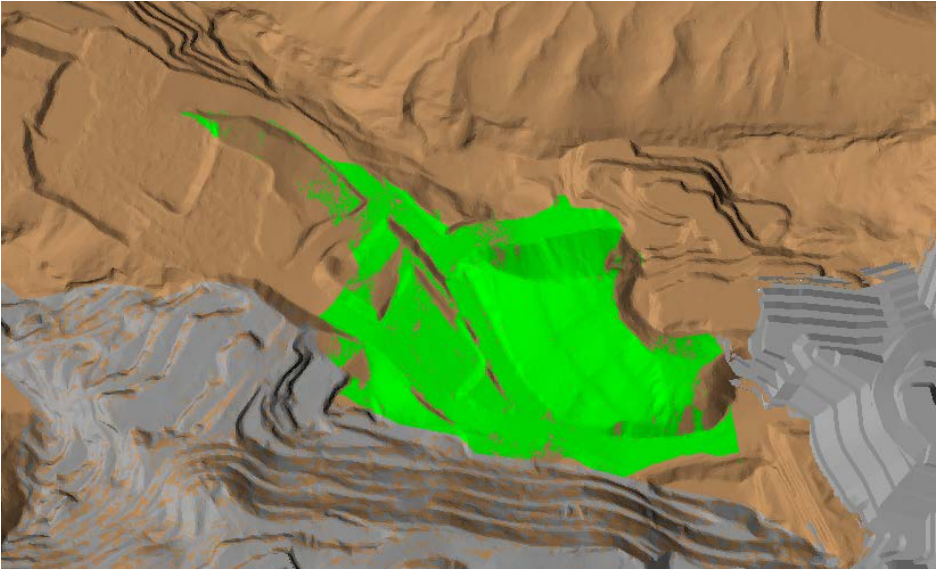
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	15°
Lift height (m)	20	20
Berm width (m)	NA	13
Berm slope (deg)	NA	3°
Footprint (ha)	26.3	26.3

Comments
Rehabilitation design to be undertaken.

Construction Design



Rehabilitation Design



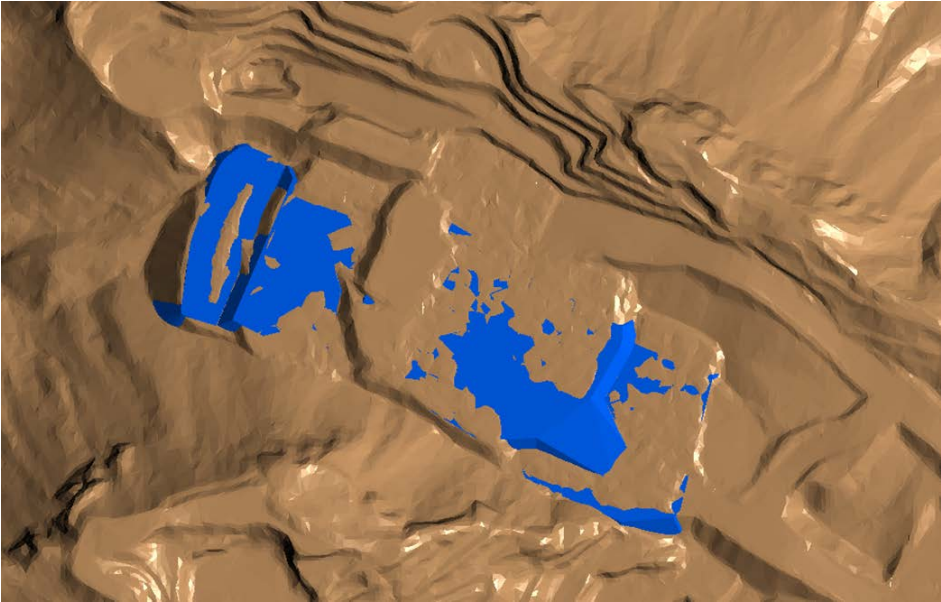
5W_Waste Dump 02

Waste volume	5,848,836 m³	
Erodibility ranking	Low	
	Low	97%
	Medium	0%
	High	3%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	60	
Topsoil required (Mm³)	0.3 Mm³	

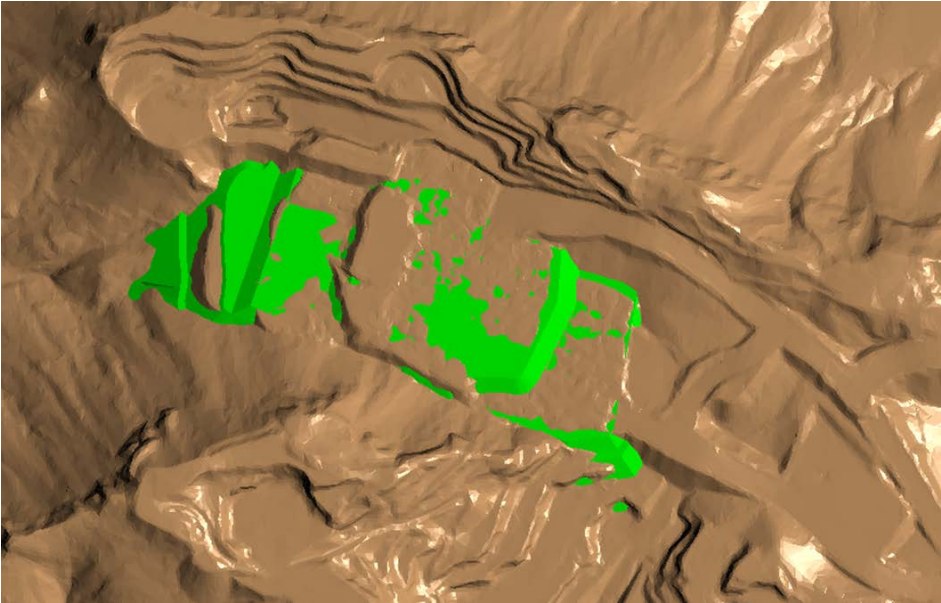
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	10	10
Berm width (m)	45	17
Berm slope (deg)	0°	11°
Footprint (ha)	13	15

Comments

Construction Design



Rehabilitation Design



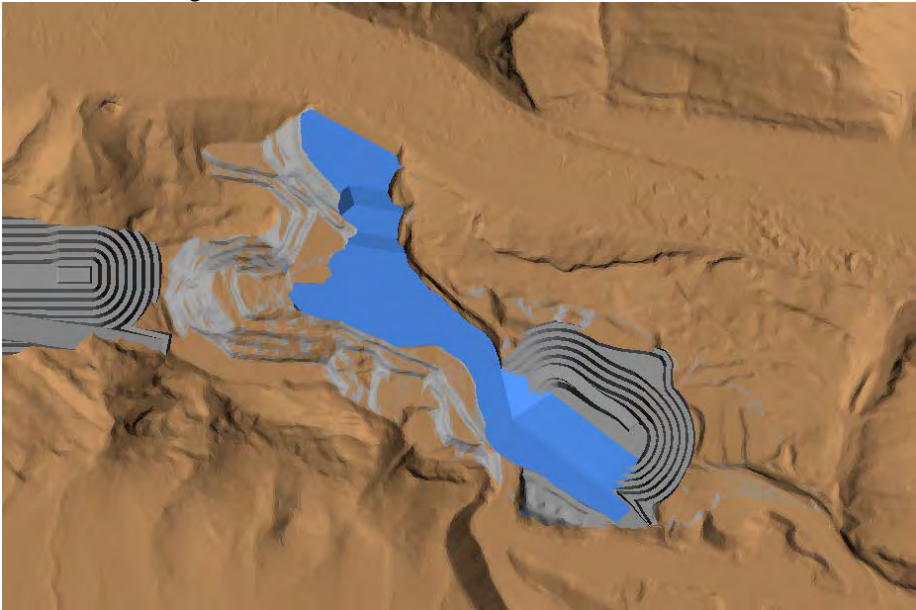
11W Backfill (11W_BF)

Waste volume	845,205 m³	
Erodibility ranking	Low	
	Low	95%
	Medium	0%
	High	5%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	50	
Topsoil required (m³)	TBC	

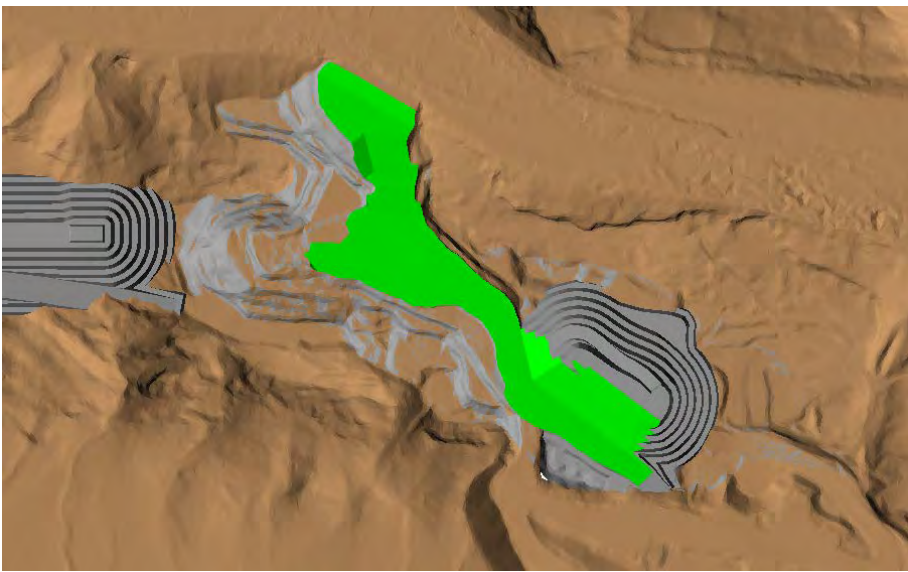
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	20	20
Berm width (m)	42 m	20 m
Berm slope (deg)	0°	11°
Footprint (ha)	8.8	8.9

Comments
11W Backfill covers waste dump 11W_WD01. Partially internally draining, with potential to expand to fill complete void depending on final 14W pit design. Backfill facing creek to be designed to prevent creek flood interception.

Construction Design



Rehabilitation Design



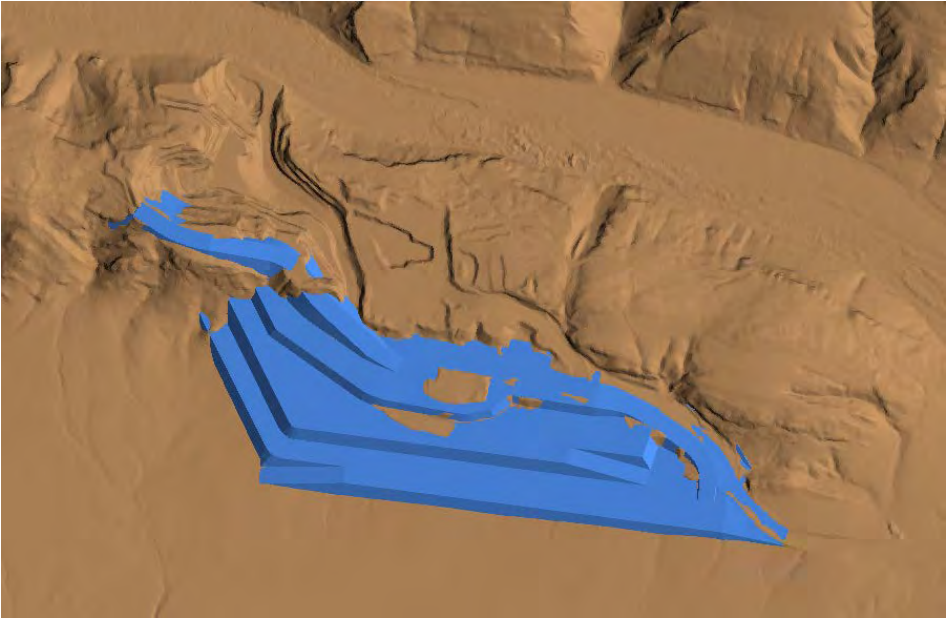
11W Waste Dump 02

Waste volume	6,119,056 m³	
Erodibility ranking	Low	
	Low	87%
	Medium	12%
	High	1%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	115	
Topsoil required (m³)	105,000	

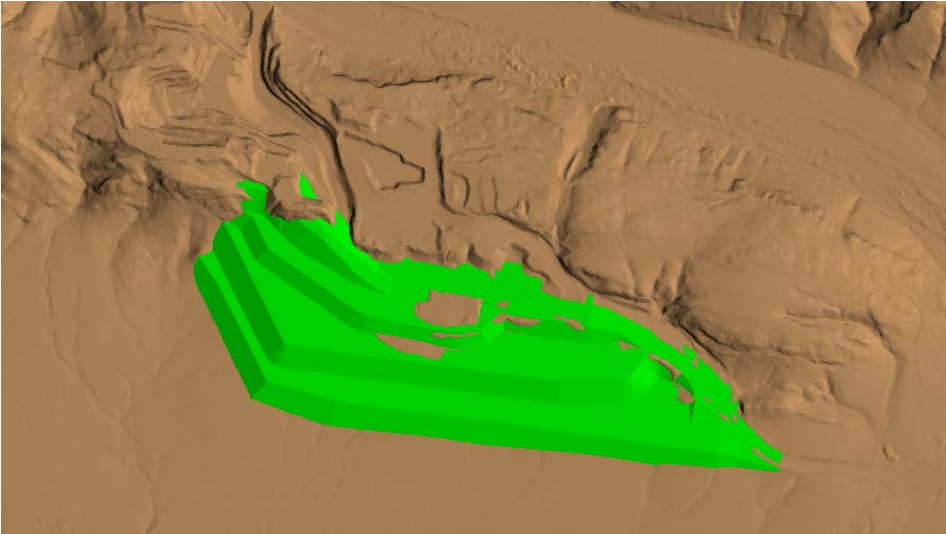
	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	35°	20°
Lift height (m)	20	20
Berm width (m)	50m	25 m
Berm slope (deg)	0°	11°
Footprint (ha)	49.5	52.3

Comments

Construction Design



Rehabilitation Design



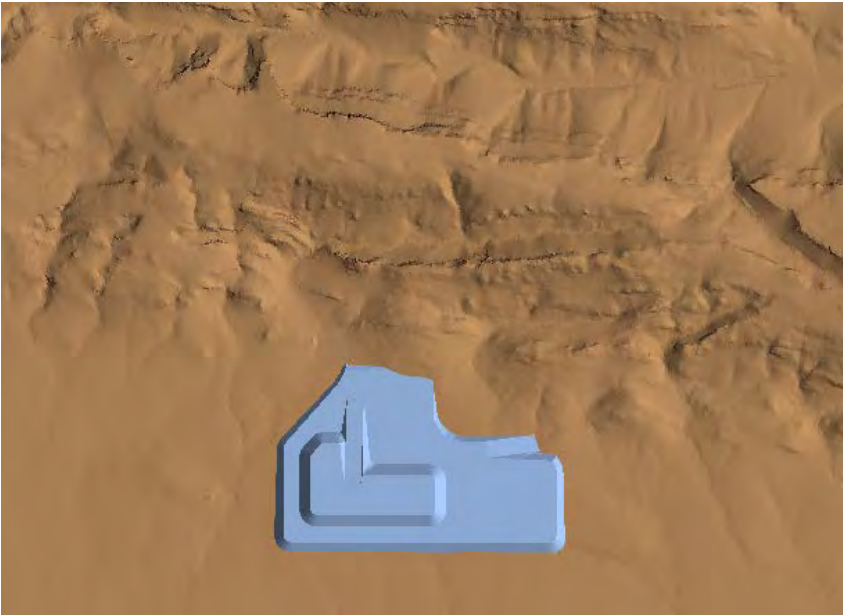
27W Waste Dump

Waste volume	4,170,891 m3	
Erodibility ranking	Low	
	Low	91 %
	Medium	3%
	High	6%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	40	
Topsoil required (m³)	50,685	

Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	35°	TBC
Lift height (m)	20m	TBC
Berm width (m)	38	TBC
Berm slope (deg)	0°	TBC
Footprint (ha)	23.8	TBC

Comments
Conceptual dump design. Rehabilitation design to be undertaken.

Construction Design



Rehabilitation Design

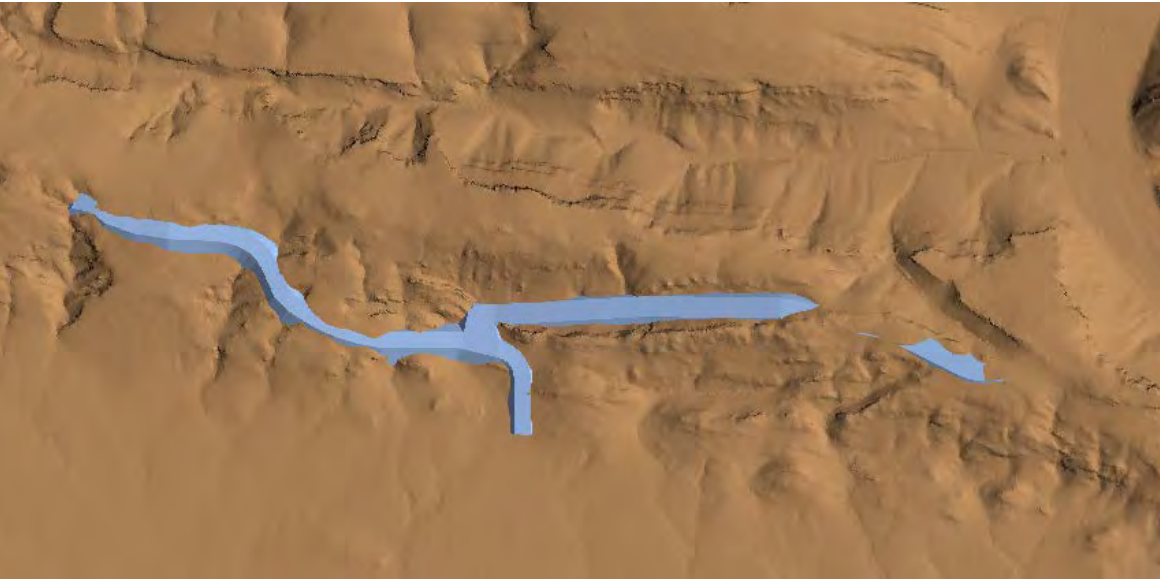
27W Landbridge

Waste volume	1,159,127 m3	
Erodibility ranking	Low	
	Low	91 %
	Medium	3%
	High	6%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	105m (highest single slope 30m)	
Topsoil required (m³)	35,431	

Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	35°	TBC
Lift height (m)	30m	TBC
Berm width (m)	n/a	TBC
Berm slope (deg)	35°	TBC
Footprint (ha)	20.8	TBC

Comments
Conceptual land bridge design. Rehabilitation design to be undertaken.

Construction Design



Rehabilitation Design

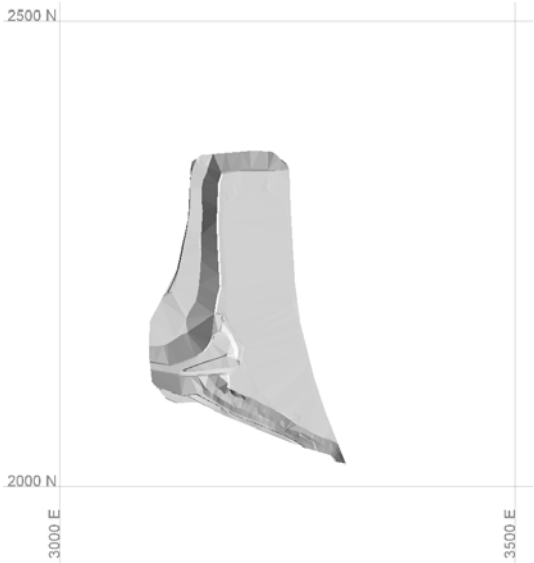
4E_North Stockpile

Waste volume	300,000 m³	
Erodibility ranking	Low/Medium or High: TBC	
	Low	TBC
	Medium	TBC
	High	TBC
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure:
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input checked="" type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	12	
Topsoil required (m³)	7,600	

Construction Specifications		Rehabilitation Specifications
Slope angle (deg)	35°	TBC
Lift height (m)	12	TBC
Berm width (m)	NA	TBC
Berm slope (deg)	0°	TBC
Footprint (ha)	4.1	TBC

Comments
Low grade stockpile. Process material prior to closure or otherwise reshape outer slopes to appropriate angles/profiles based on design criteria suitable for waste type.

Construction Design



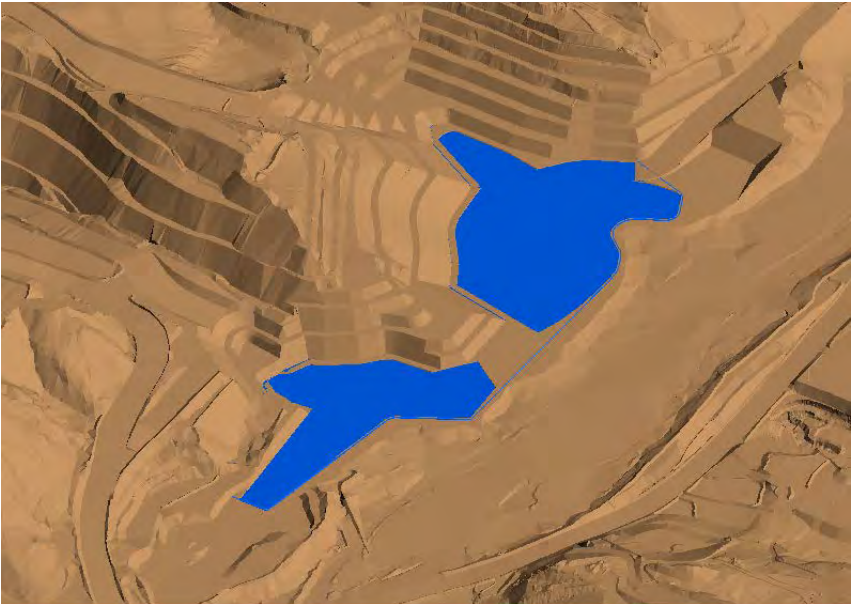
Rehabilitation Design

Waste volume	1,187,414 m³	
Erodibility ranking	Medium	
	Low	70%
	Medium	2%
	High	28%
Classification	Inert <input checked="" type="checkbox"/>	Capping required at closure: TBA
	PAF <input type="checkbox"/>	-
	Fibrous minerals <input type="checkbox"/>	-
	WFSF <input type="checkbox"/>	-
Overall height (m)	0 m	
Topsoil required (Mm³)	0 m³	

	Construction Specifications	Rehabilitation Specifications
Slope angle (deg)	n/a	n/a
Lift height (m)	n/a	n/a
Berm width (m)	n/a	n/a
Berm slope (deg)	n/a	n/a
Footprint (ha)	8.54 Ha	8.54 Ha

Comments
Backfill of NLC void to 350RL with waste from 4E pit Capping may be required to manage any creek flows that overtop 350RL. This aspect is under evaluation.

Construction Design



Rehabilitation Design

