KOOLAN IRON ORE PTY LTD

KOOLAN ISLAND IRON ORE MINE AND PORT FACILITY

MINE CLOSURE PLAN

DOCUMENT ID: MGI-KIO-MCP

VERSION: 5

Tenement Numbers: M04/416, M04/417, L04/29 and L04/68

20 September 2019

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Mount Gibson Iron

MINE CLOSURE PLAN CHECKLIST

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
1	Has the Checklist been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist)	Y	vii		N	NA	
PUBLIC AVAILABILITY							
2	Are you aware that from 2015 all MCPs will be made publicly available?	Y	NA		N	NA	
3	Is there any information in this MCP that should not be publicly available?	No	NA		N	NA	
4	If "Yes" to Q3, has confidential information been submitted in a separate document/ section?	NA	NA		N	NA	
COVER PAGE, TABLE OF CONTENTS							
5	Does the MCP cover page include: • Project Title • Company Name • Contact Details (including telephone numbers and email addresses) • Document ID and version number • Date of submission (needs to match the date of this checklist)	Y	NA		2015 Guidelines format	NA	
SCOPE AND PURPOSE							

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
6	State why the MCP is submitted (e.g. as part of a Mining Proposal, a reviewed MCP or to fulfil other legal requirements)	NA	NA	Supersede 2015 MCP (v4)	Y	NA	Multiple changes throughout document
7	Does the project summary include: • Land ownership details (include any land management agency responsible for the land / reserve and the purpose for which the land/reserve [including surrounding land] is being managed)	Y	2–1		Y	NA	MCP now includes L04/68
	• Location of the project	Y	2–2	Figure 2-1	N	NA	
	• Comprehensive site plan(s)	Y	2–0	Figure 2-2	N	NA	
	• Background information on the history and status of the project	Y	2–1		N	NA	
Legal Obligations and Commitments							
7	Has a consolidated summary or register of closure obligations and commitments been included?	Y	3–1	Appendix A	Y	Appendix A	Conditions for L04/68 included
Data Collection and Analysis							
8	Has information relevant to mine closure been collected for each domain or feature (including baseline studies, environmental and other data)?	Y	7–1		Y	4-1	Many updates to data

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
9	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?	Y	7–87	Table 7-18	Y	4-60	Revised to reflect additional studies undertaken
Stakeholder Consultation							
10	Have all stakeholders involved in closure been identified?	Y	4–1	Table 4-1 and Table 4-2	N	5-1	
11	Has a summary or register of stakeholder consultation been provided, with details as to who has been consulted and the outcomes?	Y	4–6	Table 4-4	Y	5-1	Additional consultation
Final Land Use(s) and Closure Objectives							
12	Does the MCP include agreed post-mining land use(s), closure objectives and conceptual landform design diagram?	Y	5–1, 6–4	Chapter 5 Table 6-1, Table 6-2, Table 6-3, Table 6-4	Y	6-1, 8-1	Revised landform concept and completion criteria
13	Does the MCP identify all potential (or pre-existing) environmental legacies, which may restrict the post-mining land use (including contaminated sites)?	Y	7–79		N	6-1	
Identification and Management of Closure Issues							
14	Does the MCP identify all key issues impacting mining closure objectives and outcomes?	Y	8–1		Y	7-1	Additional detail reflecting additional studies and monitoring

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
15	Does the MCP include proposed management or mitigation options to deal with these issues?	Y	8–1		Y	7-1	Updated measures reflecting additional studies and monitoring
16	Have the process, methodology, and rationale been provided to justify identification and management of the issues?	Y	8–1		Y	7-1	Additional detail reflecting additional studies and monitoring
Closure Criteria							
17	Does the MCP include an appropriate set of specific closure criteria and/or closure performance indicators?	Y	6–2	Table 6-1, Table 6-2, Table 6-3, Table 6-4	Y	Table 8.4 – 8.9	Revised completion criteria
Closure Financial Provisioning							
18	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	11–1		Y	9-1	Updated to reflect most recent MRF
19	Does the MCP include a process for regular review of the financial provision?	Y	11–1		N	9-1	
Closure Implementation							
20	Does the reviewed MCP include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	9–1		Y	10-1	Updated to reflect additional studies and monitoring

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
21	Does the MCP include a closure work program for each domain or feature?	Y	9–1		Y	Table 10.1	Updated to reflect additional studies and monitoring
22	Have site layout plans been provided to clearly show each type of disturbance?	Y	8–6		Y	Figure 2.2	Minor updates
23	Does the MCP contain a schedule of research and trial activities?	Y	9–1		Y	Table 10.1	Updated to reflect additional studies and monitoring completed
24	Does the MCP contain a schedule of progressive rehabilitation activities?	Y	9–1		N	Table 10.1	
25	Does the MCP include details of how unexpected closure, and care and maintenance, will be handled?	Y	9–1		N	Table 10.1	
26	Does the MCP contain a schedule of decommissioning activities?	Y	9–1		N	Table 10.1	
27	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	6–2, 10–2	Table 6-1, Table 6-2, Table 6-3, Table 6-4, Table 10-1	N	Table 8.4 – 8.9 and Table 11.1	
Closure Monitoring and Maintenance							

Q No.	Mine Closure Plan checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
28	Does the MCP contain a framework, including methodology, quality control and remedial strategy, for closure performance monitoring, including post-closure monitoring and maintenance?	Y	10–2	Table 10-1	N	Table 11.1	
Closure Information and Data Management							
29	Does the MCP contain a description of management strategies, including systems and processes, for the retention of mine records?	Y	12–1		N	Figure 12.1	
30	Confidentiality	N / A					

DOCUMENT STATUS RECORD

Report Title:	KOOLAN ISLAND IRON ORE MINE AND PORT FACILITY MINE CLOSURE PLAN			
Document ID	MGI-KIO-MCP			
Version	5			
Revision History				
Date Revised	Revision Comments	Originator	Reviewer	Approved
	Initial version	K. Bleby R. Mason	V. Ee	13/04/2005
22/03/2011	Revised for new DMP MCP guidelines	P. Readhead	S. Sandover	22/6/2011
1/04/2012	Revised to address DMP comments	M. Hamilton	D. Beeson	28/08/2012
1/08/2014	Revised to address DMP comments	M. Hamilton	T. Collie J. Tomich S. DeKruijff	1/09/2015
11/7/2019	Revised to address DMP comments	xx	T. Collie J. Tomich S. DeKruijff	20/09/2019
10/10/2019	Minor revision for corrected figures	T. Collie	T. Collie	15/10/2019

CORPORATE ENDORSEMENT

"I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan and checklist is true and correct, and addresses all the requirements of the Guidelines for the Preparation of a Mine Closure Plan approved by the Director General of Mines."

Name:	Scott De Kruijff	Signed:	[signature]
Position:	Chief Operating Officer	Date:	20/9/19

(NB: The corporate endorsement must be given by tenement holder(s) or a senior representative authorised by the tenement holder(s), such as a Registered Manager or Company Director).

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TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Description
°C	Degrees Celsius
Absl	Metres above sea level
ADWG	Australian Drinking Water Guidelines
AEP	Annual exceedance probability
AER	Annual Environmental Report
AHD	Australian Height Datum
AMD	Acid and metalliferous drainage
ANC	Acid Neutralising Capacity
AOPC	Area of potential concern
APM	Animal Plant Mineral Pty Ltd
BoM	Bureau Of Meteorology
C&M	Care and maintenance
DAC	Dambimangari Aboriginal Corporation
DBCA	Department of Biodiversity, Conservation and Attractions
DC	Decommissioning Cut
DEM	Digital elevation model
DER	Department of Environment Regulation
DHI	DHI Water and Environment
DIR	Department of Industry and Resources
DITR	Department of Industry, Tourism and Resources.
DME	Department of Minerals and Energy
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines And Petroleum (Western Australia)
DoT	Department of Transport
DWER	Department of Water and Environment Regulation
EC	Electrical Conductivity
EFA	Ecosystem Function Analysis
EQC	Environmental Quality Criteria
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority (Western Australia)
EWD	Early Warning Detection
IFRS	International Financial Reporting Standards
KIO	Koolan Iron Ore Pty Ltd
kVa	Kilovolt-Ampere
LFA	Landscape function analysis
LOI	Landscape organisation index
Mbsl	Metres below sea level
MCP	Mine Closure Plan
MGX	Mount Gibson Iron

Acronym / Abbreviation	Description
µS/cm	Microsiemen per centimetre
Mining Act	*Mining Act 1978*
MMP	Marine Management Plan
MOC	Mine Operational Centre
MP	Mining Proposal
MS 715	Ministerial Statement 715
MVA	Megavolt-Ampere
NTU	Nephelometric Turbidity Units
OEPA	Office of the Environmental Protection Authority
OES	Outback Ecology Services
OSA	Ore stockpile area
PMP	Probable maximum precipitation
SWC	Soilwater Consultants
t	Tonnes
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids
WMP	Water Management Plan
WRL	Waste Rock Landform

DEFINITIONS

Aspect – Critical elements of closure that need to be considered.

Care and Maintenance – Period of temporary or unexpected cessation of mining operations where infrastructure remains intact and the site continues to be managed. All mining operations suspended, site being maintained and monitored.

Closure – A whole-of-mine-life process, which typically culminates in tenement surrender after decommissioning, rehabilitation and site relinquishment.

Closure Objective – Outcome based long term goals for closure, based on the post mining land use.

Completion – The goal of mine closure. A completed mine has reached a state where mining lease ownership can be relinquished and responsibility accepted by the next land user (Department of Industry, Tourism and Resources (DITR) 2006a).

Completion Criteria – Qualitative or quantitative standards of performance used to measure the success of meeting the closure objectives.

Decommissioning – A process that begins, near or at, the cessation of mineral production and ends with removal of all unwanted infrastructure and services.

Disturbed - Area where vegetation has been cleared and/or topsoil (surface cover) removed.

Disturbance Type - A feature created during mining or exploration activity, e.g. waste rock landforms, haul roads, access roads, ROM, plant site, tailings storage facility, borrow pits, drill pads, stockpiles, office blocks, accommodation village, etc.

Domain - A group of features (landforms or infrastructure) with similar rehabilitation and closure requirements in one or more discrete areas that are geographically contiguous.

Legal Obligations Register – A register of all legally binding conditions and commitments relevant to rehabilitation and closure at a given mine site.

Life of Mine (LoM) – Expected duration of mining and processing operations.

Post-mining land use – Term used to describe a land use that occurs after the cessation of mining operations.

Project - Koolan Island Iron Ore Mine and Port Facility

Rehabilitation – The return of disturbed land to a stable, productive condition, consistent with the post-mining land use that in some settings aids rehabilitation.

Relinquishment – A state when agreed closure criteria have been met, government "sign-off" achieved, all obligations under the Mining Act removed and bonds retired, and responsibility accepted by the next land users or manager (DITR 2006a (DITR, 2006a).

Revegetation – Establishment of vegetation cover after earthworks have been completed, consistent with the post-mining land use.

1 SCOPE AND PURPOSE

This Mine Closure Plan (**MCP**) is produced in accordance with the *Guidelines for Preparing Mine Closure Plans* (Department of Mines and Petroleum (**DMP**) & Environmental Protection Authority (**EPA**), 2015). The Koolan Island Iron Ore Mine and Port Facility (the 'Project') MCP covers all closure-related aspects associated with the direct mining of the Iron ore bodies at Koolan Island and the operation of the mine site, including mine pits, post-mine landforms, supporting infrastructure, seawall, accommodation village, offices, workshops and airstrip.

The requirement for an MCP comes from a number of sources such as the *Mining Act 1978* (**Mining Act**), Ministerial Statement 715 (**MS 715**) under Part IV of *Environmental Protection Act 1986* (**EP Act**) and tenure held by Koolan Iron Ore Pty Ltd (**KIO**) (tenement conditions of M04/416, M04/417, L03/29 and L04/68). KIO is a wholly owned subsidiary of Mount Gibson Iron (**MGX**).

The MCP provides a strategic plan and implementation framework for the closure of the Project by:

- Identifying those aspects relating to decommissioning and closure, such as the environment, health and safety, which may be of relevance to regulatory agencies;
- Providing a basis for consultation with regulators and identified stakeholders regarding the post-mining land uses of the project areas and agreed completion criteria to attain these;
- Implementing management strategies during the project's design, construction and operations phases to minimise effects on relevant environmental factors and enable site closure;
- Detailing the methodology applied to understand closure costs and establish and maintain adequate financial provisions; and
- Providing details of the management strategies to be implemented by KIO to the appropriate regulatory agencies to confirm that completion criteria are met.

This MCP will be reviewed as required to consider changes in site conditions, operations, technology, and community expectations. KIO has completed a range of studies to further investigate the key environmental risks and closure aspects of operations. The results from these studies have been incorporated into this MCP with changes, where adopted, reported in Annual Environment Reports (**AER**). An updated version this MCP is submitted for review by the Department of Mines, Industry Regulation and Safety (**DMIRS**) every three (3) years as required by the DMP & EPA (2015) MCP guidelines.

The previous MCP (version 4) was finalised in September 2015. Comments received from DMIRS on version 4 have been incorporated into this revision (version 5).

2 PROJECT SUMMARY

2.1 LAND OWNERSHIP DETAILS

Land ownership details are summarised in Table 2-1.

Table 2-1: Land Ownership Details

Tenement	Occupancy	Mining Tenure	Postal Address	Site Address
M04/416	KIO	Mining Lease	Level 1 2 Kings Park Rd West Perth WA 6005	Koolan Island WA 6733
M04/417				
L03/29		Miscellaneous Licence		
L04/68				
E04/1266		Exploration Lease		N / A

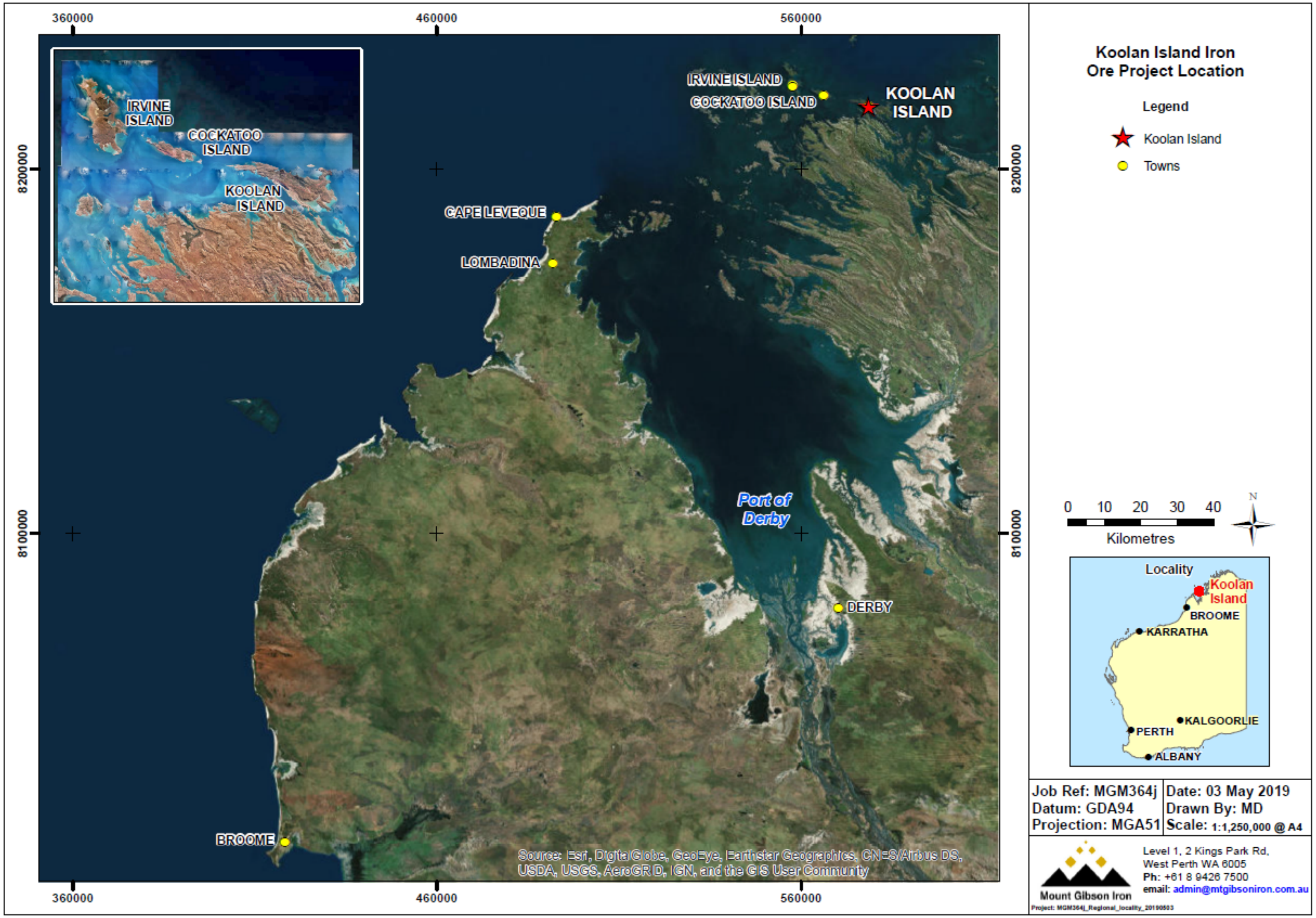
2.2 PROJECT LOCATION

The Project is located on Koolan Island, approximately 130 km north of Derby at the northern end of the Yampi Peninsula. It lies in the northern Kimberley bioregion with a dry, hot, tropical climate and summer rainfall. The regional location of the Project, including nearby sensitive receptors, is shown in Figure 2-1.

2.3 PROJECT OVERVIEW

Koolan Island had a history of small scale mining from the turn of the 20th century until BHP established and maintained substantial mining operations from 1965 to 1993. BHP extracted approximately 68 million tonnes of high-grade iron ore from five pits on Koolan Island – Main, Mullet, Eastern, Barramundi and Acacia. As part of the mining operations BHP reclaimed the area east of Arbitration Cove (Lower Mangrove Inlet) with waste rock. Waste rock dumps were also placed adjacent to each of the pits. BHP operated three domestic and four industrial landfills on the Island. There are no known records of the materials that were placed in the tips, management techniques, or the longevity of each waste disposal area. In 1993 BHP decommissioned the mine which included removal and some in situ burial of operations infrastructure, rehabilitation of cleared areas by moon-scaping and construction of a channel to allow seawater flooding of the Main Pit. Aside from the known domestic and industrial tip sites, the exact locations of other burial pits and the materials buried as part of the decommissioning operations is unknown.

Figure 2-1:: Regional Location of Koolan Island Iron Ore Mine and Port Facility


Koolan Island Iron Ore Project Location
Legend
Koolan Island
Towns
IRVINE ISLAND
COCKATOO ISLAND
KOOLAN ISLAND
CAPE LEVEQUE
LOMBADINA
Port of Derby
DERBY
BROOME
360000
460000
560000
8200000
8100000
0 10 20 30 40
Kilometres
N
Locality
Koolan Island
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Job Ref: MGM364j
Datum: GDA94
Projection: MGA51
Date: 03 May 2019
Drawn By: MD
Scale: 1:1,250,000 @ A4
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KIO gained approval to clear land (45% in previously disturbed areas) and to mine in January 2006 under MS 715. After decommissioning by BHP, the infrastructure remaining at Koolan Island was not capable of supporting a mining operation. The Project has therefore included:

- Construction and establishment of complete mine infrastructure
- Mining of ore bodies
- Dewatering of the Main Pit
- Partial infill of Arbitration Cove for expansion of the Main Pit
- Waste rock management
- Primary crushing and dry screening of ores
- Stockpiling and ship loading
- Construction of ship loading facility
- Maintenance of mine operations
- Maintenance of an accommodation village

Functionally, key activities also require:

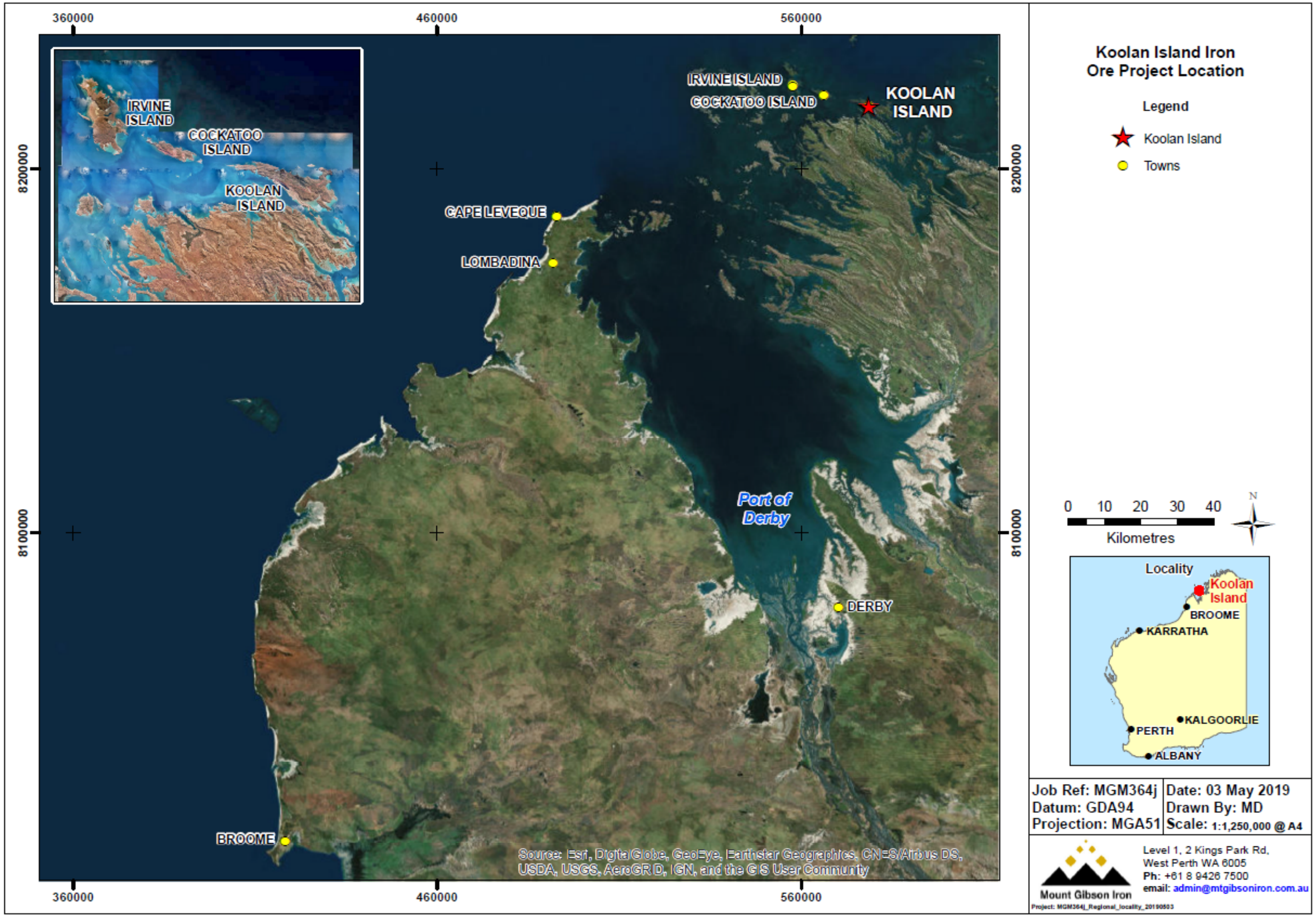
- Management of environmental impacts associated with the above operational elements;
- Rehabilitation and decommissioning across domains; and
- Relinquishment of mining tenements after successful closure.

KIO commenced production in mid-2007 at a mining rate of up to 4 million tonnes of ore per annum and a typical strip ratio of 6:1. In November 2014 the Main Pit Seawall collapsed, resulting in inundation of the Main Pit by seawater. During 2015, the mining rate (from pits other than Main Pit) was reduced and, in early 2016, operations at Koolan Island entered a formal period of care and maintenance (**C&M**).

In 2017, the MGX board approved reconstruction of the seawall, incorporating a vertical grout curtain, where it had collapsed. In July 2018, the seawall had been rebuilt and dewatering of Main Pit commenced. Excavation of waste rock from Main Pit commenced in January 2019, and mining recommenced in March 2019. KIO plans to mine the Main Pit ore body and handle waste rock to waste rock landforms (**WRL**) and pit voids, as it did up until the 2014 seawall breach, until closure.

The mine site layout identifying disturbed areas as defined in the *Mining Rehabilitation Fund Regulations 2013*, tenement boundaries, and proposed or existing disturbance types within each tenement, are shown in Figure 2-2.

Figure 2-2:: Koolan Island Iron Ore Mine and Port Facility Layout and Disturbances


360000
460000
560000
8200000
8100000
IRVINE ISLAND
COCKATOO ISLAND
KOOLAN ISLAND
CAPE LEVEQUE
LOMBADINA
Port of Derby
DERBY
BROOME
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Koolan Island Iron Ore Project Location
Legend
Koolan Island
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0 10 20 30 40
Kilometres
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Job Ref: MGM364j
Datum: GDA94
Projection: MGA51
Date: 03 May 2019
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3 IDENTIFICATION OF CLOSURE OBLIGATIONS AND COMMITMENTS

Mine closure is subject to the requirements of legislation, mining tenement conditions, commitments made in Mining Proposals (**MP**) upon approval and conditions on environmental approvals such as MS 715. KIO has established a compliance management system which records obligations arising from various legislation and approvals, and has been used to identify Project closure obligations and commitments.

In recognition of mining being a temporary land use, the predominant intent of closure obligations and commitments is to avoid liability to the State by returning the land to a safe, stable, non-polluting and, where possible, self-supporting revegetated landscape. As a result, closure obligations and commitments at Koolan Island cover a range of environmental aspects such as topsoil reclamation, infrastructure removal, landform rehabilitation and environmental monitoring.

The closure obligations and commitments for the Koolan Island Mine and Port Facility are identified within APPENDIX A. Key sources for closure obligations and commitments include:

- A range of Acts and subsidiary regulations such as the *Mining Act 1978*, *Environmental Protection Act 1986*, *Contaminated Sites Act 2003*, *Aboriginal Heritage Act 1978*, *Soil and Land Conservation Act 1945*, *Dangerous Goods Safety Act 2004* and *Health Act 1911*;
- Mining tenements M04/416 and M04/417;
- Miscellaneous Licences L04/29 and L04/68;
- MPs submitted and approved since 2005;
- Ministerial statement 715 (MS 715); and
- Environmental Management Plans.

3.1 DMIRS FEEDBACK ON MINE CLOSURE PLAN VERSION 4

DMIRS provided comments, queries and other feedback on version 4 of the MCP to KIO within a letter dated 18 April 2017. A copy of the DMIRS letter is included as APPENDIX B. In addition to the closure obligations and commitments summarised in Section 3 and collated in APPENDIX A, KIO has responded to the DMIRS feedback within this updated MCP. KIO's responses, and references to the MCP sections detailing those responses, are provided in Table 3-1.

Table 3-1: DMIRS Feedback on MCP Version 4 and KIO Responses

Section of MCP v4	DMIRS Comment	KIO Response	Section of MCP v5
Identification of Closure Obligations and Commitments	The MCP notes that there is a conflict between the closure design for the Mullet pit backfill approved in Mining Proposal REG ID 34572 and the outcome proposed in the MCP. In order to change the closure design for Mullet Pit, a revised Mining Proposal will be required to be approved by DMP. It is also noted that the proposed landform design includes slopes at angle of repose, which is not generally conducive to forming a 'safe and stable' post closure landform. The Mining Proposal will need to include a justification as to why the proposed landform design will have a better closure outcome than the previously approved landform design, and include evidence to justify that the angle slope is safe and will be stable.	The Mullet Pit backfill design has been retained (as per MCP v4) and requires amendment of MP 34572 i.e. final surface slopes ≤ 20° and deep ripped on contour. Submission of a revised MP for Acacia East is not required, but KIO will design a retention volume of 280,000 m^3 below the outlet level to Mullet Bay (equating to retention of flows from a 1:100 72 hour run-off event. The Mullet Pit backfill strategy is a positive environmental outcome compared to the alternative of a pit void with walls at much steeper slopes, and a new waste dump requiring additional disturbance. Battering the backfill slopes ≤ 20° will ensure they are safe and stable.	Sections 8.5 and 8.5
Collection and Analysis of Closure Data	Overall this section was well done. The "considerations for mine closure planning" for each section of data showing how this data has influenced the closure planning onsite is considered particularly useful. In relation to baseline date for "Geochemistry", the MCP indicates that seven drill holes were analysed for pH, pHFOX and EC, and a further 1,800 drill hole assays reviewed for total sulfur. It is unclear why standardised acid base accounting tests have not been used to determine the maximum potential acidity (MPA), acid neutralising capacity (ANC) and Net Acid Producing Potential (NAPP), across a representative sample of the mine wastes. The MCP desktop analysis indicates that the potential for Acid Metalliferous Drainage (AMD) formation is low, but it is considered that this needs to be clearly justified using recognised and acceptable methodologies (for example refer to the 'Leading Practice Sustainable Development Program for the Mining Industry – Managing Acid and Metalliferous Drainage Handbook' – September 2016).	Page 40 of the referenced handbook states: "For many sites, early indications of AMD potential can be provided by measurements of total sulfur and total carbon content in collected materials. Screening for total sulfur in the field can be done using a handheld X-ray fluorescence (XRF) analyser. The need for and scope of more detailed investigations depends on the findings from this initial screening." KIO's review of total S assays has identified low risk and is therefore consistent with the handbook. MGX assesses potential acid and metalliferous drainage (**AMD**) risk as negligible as historical WRLs are present, waste rock sulfur content is uniformly low, and no AMD impacts have been observed. Nevertheless, standardised acid base accounting will be undertaken prior to closure.	Section 7.4
Collection and Analysis of Closure Data	It is noted that for most of the closure scenario's (such as the capacity of the Mullet pit void to contain storm water) a 1:100 72hr storm event was used. As DMP has stated to MGI previously, for closure planning the probable maximum precipitation (**PMP**) level is recommended.	Stantech were engaged to assess the area of the catchment reporting to Mullet Pit, capacity of Mullet pit, run-off draining to the pit during the 1% annual exceedance probability (**AEP**) 72 hour storm, and run-off draining to the pit during the PMP 72 hour storm event. Mullet Pit will be backfilled to retain a 280,000 m^3 basin below the outlet level to Mullet Bay (equating to retention of flows from a 1:100 72 hour run-off event), as designing a basin to retain a PMP event would result in insufficient waste rock storage.	Sections 7.5.4, 7.5.8 and 8.5
Collection and Analysis of Closure Data	The MCP is not clear on whether all seed will be sourced on the Island and this should be clarified in the next revision.	Seed to be utilised for reseeding will be of local provenance (i.e. sourced from Koolan Island, the Buccaneer Archipelago or Dampier Peninsula).	Section 7.8.2
Collection and Analysis of Closure Data	Table 4.7 identifies knowledge gaps that MGI will need to address before closure. It is acknowledged that MGI are currently conducting work to close a number of these gaps but it would be preferred if there were indicative targets or timelines assigned to each knowledge gap in the next revision of the MCP.	Noted. Timelines have been added to the table.	Table 7-18
Stakeholder Consultation	It is noted that the consultation strategy summarised in Table 5.3 does not appear to include closure specific consultation for external stakeholders and this is still required. Please note that input will need to be sought from the Resources Safety Division, DMP in relation to the abandonment bund strategy, and from Department of Transport in relation to the closure strategy for any infrastructure and landforms that are located in or directly adjacent to the Port of Yampi Sound.	Noted. The consultation strategy has been updated to include closure-specific consultation including with the Resources Safety Division, DMIRS, Dambimangari Aboriginal Corporation (**DAC**) and Department of Transport (**DoT**).	Section 4.2

Post Mining Land Use	It is acknowledged that MGI have progressed work on determining the post mining land use for Koolan Island, but the most likely scenario still does not yet appear to have been defined in the MCP. A lack of a defined post mining land use is of concern to DMP as good planning for closure essentially depends on the end goal being defined as early in the project as possible to enable progressive rehabilitation during the life of the operation. MGI must continue to progress work in this area and define the most likely post closure land use as soon as possible. Additional detail is required on the most likely closure scenarios including more detail about the timing and areas for rehabilitation if Land Act leases are granted over some sections of the Island.	KIO is working towards either of two closure strategies as stakeholder negotiations progress and closure options are further defined: • Removal and rehabilitation of virtually all improvements with the exception of the barge ramp; or • Transfer of select infrastructure to DAC and DoT for ongoing productive utilisation.	Section 5.2
Closure Objectives	Overall the closure objectives as worded are mostly acceptable, however it is noted that two of the six objectives include the wording “where possible” and it is not clear how that is defined and who will determine what was possible after the mine site has been closed and rehabilitated. This aspect needs to be more specific in the next version of the MCP.	Closure objectives have been revised to address DMIRS comments and with consideration given to the DMP & EPA (2015) Guidelines.	Section 5.3
Management of Closure Issues	Several subsections in Section 7.7 indicate that the management of the closure issue of ‘underperforming revegetation’ is detailed in Section 7.1.2. Section 7.1.2 details the measures that MGI have undertaken to limit the likelihood of underperforming revegetation (which is a good primary control measure), but does not outline what measures MGI will undertake if this issue does occur.	The 2019 EFA better defines 'underperforming vegetation' by nominating the Open Woodland as the analogue. Describing the analogues in terms of LFA/EFA/erosion variables allows comparison to the rehabilitated areas in quantitative terms. The progress of rehabilitated areas, as evidenced by landscape function analysis (LFA) and ecosystem function analysis (EFA) monitoring, and vegetation now established at rehabilitated areas and surface trials, provides much greater surety about the appropriateness of KIO’s preferred rehabilitation strategy and the likelihood of successful landform rehabilitation than was possible in 2015 when the previous version of this MCP was published. Project closure objectives and completion criteria have also evolved during this period in response to additional data analysis, further increasing the probability of successful revegetation. Nevertheless, additional detail regarding KIO’s response to underperforming revegetation has been provided. The introduction of remote spatial analysis by Emapper™ assists in identification of underperforming vegetation. This MCP also introduces supplementary seeding with pelletised seeds to address underperforming vegetation.	Section 8.2.2
Management of Closure Issues	The MCP does not include detail of the closure strategy for the seawall. If the seawall rebuild has commenced at the time of the next MCP submission, the closure strategy for the seawall must be detailed, with geotechnical data provided to support the chosen strategy. If the seawall rebuild has not commenced at the time of the next MCP submission the stabilisation/removal of the remaining section of the seawall must be detailed in the MCP.	A preferred closure strategy for Main Pit has been selected – a bay / lake connected with the ocean at higher tides by a channel, with the seawall remaining in situ. Geotechnical and coastal engineers has been engaged to assess coastal processes and stability of the seawall landform. DHI Water and Environment (**DHI**) has been engaged to model tidal conveyance in channels and pit lake hydrodynamics.	Sections 5.2 and 8.4.1
Management of Closure Issues	The abandonment bund strategy will need to be approved by the Resources Safety Division, DMP.	Ongoing discussion with the Resources Safety Division is included in the consultation strategy.	Section 4.2
Closure Criteria	It is noted that there has been a lot of development in completion criteria from Version 3, and while the specific targets of ‘revegetation’ in the criteria are not yet defined, overall this section appeared to be done well. MGI should continue to progress work to define these targets. Specific comments for areas of the criteria which require improvement are detailed below:	MGI has developed closure criteria since the submission of MCP v4.	Chapter 6
Closure Criteria	Many of the domains do not have criteria for safety (for example Table 8.5 for backfilled pit (Mullet pit), Table 8.6 for Waste Rock Landforms and Table 8.8 for onshore infrastructure).	Safety criteria have been added to all domains.	Section 6
Closure Criteria	In the monitoring tools for revegetation, it would be useful for MGI to consider vegetation coverage as well as structural diversity and species composition, as the latter could be achieved with limited individuals present and therefore not give an accurate measure of the actual objective (the rehabilitated land retains landscape and biological values of the surrounding landscape).	KIO has been engaging Animal Plant Mineral Pty Ltd (**APM**) to undertake LFA / EFA at a range of rehabilitation sites since 2016. LFA measures canopy volume, providing an indication of vegetation coverage. Furthermore, in 2019 Astron Environmental Services is mapping historical rehabilitation trials and current KIO on-ground trials using Emapper™ as part of a successful METS Ignited funding award, providing spatial data on revegetation coverage trends.	Section 7.8

Closure Criteria	Where any infrastructure is to be left (as detailed in Table 8.7 and 8.8), there must be a formal sign off and transfer of any residual liability to the post mining landholder. This landholder must have appropriate tenure and approvals (if required) to accept the liabilities associated with the infrastructure.	KOI is working towards either of two closure strategies as stakeholder negotiations progress and closure costs are further defined: • Removal and rehabilitation of virtually all improvements except for the barge ramp; or • Transfer of select infrastructure to DAC and DoT for ongoing productive utilisation.	Section 5.2
Financial Provision for Closure	It is noted that the external financial provisioning conducted by Preston Consulting was undertaken before the seawall failure, and this change in circumstances does not appear to be reflected in the provisioning assumptions. Closure cost calculations and financial provisioning information should be current, ideally closure costs are continuously updated with considerations of any changes in the mine plan.	Preston Consulting (**Preston**) has undertaken financial provisioning for the most likely closure scenario since the seawall was reconstructed and production recommenced.	Chapter 11
Closure Implementation	This section does not appear to address the non-domain specific aspects of management of a site that has suspended operations and is under 'Care and Maintenance', and has grouped the care and maintenance tasks with the 'unexpected closure tasks'. The MCP does not have any detail of the specific ongoing management actions which will be undertaken to meet environmental obligations while under care and maintenance. It is suggested that MGI add reference to the Care and Maintenance Plan that was developed in May 2016 into the next MCP revision.	KIO has referenced the Care & Maintenance Plan in this version of the MCP.	Section 9.1
Closure Implementation	In Table 10.1 there is no indicative timing/schedule provided for the closure of knowledge gaps detailed in "Schedule of work for research, investigation, trails and materials required", and this should be provided in the next revision of the MCP.	In the column "Schedule of works for research, investigation, trials and materials required" a schedule of works has been added, and in the column "Identification and Management of Information Gaps" a timeframe has been specified, for each item.	Chapter 9
Monitoring	The flora monitoring methodology section indicates there will be 10x10m quadrats for surveys of rehabilitated land, but there is no rationale provided to explain the appropriateness of this method of surveying. It is noted that the Office of the Environmental Protection Authority (OEPA) and Department of Parks and Wildlife (DPAW) have produced new guidance in 2015 for flora and vegetation surveys (http://www.epa.wa.gov.au/EPADocLib/Technical-guide-Flora-Veg-Dec2015.pdf), and while this guidance is aimed at environmental impact assessment surveys, it would be worth reviewing the document for guidance on quadrat size. If MGI require further guidance on monitoring rehabilitation it would be advisable to seek advice from OEPA and DPAW.	10 x 10 m quadrats were initially used to develop the seed mix and assess the success of seeding in the rehabilitation areas, and are of a suitable scale for these purposes. LFA / EFA has continued to use 10 x 10 m to allow comparison with historic data and identify trends. Significantly, sufficient quadrats have been monitored at a frequency which has identified clear revegetation trends. KIO therefore maintains that 10 x 10 m quadrats are appropriate and fit for purpose under the current LFA / EFA regime, and will continue to be so through closure.	Section 7.8
Monitoring	There is also no detailed monitoring methodology provided in the MCP. Given the stage of mine life more detailed information is expected in the next revision of the MCP, including detailed methodology, quality control and remedial strategies.	Vegetation is assessed using the Point Cantered Quarter and Wandering Quarter methods as suggested by Tongway & Hindley (2004). This gives both the number of plants per ha and the canopy density of plants per hectare. Both flora and vegetation are assessed by strata which identifies gaps in the vegetation structure. Quality control is addressed by nominating undisturbed Open Woodland as analogues and detailing the same set of variables for analogues as rehabilitated sites (15 variables for flora and vegetation) so that a quantitative comparison can be made. Quality control is also provided by the Emapper analysis which allows the EFA results to be extrapolated over whole landforms and identifies areas of low vegetation success. Remedial strategy is to use the Emapper results to create zones within the rehabilitation areas. Zones of low vegetation success will be supplementary seeded with pelletised seeds. The EFA results identify which strata and species should be targeted (on a site by site basis) for the supplementary seeding.	Section 7.8

Department of Environment Regulation (DER) Comments	Overall the MCP does not provide sufficient detail in relation to the management of contaminated sites in relation to the *Contaminated Sites Act 2003*. The MCP does not adequately address legacy contamination issues. The MCP fails to identify all areas which could have potential contamination and a Preliminary Site Investigation across the whole Island is likely to be required. More detail, (and potentially more work) is required around acid metalliferous drainage (note this is also raised by DMP above). DER does not agree with some of the groundwater contamination assumptions stated in the MCP. Landfills need to be included in the contamination assessment. It recommended that further consultation with DER occurs to address these shortfalls in the MCP.	A Contamination Management Plan has previously been prepared for the Project, as required by MS 715 and administered by Department of Water and Environment Regulation (DWER). In 2019 KIO consulted with DWER Contaminated Sites Branch directly in relation to the content and future requirements of a revised Contaminated Management Plan. AECOM has since been engaged amend the Contaminated Management Plan - key aspects of the amended plan are included in this MCP.	Section 7.14

4 STAKEHOLDER CONSULTATION

Stakeholder consultation is an integral component of KIO's mine closure planning. KIO seeks to consult with its key stakeholders on key aspects of mine development and mine closure. As a component of the KIO stakeholder consultation strategy, open consultation meetings with key stakeholders have been and will continue to be held frequently to discuss mine operations and mine closure planning.

The following sections outline the stakeholder consultation strategy, the stakeholders identified and a record of consultation undertaken and planned.

4.1 IDENTIFICATION OF RELEVANT STAKEHOLDERS

Key internal stakeholders for Project closure planning are summarised in Table 4-1 and key external stakeholders are summarised in Table 4-2. These tables are limited to stakeholders relevant to Project closure.

Table 4-1: Project closure internal stakeholder list

Category	Internal Stakeholder
MGX	MGX Board Chief Executive Officer Chief Operating Officer Chief Financial Officer Project Director – Environment and Approvals
Koolan Island Operations	General Manager Health, Safety, Environment and Training Manager Environmental Superintendent Technical Services Manager Planning Superintendent Mining Manager

Table 4-2: Project closure external stakeholder list

Category	External Stakeholder
Federal Government	Department of the Environment
State Government	DMIRS
	EPA
	DWER
	Department of Planning, Lands and Heritage
Local Government	Shire of Derby / West Kimberley
Community	Kimberley Land Council
	Dambimangari (acting for Wanjina Wunjurr, the Native Title Holders)
	Derby Community
	Australian Customs and Border Protection Services - Broome
	Department of Fisheries – Broome
	Broome Visitor Centre
	Kimberley Quest
	Department of Biodiversity, Conservation and Attractions (DBCA)

Note: Only managers and superintendents are mentioned as they are the roles ultimately responsible for planning and implementation as well as feedback on the development of the MCP. More specifically, they are considered the key stakeholders. At their own discretion managers will draw on staff feedback.

4.2 STAKEHOLDER CONSULTATION STRATEGY

MGX clearly understands the value and importance of its social license to operate and places significant emphasis on external stakeholder relationships. The communities in which MGX operates are empowered to participate in decision making processes that may affect their community or organisation. Ongoing stakeholder engagement ensures mutual understanding with interested parties and assists the company's focus on continuous improvement.

To achieve this level of consultation a specific communication platform is tailored for each stakeholder group. For example, various senior managers are directly responsible for communication and consultation with certain stakeholder groups including customers, shareholders, employees and suppliers. The communication platforms involve regular open and participative consultation, particularly with landowners, traditional owner groups, regulators, local governments, interest groups and each community where MGX operates.

The KIO stakeholder strategy including stakeholders engaged, and format and frequency of engagement, is presented in Table 4-3.

Table 4-3: Stakeholder consultation strategy summary

Internal Or External	Stakeholder	How we engage	Key items of interest	Company approach	Frequency
Internal	Employees	Inductions Discussion with supervisors Toolbox meetings Intranet, website, and email Staff meetings Internal newsletter Employee survey	Training and development Cultural and environmental awareness Individual employment circumstances	Encourage open and ongoing dialogue with all employees to ensure that individual concerns are addressed.	Ongoing throughout each year and the life of the mine
Internal	General Manager Planning Superintendent Environmental Superintendent Tech Services Manager Mining Manager	Meetings on key items Reports and their distribution for review	Rehabilitation Geotechnical stability Financial provisioning Completion criteria	The input from internal stakeholders is considered in the development of the MCP	Annual Life of Mine Planning (when held) Quarterly planning meetings (QPP) Or on an as needed basis
Internal	MGX Board Chief Executive Officer Chief Operating Officer Chief Financial Officer	Review and revision of financial provisioning	Mine closure costing and adoption of provision rate	Adoption of provisioning rate. Reporting in Annual Report.	Annual or Tri-Annual closure provisioning review
External – Traditional Owners	Native Title Holders	Ongoing face to face liaison Formal review meetings Annual Report Annual Environmental Report	Protection of cultural heritage Cultural awareness Environmental management Opportunities for business, training and employment	KIO maintains regular dialogue with the Traditional Owners including formal review meetings throughout the year through the Deed of Agreement between parties.	Typically 4 co-existence meetings per year. Or on an as needed basis
External - DMAs	DoE DMIRS DWER	Annual Environmental Report Management Plans Briefings	Adherence to Ministerial statements and tenement conditions Environmental management plans	Environment and Community team manage this engagement.	Annually with reports and site inspections

		Individual meetings Annual site inspections	Approval of abandonment bund strategy MCP implementation		Tri-annually with review of MCP Or on an as needed basis
External	Shire of Derby and West Kimberley Kimberley Land Council Derby Community Australian Customs and Border Protection Services - Broome Shire of Broome Department of Fisheries – Broome Broome Visitor Centre Kimberley Quest	Presentations Site tours Annual consultation meeting Individual meetings Annual Environment Reports Annual Report Website	Environmental management that effects community (amenity; heritage) Infrastructure maintenance Community investment	Senior company and Site managers manage these relationships.	Annual presentations and reports Or on an as needed basis

4.3 STAKEHOLDER CONSULTATION SUMMARY

Internal consultation continues throughout the operations as per the consultation strategy (section 4.2), drawing on the expertise of the disciplines, with additional specialist external expertise being sought as necessary. It has also involved the review and refinement of the MCP during its development. This allows internal stakeholders to understand the Closure Plan and its potential implications. The internal consultation strategy is aimed at increasing knowledge on mine closure planning and it is expected that general awareness and knowledge will improve resulting in better outcomes for mine closure.

External consultation has involved meetings with relevant external stakeholders. Mine closure and rehabilitation has been on the agenda for many meetings including those prior to the commencement of current operations. A summary of meetings from the past couple of years is presented in Table 4-4.

Table 4-4: Summary of external stakeholder consultation

Date	Description of Consultation	Stakeholders	Stakeholder comments/issue	Proponent Response	Stakeholder Response
August 2012	Version 3 MCP submitted to DMP	DMP	Comments received from DMP in August 2014	The MCP (version 4) aimed to address DMP comments	DMP Reg ID 56401 MCP version 4 approval with comments
September 2015	Version 4 MCP submitted to DMP	DMP	Comments from DMIRS in April 2017 including:	This MCP version (version 5) aims to respond and progress the previous DMIRS comments.	Pending DMIRS review of version 5
Annually	DMP Annual Site Inspection. Presentation delivered Site inspections by DMIRS with KIO personnel on conditions and investigations undertaken into waste characterisation, rehabilitation methods and final landform designs. The DMP annual site inspection raised a number of items in relation to mine closure planning	DMIRS representatives	The preferred final landform design needs to meet the requirements of the likely post end land use. Provide justification that current obligations and requirements for fully vegetated landforms cannot be met and be safe, stable and non-polluting. Main items raised from site inspections, meetings and other discussions are in relation to the need for good planning and communication, progressive rehabilitation / revegetation and surface water management of WD4. Also, design for battered down slopes in final landforms, both landside and along the shoreline.	Continue trials and investigations into WRL designs. Provide further data and information in this revised MCP. Ongoing information and responses are also made in the Annual Environmental Reports.	Pending DMIRS review of version 5 Responses in relation to comments of Annual Environmental Report.
Sept 2014 Aug 2015	Commencement of process with Department of Lands to assist in tenure assignment and certain infrastructure to traditional owners. DAC made a crown lease application for land at the east end of Koolan Island including the Cultural Centre and access tracks to the mine camp.	Department of Lands	This is new ground, but there are processes in place to facilitate the requirements. It is good that DMP and KIO are considering this issue early in the life of the Project. Traditional owners will need to determine what infrastructure will remain and tenure requirements, and then work with the department of lands through regulatory requirements. KIO were and remain supportive of the DAC applications under Land Administration Act.	KIO remains supportive of DAC holding its own tenure for access in certain areas of the mining leases during operations and then more widely on Koolan during post closure.	Accepted and will work with tenement holders, Dambimangari and the DMIRS as required.

Date	Description of Consultation	Stakeholders	Stakeholder comments/issue	Proponent Response	Stakeholder Response
Quarterly meetings since 2018	Collaborative meetings with Traditional Owners (Dambimangari) as required by Co-Existence Deed. Post mining land use discussed. Also discussed status of MCP and rehabilitation trials and closure options which have been in progress and are working towards determining a final WRL design and rehabilitation process. In 2018, KIO had developed a position paper which it submitted to both DAC and DMIRS on the closure of the Seawall-Main Pit mining domain.	Dambimangari (Native Title Holders)	No key concerns raised. Post mining end land use of the Dambimangari utilising the Island as a base for their marine park (water) and landside tourism activities remains a key possibility. Other commercial and passive use activities raised and being considered. This will be addressed as per the co-existence deed in this phase of mining activity occurs. In June 2019, the options for Seawall-Main Pit closure described in the report were discussed at quarterly Coexistence Deed meeting in Derby. DAC were receptive to the suggested preferred option and appreciated the need for further investigation for determining the final trench conveyance design to transfer water and retain the seawall intact.	As of 2019, DAC members were supportive of the retention of seawall and reflooding of Main Pit at closure, in order that it returns natural values and water quality to the disused mining area and allows potential for some access into the lake that forms. Further meetings to discuss closure in greater detail and these will continue to be held quarterly through the life of KIO project, including attendance by General manager – Koolan Island operations and Chief Operating Officer MGX. KIO continues to refine its hydrodynamic model to optimise post closure tidal flushing and restrict vessel access.	KIO awaits formal input from DAC on its preferred post closure ventures. KIO will support DAC through the Deed to seek independent advice on the feasibility of business propositions post-mine closure.
2017-2019	Annual stakeholder consultation session held in Derby. Advertised to local population in Derby and open for all to attend. Presentation partly covered closure planning. Update provided on MCP status, intent to hand the Island back to Dambimangari and rehabilitation trials which have been in progress	Open Community Forum (all members of the community invited by personal mail)	Question raised as to whether passion vine was a problem for Koolan also.	Yes. MGX is looking to support further research being conducted by CSIRO and DBCA with the aim of developing a biological control for the weed.	Non-applicable
2017-2019	Annual Stakeholder Consultation sessions with individual groups in Broome. Each group was presented information as a general update regarding the site. Closure specific information was in relation to the status of the MCP, the intent to hand back the Island to the Dambimangari and the rehabilitation trials which have been in	Australian Customs and Border Protection Services - Broome Shire of Broome Kimberley Environ Horticulture Department of Fisheries – Broome Broome Visitor Centre Kimberley Quest	Department of Fisheries asked if Koolan Island would be handed back to the Traditional Owners.	Yes, the Island will be available for the Traditional Owners and they have the opportunity to request what infrastructure may be left for business opportunities. This will be resolved and negotiated as per the requirements of the co-existence deed.	Non-applicable

Date	Description of Consultation	Stakeholders	Stakeholder comments/issue	Proponent Response	Stakeholder Response
July / August 2015	DMP – Resources Safety Division – Abandonment bund locations and geotech stability management of Main Pit for post end land use (see Section 8.1.1 and Figure 8-4).	DMP (Jim Boucat and Jay Ranasooriya)	DMP has a guideline and any deviation must be demonstrated as better or equivalent. In such instances, technical expertise may be required. The technical experts on such matters will need to liaise with the DMP. The actual post end land use which will develop over time will influence the management of post closure pit safety. If the proposed management method is not infinite, the post land users will need to take responsibility. Utilise competent, fresh draining quartzite for abandonment bund construction, of there is plenty available in the form of quartzite. Present the concept in the MCP. Agreement on the methodology won't be reached at this stage, but will develop over time as the MCP develops. Remain in contact with the DMP safety division on these matters.	Conceptual abandonment bund locations presented in this MCP. Will continue liaising with Safety division on these matters.	Further input to be gained over the life of the Project.
2018/19	Dialogue with Department of Transport / Kimberley Ports Authority	Kim Davis (DoT, Manager Regional Facilities Marine & Harbours) Reece Waldock (Chair of KPA)	Retain barge ramp/landing/ laydown (after requisite remediation as required). Consider the potential of any future bulk material outloading; otherwise remove the shiploader and potentially the jetty/wharves in the absence of future bulk products; possibly retain the abutment/jetty/small craft berth area on the barge ramp reclaim given there may be future regional use (DBCA; DAC; tourism etc). Interest for KPA representatives to visit the Island in 2019 to discuss future use post closure, after KPA appoints its new CEO.	KIO will liaise with DOT/KPA in relation to its regional interests in retention of the industrial assets (jetty/shiploader). It is understood that KPA will ascend responsibility and rights from 2020 more completely for DoT. KIO in Q1 2020 will lodge an options assessment examining the viability of retention of jetty/wharves and shiploader atop the jetty. Submit to DOT, KPA, DAC and DMIRS for comments.	KPA plans to attend site in latter 2019, after appointment of its new CEO.

5 POST-MINING LAND USE(S) AND CLOSURE OBJECTIVES

5.1 PRE-PROJECT LAND USES

5.1.1 ABORIGINAL HERITAGE

The Dambimangari people are the traditional owners of Koolan Island and key matters are collaboratively managed through the Wanjina – Wungurr (Native Title) Aboriginal Corporation – Registered Native Title Bodies Corporate. Heritage sites on Koolan Island exist that are of significance to the Dambimangari people (Section 5.1.1).

5.1.2 HISTORICAL MINING

Large scale mining was undertaken by BHP between 1965 and 1993. Decommissioning of the mine in 1993 included removal (and some in-situ burial) of infrastructure, rehabilitation of cleared areas of terrestrial land by moonscaping, and the construction of a channel to allow sea water to inundate the Main Pit (Ecologia, 2005a).

During former occupation of the Island, BHP held a variety of tenure including crown land and mining leases. At the end of BHP's occupation, all forms of tenure held were relinquished and the land was released to Unallocated Crown Land.

5.1.3 UNALLOCATED CROWN LAND

The predominant land use from 1993 until 2005 when KIO acquired the mining leases (L04/29, M04/416, and M04/417) was rehabilitated land from previous mining. The primary intent of KIO is to return the land to a similar state to that when KIO acquired the mining leases it currently holds.

5.2 POST-MINING LAND USES(S)

Closure is scheduled to occur post-2023. KOI has identified two potential post-mining land use scenarios in consultation with key external stakeholders (DAC and DoT) in full:

- Option 1: Rehabilitation of all improvements developed by KIO with the exception of the barge ramp (ownership of which would be transferred to DoT) and a central unsealed access track; or
- Option 2: Rehabilitation of all improvements developed by KIO with the exception of selected infrastructure, ownership of which would be transferred to DAC, and ownership of the barge ramp to DoT.

Option 2 is the most likely closure scenario, and the scenario towards which KOI is planning and working, including during Version 4 MCP. The DAC has expressed interest in retention of certain infrastructure including the cultural centre (for which they currently seek their own tenure), and built elements such as the airstrip and camp mess and accommodation units. The DoT and KPA may continue to consider the coastal infrastructure to facilitate post-project maritime access to Koolan Island – by 2023/24, this infrastructure would, upon agreement, be transferred to KPA under the *Land Administration Act 1997*. The reclaim land adjacent the barge landing would likely be recognised as territorial baseline. Main Pit would be flooded by constructing a channel/s in shoreline rock adjacent the sea wall, constructed such that access by vessels is constrained. The remainder of the pits, WRLs and improvements developed by KIO would be rehabilitated and revegetated at closure. These would generally be on UCL after tenement relinquishment, unless on leases assigned to DAC (or other entitled entities).

Preston Consulting was engaged to calculate the costs of closure Option 2 in 2019. KIO has sufficient liquidity to carry out the works required for this option to meet the stated closure objectives (section 5.3), in accordance with the completion criteria (Chapter 6).

In addition to assessing closure Option 2 above, ongoing consultation between KIO and DAC has identified post-mining beneficial uses for certain Project infrastructure. Option 2 would see assets transferred to DAC for productive utilisation in the future. Specifically, Koolan Island's environmental values represent potential opportunities to engage in future tourism, aquaculture, heritage / environmental and other economic enterprises. The Dambimangari have proposed that certain parts of the Island could be used as a base to support future activities and have formally communicated to KOI their interest in potentially acquiring the:

- Cultural heritage and training centre; and
- Cyclone moorings (buoys).

In the event that these assets are transferred to the Dambimangari, KOI would close and rehabilitate the remainder of the Project (with likely exception of the barge ramp, as discussed above) to meet the stated closure objectives (section 5.3), in accordance with the closure criteria (Chapter 6).

KIO has identified Project infrastructure which may have beneficial uses post-mining for other entities wishing to occupy the Island for economic or other reasons:

- Part or all of the village;
- Airstrip (one existing as of 2019);
- Barge landing;
- Wharf (with ship loader removed or retained);
- Main Pit flooded with sea water, with channel(s) hydraulically connecting the lake with the adjacent sea; and
- Roads and tracks (with roads being reduced to light vehicle access), allowing access across the Island and fire control.

For the Traditional Owners (or other third parties) to secure appropriate tenure and occupation over the parts of the Island containing infrastructure of beneficial use, parties will need to consult primarily with Department of Planning, Lands and Heritage, DMIRS and the mining tenement holders (KIO). The Traditional Owners will also need to identify the type of tenure for which they wish to apply and this should be based on the type of infrastructure to remain such as that identified above.

DMIRS will need to provide *Mining Act 1978* section 16(3) approval for any proposed action over Crown land to proceed while tenements exist. The *Land Administration Act 1997* requires land assembly to be completed (inclusive of application to Department of Planning, Lands and Heritage and referrals to other agencies for their comments) for any proposed action over Crown land before it can proceed.

The process for the handover of rights to occupy unallocated crown land from a tenement holder to another entity and / or Native Title holders is relatively new and KIO will work with DAC (or any other entity) and agencies so that the process is executed and the desired outcomes achieved.

5.2.1 Assessment of Post-Mining Land Use

Section 4.8 of the DMP & EPA (2015) MCP Guidelines identifies that the post-mining land use must be:

- Relevant to the environment in which the mine will operate;
- Achievable in the context of post-mining capability;
- Acceptable to the key stakeholders; and
- Ecologically sustainable in the context of the local or regional environment.

KIO's proposed post-mining land use is assessed against these criteria below.

Relevant

The pre-mining land use was formerly mined and rehabilitated land on UCL. The Island is characterised by steep terrain and skeletal soils that would not be generally suitable for development for improvement to agricultural land or broad scale pastoral use. The land is therefore considered likely to remain as UCL unless select assets are transferred to Dambimangari Aboriginal Corporation and DoT (which would require revision of the tenure underlying those assets), and/or other tenured entities. Hence, UCL is a viable post-mining land use that is relevant to the location.

Achievable

Without a defined purpose for the land, achievability would be deemed to relate to whether there is a demonstrated ability to return the land to a condition consistent with the surrounding areas - such that additional management is not required post-mining. The revegetation strategy developed by KIO indicates that rehabilitation of landforms and native revegetation is achievable in the medium term.

Acceptable

Acceptability to key stakeholders is identified in the DMIRS objective for mine closure. It may be able to be judged via the outcomes of consultation completed by the Proponent and EPA (with relevant DMAs and via public review). The acceptability in the definition provided by DMIRS appears to relate to the acceptability of the post-mining land use, rather than acceptability of the environmental risks and potential outcomes. UCL as a post-mining land use is acceptable at many other mine sites, and by extension, is considered to be acceptable for KI.

Acceptability of mine closure, however, is less likely to be based on post-mining land use, and more likely to be based on key stakeholder assessment of the mine closure risks and potential outcomes. This MCP summarises the main interests or concerns of key stakeholders in relation to mine closure. Ultimately, DMIRS (as the key regulator of environmental management under the Mining Act 1978) will determine the acceptability of mine closure risks and outcomes through assessment of this MCP.

Ecologically Sustainable

As a land use, unimproved UCL is in the true sense ecologically sustainable. It has been successfully applied to thousands of hectares of WA, with sustainability questions almost entirely related to the undue of feral animals and weeds. To be sustainable in the context of the Koolan Island environment, post-mine rehabilitation would need to enable a return to natural water, energy and nutrient cycles. These natural systems are low in nutrients and highly dependent on the ability to retain water and nutrients locally to sustain levels of vegetative productivity – KIO's rehabilitation strategy aims to emulate these characteristics, and trends in past rehabilitation and revegetation have shown this.

5.3 CLOSURE OBJECTIVES

KIO has adopted general closure objectives developed from those stated by DMIRS and EPA in the DMP & EPA (2015) mine closure guidelines. KIO's principle closure objectives are that the rehabilitated mine is:

- Physically safe to humans and animals:
    - Bunds and / or other physical barriers restrict access to hazards including open pits;
    - Provision for egress points from remaining excavations; and
    - Rehabilitated areas are not hazardous for future site users.
- Geotechnically stable:
    - Landform batter surfaces will be stabilised with a competent coarse waste rock matrix to limit erosion and encourage vertical infiltration of rainfall; and
    - Landform slopes will be battered down where doing so will not clear habitat on unapproved adjacent land.
- Geochemically non-polluting / non-contaminating:
    - Non-benign waste materials covered.
- Capable of sustaining an agreed post-mining land use:
    - Sites contaminated by KIO will be assessed and remediated such that they are suitable for post-mining land use;
    - Infrastructure and assets removed and rehabilitated as agreed with stakeholders; and
    - Infrastructure and assets transferred to stakeholders for productive / beneficial use or returned to Crown Land.
- Premises are decommissioned and rehabilitated in an ecologically sustainable manner:
    - Surface and groundwater levels and quality are not affected;
    - Reconstructed ground surface to support self-sustaining revegetated communities comprised of local provenance species;
    - Revegetation is functionally analogous to natural vegetation;
    - Rehabilitated landforms similar in elevations and / or slope fields to the surrounding natural landscape; and
    - Hard coral rehabilitated areas recovering post-closure.

6 DEVELOPMENT OF COMPLETION CRITERIA

KIO has developed S.M.A.R.T completion criteria (Australian and New Zealand Mineral And Energy Council & Mineral Council of Australia, 2000) derived from the Project closure objectives (section 5.3). Completion criteria have been considered and developed for each closure domain – Table 6-1 to Table 6-3 list the criteria by closure domain. Project completion criteria were developed in consultation with key internal and external stakeholders (section 4.1) where appropriate. Completion criteria are presented by Project closure domain as follows:

- Open pits - Table 6-1;
- Waste Rock Landforms (including backfilled pits) - * Should an undersupply of waste rock result in a remnant void (e.g. East or Barra pits), then the relevant criteria should apply at those locations.
- Table **6-2**; and
- Infrastructure - Table 6-3.

As detailed in section 3, mining operations at Koolan Island are regulated by a variety of obligations and commitments required by a range of approvals. **Table 6-4** identifies closure objectives and completion criteria which are relevant to the various obligations and commitments not covered by the Domain Specific Completion Criteria (Section 1).

Table 6-1: Open Pits rehabilitation objectives, completion criteria, monitoring and compliance procedures (i.e. mine pits retained as voids)

Objective	Completion Criteria	Monitoring tools	Compliance register
Bunds and / or other physical barriers restrict access to hazards including open pits*	Inadvertent vehicle access controlled through abandonment bunds Bunds constructed outside the zone of instability Vessel access to Main Pit constrained by tidal trench Vessel access to Main Pit foot wall restricted by buoys and / or dolphins Signage communicating restricted zone installed	Geotechnical assessment to identify open pit zones of instability Post-closure geotechnical assessment of constructed bunds Closure audit to include restricted zone barrier and signage	DMIRS approval of bund strategy Bunds assessed as geotechnically stable by a suitably qualified engineer Closure audit report
Provision for egress points from remaining excavations	Egress points have been constructed	Closure audit to include egress points	Closure audit report
Surface and groundwater levels and quality are not affected	Groundwater chemical parameters within 10 % of 2006 values Groundwater table trending towards 2006 levels for two consecutive post-abstraction monitoring events Marine water quality meets Marine Management Plan (**MMP**) criteria	Groundwater monitoring (bore water level / quality) Marine water monitoring	L8148/2006/4 – Compliance Assessment report
Hard coral in rehabilitation areas recovering post-closure	Coral diversity within the proposed rehabilitation locations at least 50% of adjacent undisturbed coral communities at nearby unaffected monitoring sites in Arbitration Cove At least 0.2 hectares of coral habitat rehabilitated Within the proposed rehabilitation location(s), a minimum of one-fifth of the mean coral cover of nearby unaffected monitoring sub-sites in Arbitration Cove Coral habitats at the proposed rehabilitation trial locations demonstrate a clear increasing trend of diversity and cover over the course of at least five years, assuming no corresponding decreases in coral condition parameters at relevant reference sites Hard corals observed colonising photic zone within flooded Main Pit (post-closure)	Triennial marine surveys	Triennial reporting on marine monitoring within AER

* Should an undersupply of waste rock result in a remnant void (e.g. East or Barra pits), then the relevant criteria should apply at those locations.

Table 6-2: Waste rock landforms (including backfilled mine pits) rehabilitation objectives, completion criteria, monitoring and compliance procedures

Objective	Completion Criteria	Monitoring tools	Compliance register
Landform batter surfaces will be stabilised with a competent coarse waste rock matrix to limit erosion and encourage vertical infiltration of rainfall	Batter slopes covered with ≥ 500 mm of quartzite waste rock Rills ≤ 0.3 m deep and gullies > 0.3 m deep per 200 m and mean cross-sectional area of rills/gullies trending towards stabilisation post-rehabilitation	Post-construction geotechnical assessment of batter materials profile Annual LFA / EFA survey	WRL construction assessed by suitably qualified geotechnical engineer Annual reporting on LFA / EFA monitoring within AER
Landform slopes will be battered down where doing so will not clear unapproved adjacent native vegetation	Completed batter slopes ≤ 20° unless otherwise designed and approved by DMIRS in subsequent MP No unapproved clearing of land adjacent to constructed landforms	Post-construction survey of batter slopes and comparison of footprint with approved disturbance area shapefile and approved design	WRL survey report Native Vegetation Clearing Permits NVCP and other approvals (e.g. section 45Cs)
Non-benign waste materials covered	Non-benign waste material covered by ≥ 1 m of benign waste material and ≥ 500 mm surficial matrix (i.e. siltstone or quartzite)	Location/s non-benign waste is placed to be recorded	WRL construction records
Surface and groundwater levels and quality are not affected	Groundwater chemical parameters within 10 % of 2006 values Marine water quality meets MMP criteria	Groundwater monitoring (bore water quality) Marine water monitoring	L8148/2006/4 – Compliance Assessment report
Reconstructed ground surface to support self-sustaining revegetated communities comprised of local provenance species	Landscape Organisation Index within 25 % of analogue site post-rehabilitation Stability Index within 25 % of analogue site post-rehabilitation	Annual LFA / EFA survey	Annual reporting on LFA / EFA monitoring within AER

Objective	Completion Criteria	Monitoring tools	Compliance register
Revegetation is functionally analogous to natural vegetation	Number of plants per hectare and Canopy Volume (m^3) per hectare within 25 % of analogue site post-rehabilitation	Annual LFA / EFA survey	Annual reporting on LFA / EFA monitoring within AER
Rehabilitated landforms similar to the surrounding natural landscape.	Rehabilitated areas vegetation to include at least two Target Species of flora WRLs to incorporate quoll dens (overhangs)	Annual LFA / EFA survey	Annual reporting on LFA / EFA monitoring within AER

Table 6-3: Infrastructure rehabilitation objectives, completion criteria, monitoring and compliance procedures.

Objective	Completion Criteria	Monitoring tools	Compliance register
Rehabilitated areas are not hazardous for future site users	Excavations (other than Table 6-1) backfilled. Above ground plant, equipment, chemicals and consumables removed from ore stockpile area (**OSA**), processing plant, logistical support areas, and general infrastructure areas. Fragmented concrete pads to be covered with a minimum 1,000 mm growth media.	Closure audit to include infrastructure areas	Closure audit report
Non-benign waste materials covered	Approved waste disposed to mine site landfill. Other wastes disposed offsite to licensed waste disposal facilities Non-benign waste material covered by ≥ 1 m of benign waste material and ≥ 500 mm surficial matrix (i.e. siltstone or quartzite)	Preliminary site investigation at closure	Preliminary site investigation report Waste disposal certificates
Sites contaminated by KIO will be assessed and remediated such that they are suitable for post-mining land use	Soil quality at infrastructure areas suitable for post-closure site use in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure*	Site contamination assessment at closure	Site contamination assessment report
Infrastructure and assets removed and rehabilitated as agreed with stakeholders	Agreement reached on infrastructure condition as per the requirements of consultation Infrastructure and assets not subject to stakeholder agreements removed and rehabilitated in accordance with Mine Closure Plan	Closure audit	Stakeholder agreements Closure audit report Mine Closure Plan
Infrastructure and assets transferred to stakeholders for productive / beneficial use or returned to Crown Land	Agreement reached on infrastructure condition as per the requirements of consultation Infrastructure and assets not subject to stakeholder agreements removed and rehabilitated in accordance with Mine Closure Plan	Closure audit	Stakeholder agreements Closure audit report Mine Closure Plan
Surface and groundwater levels and quality are not affected	Groundwater chemical parameters within 10 % of 2006 values Marine water quality meets MMP criteria	Groundwater monitoring (bore water quality) Marine water monitoring	L8148/2006/4 – Compliance Assessment report
Reconstructed soil profiles to support self-sustaining revegetated communities comprised of local provenance species	Landscape Organisation Index within 25 % of analogue site post-rehabilitation Stability Index within 25 % of analogue site post-rehabilitation	Annual LFA / EFA survey	Annual reporting on LFA / EFA monitoring within AER
Revegetation is functionally analogous to natural vegetation	Number of plants per hectare and Canopy Volume (m^3) per hectare within 25 % of analogue site post-rehabilitation	Annual LFA / EFA survey	Annual reporting on LFA / EFA monitoring within AER
Rehabilitated landforms similar to the surrounding natural landscape	Rehabilitated areas vegetation to include at least two Target Species of flora Decommissioning cut (**DC**)constructed and 'Arbitration Lake' supports productive photic zone benthic and pelagic organisms within flooded Main Pit	Annual LFA / EFA survey Triennial marine monitoring	Annual reporting on LFA / EFA and marine monitoring within AER
Retained infrastructure	No infrastructure left on site unless agreed to by post closure recipient(s) and tenured lease holder(s) in view of key stakeholders.	Records identify agreements executed with recipient(s) and lease holder(s) regarding remaining infrastructure Evidence provided to key stakeholders and regulators of progress towards and execution of agreements	Stakeholder agreements

Table 6-4: Objective, completion criteria, monitoring and compliance procedures for Koolan Island closure specific compliance requirements

Objective	Completion Criteria	Monitoring tools	Compliance register
1. Maintenance of groundwater quantity and quality. MS 8-1: Maintain the quality and quantity of water so that existing and potential environmental values including ecosystem maintenance are protected MP5194 Commitment 11: Maintain the quantity of groundwater so that existing and potential uses including ecosystem maintenance are protected MP5194 Commitment 15: Maintain or improve the quality of groundwater to ensure that existing and potential uses including ecosystem maintenance are protected, consistent with Australian and New Zealand Water Quality Guidelines (ANZECC, 2000).	1.1.1. Compliance with water management plan	1.2.1. Implement Water Management Plan	1.3.1. Annual reports and audits required by MS715 and Water Management Plan 1.3.2. Monitoring database maintained as a result of implementing the Water Management Plan
2. Maintenance of flora and fauna abundance and species diversity MS 9-2: Maintain the abundance, diversity, geographic distribution, conservation status and productivity of flora and fauna species ecosystem levels through the avoidance or management of adverse impacts and improvements in knowledge. MP5194 Commitment 1: Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities MP5194 Commitment 7: Maintain the general abundance and diversity of species and maintain the general abundance, species diversity and geographic distribution of terrestrial fauna	2.1.1. Compliance with Significant Flora Management Plan 2.1.2. Compliance with Significant Fauna Management Plan 2.1.3. Compliance with Northern Quoll Management Plan 2.1.4. Compliance with Quarantine Management Plan	2.2.1. Implement Significant Species Management Plans, Northern Quoll Management Plan and Quarantine Management Plan	2.3.1 Annual reporting and auditing required by management plans 2.3.2. Monitoring databases and information maintained as a result of implementing the management plans
3. Maintenance of subterranean fauna MS 10-1: Maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna at species and ecosystem levels through the avoidance or management of adverse impacts and through improvements in knowledge MP5194 Commitment 8: Maintain the abundance, species diversity, geographic distribution of subterranean fauna	3.1.1. Compliance with Subterranean Fauna Management Plan	3.2.1. Implement Subterranean Fauna Management Plan	3.3.1. Annual reporting required by Subterranean Fauna Management Plan 3.3.2. Monitoring databases and information maintained as a result of implementing the Subterranean Fauna Management Plan
4. Maintenance of Quarantine requirements MS 11-1: Manage the environmental impacts concerning introduced flora and fauna species that arise from the implementation of the proposal to: • Prevent the spread of existing introduced flora and fauna within Koolan Island and between Koolan Island and the mainland • Prevent the further establishment of introduced flora and fauna species on Koolan Island as a result of the implementation of the proposal; and • Control or eradicate introduced flora and fauna species on Koolan Island	4.1.1 Compliance with Quarantine Management Plan	4.2.1. Implement Quarantine Management Plan	4.3.1. Reporting and auditing required by Quarantine Management Plan 4.3.2. Monitoring databases and information maintained as a result of implementing the management plans

Objective	Completion Criteria	Monitoring tools	Compliance register
5. Maintenance of Marine Water Quality and Marine Fauna MP5194 Commitment 9: Maintain the abundance, species diversity, geographic distribution of marine fauna MS 7-1: Prior to the commencement of activities which may affect the marine environment, the proponent shall prepare a marine management plan. The objectives of this plan are to manage the impacts to the marine environment that arise from the implementation of the proposal to: • maintain the ecological integrity and biodiversity of the marine environment • avoid impacts that arise from the implementation of the proposal on the coral pool community at the mangrove inlet; and • manage project activities to ensure that impacts on marine habitats, communities and biota outside the project footprint are avoided.	5.1.1. Compliance with Marine Management Plan	5.2.1. Implement Marine Management Plan	5.3.1. Reporting required by Marine Management Plan 5.3.2. Monitoring databases and information maintained as a result of implementing the Marine Management Plan

7 COLLECTION AND ANALYSIS OF CLOSURE DATA

This section collates data from baseline environmental studies for the purposes of identifying their limitations and principal management implications for closure.

7.1 CLIMATE

7.1.1 SUMMARY

The Buccaneer Archipelago experiences a tropical, sub-humid climate. The Bureau of Meteorology (**BoM**) climate stations nearest the Project are Cygnet Bay (BOM station #3057, ≈100 km southwest of Koolan Island) and Kimbolton (BoM station #3073, ≈64 km southeast of Koolan Island). These stations have mean annual rainfalls of 804.1 mm and 1,091.6 mm, respectively (BOoM, 2019a), highlighting significant spatial variation in rainfall in the region. Rainfall intensity-frequency-duration data emphasise the temporal variability of rainfall (BoM, 2019b). For example, in an average year, at least one 24-hr storm of >100 mm of rainfall may be expected. A 72 hr 1:100 ARI storm event would be expected to deliver 640 mm.

Rainfall is seasonal, with the 'wet season' extending from December to April, and with little to no rainfall occurring between May and November. The average maximum temperature varies by less than 8°C through the year (28.2-35.3°C), with the hottest months being November and December. Solar exposure also does not vary considerably (18.3-27.2 MJ/m^2), with the maximum and minimum values occurring at the same time of year as the maximum and minimum temperatures. As such, evaporation is also relatively constant throughout the year.

7.1.2 CONSIDERATIONS FOR MINE CLOSURE PLANNING

The large seasonal variability in rainfall at Koolan Island requires consideration when designing final landforms. Large storm events of >100 mm/24 hrs are relatively common and post-mine landform designs and surface disturbance must take this into consideration.

7.2 GEOTECHNICAL

7.2.1 SUMMARY

Geotechnical investigation and stability of mine openings is a critical aspect of any operation, and is ongoing for the life of any pit. Significant work has been done on the geotechnical aspects of mined pits, during BHP's operations, prior to commencement of mining by Aztec in 2006 and by KIO during current operations.

Main Pit is of the most importance due to its vertical and lateral extent, existing final wall profiles (planned to be extended in the course of mining operations), and proximity to the ocean.

7.2.2 ONGOING WORK DURING OPERATIONS

During the course of mining operations at Koolan Island ongoing geotechnical investigation, including mapping, monitoring, drilling, and modelling has been undertaken.

Mapping of structures has been undertaken on both the footwall and hanging wall of Main Pit, and more locally on the Mullet-Acacia footwall. Both large-scale (faults) and smaller-scale (joints) have been mapped, and the areas where these features control stable slope geometry identified.

Monitoring has been undertaken by a combination of manual and instrumented means. Manual monitoring has comprised regular, weekly inspections of pit faces, including photographing critical areas. The results of which are communicated weekly to management through a formal memorandum-style report. Instrumented monitoring consists of automated prism monitoring, using the Softrock Autoslope/Quikslope system, and a slope stability radar (MSR), to track slope movements. A limited number of piezometers have also been installed behind the footwall of Main Pit, and locally on the Main Pit hanging wall to monitor water levels. Instrumented monitoring has concentrated on Main Pit as the main producing component of the operations. The results of this monitoring provide crucial information as to the behaviour of the pit slopes in the long-term, and can be used to predict the most likely modes of failure (if any) that may be anticipated post-closure.

Geotechnical drilling (and associated testing) programs have been conducted on a campaign basis throughout the entire period of operations at Koolan Island. Geotechnical holes have been drilled in or near all of the pits, but with the majority concentrated on Main Pit, and in particular, the Main Pit footwall (highwall), which is regarded as the most critical area from a geotechnical perspective in the period between now and forecast completion in 2023/24. The results of the geotechnical drilling programs since the 1990s are maintained in an electronic database.

The last geotechnical drilling prior to submission of MCP version 4 concentrated on the footwall of Main Pit, with some holes into the hanging wall, during 2012-2013. Significant geotechnical investigations were then undertaken by Coffey (2016) to inform reconstruction of the Main Pit seawall. Coffey (2016) drilled through remnant seawall embankment rock fill and seafloor coral reef to test underlying low strength materials, and sampled seawall embankment and embankment foundation materials for laboratory testing. Monitoring instrumentation was also installed. The information collated from Coffey's (2016) study informed a detailed 3D model of the various geological layers present in and around the seawall area. The study further sought to establish and agree the definitive location and parameters of materials that would be used within numerical analysis of the new seawall design. Golder peer reviewed the study, confirming it was "reasonable and sufficient for the preliminary design of the seawall".

Embankment slope stability analysis modelling using PLAXIS finite element software was then undertaken to understand how the planned embankment slopes performed during various construction stages of the project including dewatering of Main Pit. A revised design concept was then developed, comprising:

- Construction of an armour rock embankment, modifying the nature and properties of the proposed material used on construction to an Engineered Rock Fill;
- Installation of a full depth seepage barrier within the rock embankment; and
- Construction of supporting buttresses on the pit side to be formed during dewatering operations.

Geotechnical modelling of the pit slopes (both actual and designed) has been carried out on an on-going basis. Back analysis modelling, based on slope performance, is used to calibrate the model parameters (which are derived in the first instance from logging and testing of samples from the geotechnical boreholes). These can then be used for 'forward modelling', to predict the behaviour of future design slopes.

The above processes are carried out with a view to maintain a safe working environment for personnel during operations. The results of these studies are integrated into the mine plan, with remedial works undertaken as necessary. These remedial works include and may not be limited to:

- Depressurisation via horizontal drain holes to reduce water pressure behind the Pit walls;
- Cable bolts installed for shallow and deeper support of batter faces; and
- Spraying of shotcrete to reinforce foot wall slopes.

7.2.3 Considerations for Mine Closure Planning

As with the closure of any open pit, the guidelines covering abandonment requirements will be followed. This includes the provision of appropriately located abandonment bunds, which are situated to prevent inadvertent access to potentially unstable areas, such as pit crests.

Although the Main Pit was previously inundated at the closure of operations in 1993 and remained relatively stable during this period, the overall stability of the saturated Main Pit footwall has still to be demonstrated. Though the Main Pit footwall was constructed and continues to be operated in accordance with the DMP (1999) Guidelines, the re-introduction of seawater may be expected to slowly corrode and degrade the existing geotechnical control systems and rock reinforcements (i.e. anchoring, mesh and shotcrete).

Observations of the footwall behaviour since the previous flooding suggest that continuing erosion of gullies on the main footwall face and erosion of friable layers behind the facing layer of quartzite on the face of the footwall may also continue due to a combination of rainfall run-off and groundwater percolation. As a result of the degradation of the ground support, and erosion of weaker materials in and behind the face, it is assessed likely that small-scale failures of the footwall, and progressive erosion of gullies on the footwall will continue post-abandonment. It should be noted however, that the failures are anticipated to be ‘thin-skinned’ rather than circular in nature, as are those which have occurred to date. The bedded structure of the footwall (where the bedding planes, which constitute the vast majority of observed failure planes, are parallel to the footwall face), ensures that this is the case. The existence of a wide berm (c. 16 m) at 38 m Relative Level over most of the length of the footwall should mitigate against these failures propagating the full height of the footwall.

Further geotechnical stability analysis is required to confirm the overall stability of the Main Pit foot wall. As noted above, based on performance to date, it is anticipated that any post-closure failures would be small-scale, ‘thin-skinned’ slips, rather than major circular failures, but this needs to be more formally assessed by geotechnical slope stability modelling. Inundation of the pit from 2015 to 2018 is likely to have increased stability of the overall wall due to the buttressing effect of the weight of water in the pit; this can also be demonstrated by slope stability modelling. It is considered very unlikely that tidal fluctuations have any effect on the stability of the footwall, as no such effects were noted after the pit had been dewatered in 2007 and 2018.

The other pits on Koolan Island do not extend to the depth of Main Pit; additionally their pit walls are constructed with a batter-berm configuration typical of open pit mines. They are also excavated in areas where the structural geology is more complex; thus large-scale thin-skinned failures are less likely to occur than in Main Pit. Observed failure in these pits consists of small-scale ‘fretting’ and ‘sloughing’, with occasional berm-scale failures. Notwithstanding this, a geotechnical assessment of long-term slope stability will also need to be made for retained open pits, taking weathering and erosion into account. This will enable an appropriate alignment for abandonment bunds to be determined.

Detailed closure studies should comprise a combination of physical and photogrammetric analysis of the rock in existing outer WRL slopes, to categorise the rock size distribution around the perimeter of these landforms. The required ultimate slope angles should be based on this rock size distribution, with the slope angle generally being proportional to the average rock size.

7.3 GEOMORPHOLOGY

7.3.1 SUMMARY

Koolan Island has an area of 2,580 ha. Its Proterozoic sandstone lithology is expressed as rugged slopes, ridges and uplands mantled with rock scree and shallow skeletal soils (Plate 7-1). The coast is steep with narrow gullies and frequent embayments, but few beaches. There are no known permanent creeks or pools (GHD, 2010). Natural slope angles can be in excess of 40° with frequent outcropping of the bedrock geological units occurring over the entire Island.

Approximately 45% of the 670 ha approved for disturbance by MS 715 was formerly disturbed and rehabilitated by BHP at closure and decommissioning in 1993. A prominent feature of this rehabilitation was moonscaping along with a seed mix containing several exotic species (Section 7.8.3). Due to the presence of exotic species, topsoil which otherwise might have been salvaged from certain BHP rehabilitation areas has been deemed low grade and segregated from topsoil salvaged within undisturbed areas. Often, BHP rehabilitation areas didn’t contain topsoil. However due to the time since rehabilitation, a cover material had developed from the accumulation of leaf litter. Also, the majority of surface material which could be recovered was very rocky (Pers comms – Simon Sandover – former Koolan Island Environment and Community Manager).

7.3.2 CONSIDERATIONS FOR MINE CLOSURE PLANNING

The rugged topography of the Island coupled with tropical rainfall events prohibits the formation of deep soil profiles. The prevalence of steep slopes (Plate 7-1) over much of the Island and the extensive rock outcrop makes stripping of the fine skeletal topsoil challenging from an operational and safety viewpoint. Koolan Island was already a highly disturbed environment due to former mining and human occupation. Presently, these factors have acted to severely limit the available stockpiled topsoil / growth medium resource available for land rehabilitation. Additionally, the rugged topography may impose additional controls on the practicable alignments of abandonment bunds.

Plate 7-1: Steep gully feature typical of Koolan Island topography

7.4 GEOCHEMISTRY

7.4.1 SUMMARY

Exploration and infill drilling of the Koolan Island iron ore deposits has been carried out for the last 60 years generating large databases of drilling information. This data enables desktop risk analysis of potential problems such as potential for sulfidic material to be disturbed during mining or by previous mining and the development of AMD from sulfidic materials to be assessed with a large degree of confidence. Geochemical risk assessment has included:

- pH, pH_{FOX} and EC in material from 7 investigation drillholes - PKRC 1544, PKRC 1538 and PKRC 1543 (all Acacia East); PKRC 1534 (Arbitration Cove), K36 (Blinker Hill); PKRC 1529 (Elgee) and K36 (Jap Bay);
- Geochemical Abundance Index (GAI) and total sulfur in historical assay data (pre – 2007 drilling) for approximately 1800 drill holes taken from across the site; and
- Sulfur concentrations in the current Main Pit block model.

Based on the above analyses, further detailed in sections 7.4.2 to 7.4.4, material AMD risk has been assessed as negligible.

7.4.2 pH/pH$_{FOX}$ and EC

The results from 1,800 drill hole assays analysed showed that the pH of the materials at all depths ranges between 5.0 and 8.0, with the exception of PKRC 1543 which recorded a pH value of 8.25 at a depth of 55m (Yampi Schist).

In general the values measured for pH are higher than for pH$_{FOX}$ for all drill holes across all depths. The exceptions to this are for PKRC 1538 (below -50 m; Elgee Siltstone). Only one sample tested returned a result where the pH$_{FOX}$ was found to be significantly lower than natural pH; PKRC 1534 at -115 m the pH$_{FOX}$ and pH values were 2.76 and 6.28 respectively. The significant difference between the two values (change of >1 pH unit) and the pH$_{FOX}$ value of <3, indicates the possible presence of sulphides in the material.

Results for the EC data in contrast, show a high variability both between drill holes and with depth. There was a wide range of EC values recorded across the site with overall EC ranging from 0.933 mS/m (Elgee Siltstone) and 986 mS/m (Elgee Siltstone). The greatest variability in EC values was recorded for borehole PKRC 1529 which was logged entirely as Elgee Siltstone, with minimum and maximum EC of 10.67 and 986 mS/m respectively. The lowest variability was found in borehole PKRC 1544 with minimum and maximum EC values of 0.933 and 4.08 mS/m measured.

7.4.3 Geochemical Assay

The results of the desktop analysis across 1800 drill hole assays show that there is great variability across the site in terms of geochemical parameters. P for example, ranges from 0.005 mg/kg to 160,000 mg/kg. The mean values for As, Ni, Mn and V exceed the associated EIL. A further comparison of these values against the Average Crustal Abundance (ACA) yields a Geochemical Abundance Index (GAI) which provides a measure of how enriched material is with a given element compared with normal background levels through the equation shown below, where C = element content.

Equation 7.1: Geochemical Abundance Index

$$GAI = \log_2\left(\frac{C}{1.5 * ACA}\right)$$

A GAI of 0 indicates that the content of the element is less than, or similar to, the ACA. A GAI of 3 corresponds to a 12-fold enrichment above the ACA whilst a GAI of 6 indicates a 96-fold or greater enrichment above the average crustal abundance. In general, a GAI > 3 indicates a significant level of enrichment. Using this method of comparison shows that the mean value for Ni, Mn and V are all below a GAI of 3 (being 1, 0 and 0 respectively). The mean value of As is equivalent to a GAI of 4, indicating that this element is considered to be significantly enriched with regard to background levels. Arsenic is a Chalcophile element with a low affinity for oxygen which is generally bonded with Sulfur(s) or similar chalcogens and therefore it is likely that it is present in these materials as an isomorphic substitute for Fe within the mineral structure due to their similar ionic radii (Sposito, 1984) and therefore will be immobile (i.e. non soluble).

The results from the desktop analysis show that although high maximum sulfur values from samples do occur (i.e. 3.4 % Total S in Sandstone, 1.92 % Total S in Schist), the average values for Total S are uniformly well below the accepted 0.3 % Total S criteria adopted by AMIRA (2002). Additionally the standard deviation for the Total S contents of each lithology show that the distribution of Total S values within each lithology is limited, with the majority of values falling close to the calculated mean. This indicates that large volumes of materials containing high Total S are not likely within the Koolan Island deposits, with only isolated high Total S values in non-mined geologies.

7.4.4 Main Pit Block Model Sulfur Concentrations

Main Pit block model tonnages and sulfur concentrations are listed in Table 7-1. The sample locations from which these values were obtained are shown in Figure 7-1. Table 7-1 and Figure 7-1 show that all points within the final Main Pit design have < 0.3% sulfur. Thus, no sulfur laden materials are destined to be mined out of Main Pit during the remaining life of mine (2019 - 2023).

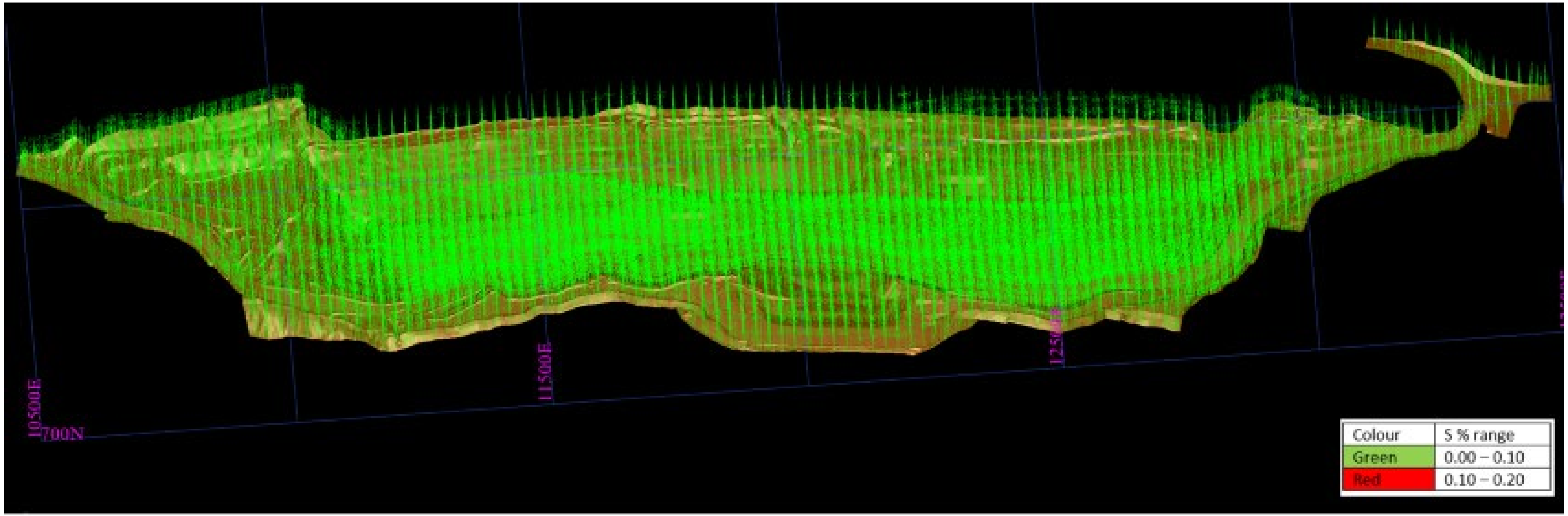
Table 7-1: Main Pit Tonnages and Sulfur Concentrations

% S range	Volume (m^3)	Mass (T)	% Sulfur
0.0 -> 0.01	14,457,480	46,021,398	0.004
0.01 -> 0.02	8,712,207	23,607,488	0.01
0.02 -> 0.03	5,268	17,120	0.021
Grand Total	**23,174,955**	**69,646,006**	**0.006**

7.4.5 Considerations for Mine Closure Planning

The results of pH_{FOX} and Total S analysis suggest that the potential for AMD formation is low as any occurrence of sulfidic material on the site will necessarily be isolated and low occurrence. The generally low salinity reported in materials from the Acacia East drill holes contrasts with the considerable variability of salinity values found within the Elgee Siltstone of the Main Pit. This suggests further investigation is needed to ensure that materials with unsuitable characteristics as growth medium (i.e. high salinity) are identified and materials with suitable characteristics are also identified so that appropriate management strategies for their handling and utilisation are developed.

The results of geochemical assay analysis have shown that the majority of metals and metalloids can be considered at or below the average crustal abundance (i.e. natural background levels) and are therefore not considered to be of environmental concern. The measured levels of Arsenic exceed the corresponding EIL and are considered significantly enriched in comparison with natural background levels, however the bonding behaviour of the most common Arsenic species, and in particular the similar ionic radius with Fe, suggests that the element will be strongly bound within the crystal mineral structure and therefore likely to be highly insoluble.



Picture 1. Oblique view of Main Pit showing every estimated point for Sulphur.

Figure 7-1: Oblique view of Main Pit showing every estimated point for Sulfur (note no records above 0.1 % total sulfur)

7.5 SURFACE WATER HYDROLOGY

7.5.1 SUMMARY

A hydrological Investigation (SWC, 2014a) was conducted to determine how the mining-related constructed landforms on Koolan Island interact with the natural landscape, and to establish their long-term environmental risks. The following tasks were completed as part of this study:

- Establish the hydrological properties of the waste rock materials;
- Undertake detailed surface flow analysis of the pre-mine and as-built land surfaces;
- Undertake unsaturated zone hydrological modelling of the WRLs; and
- Assess the need for sedimentation and drainage structures.

7.5.2 CATCHMENT DELINEATION

A surface flow analysis was completed to assess how the as-built landforms fit and function within the surface hydrological system of Koolan Island (SWC, 2014a). This analysis identified 92 surface water catchments of ≥1 ha across the Island. Eight surface water catchments were identified that intersect the waste dump footprint areas and these are shown on Figure 7-2 and further described in section 7.5.5, along with a number of additional smaller catchments that intersect the open cut pits, ROM Pad, and Crusher areas. As depicted, the majority of these catchments have their outlets in the ocean. However, Catchment 1 empties into the Main Pit, Catchment 2 ends in a sumpland, and the majority of Catchment 7 flows into Mullet Pit.

For the purpose of this analysis, the WRLs were assumed to be largely internally draining, with the upper surfaces being bunded to contain the majority of surface water runoff. Further, the WRLs constructed of waste rock materials are expected to allow rapid infiltration of rainfall. Surface water runoff from the WRLs is expected to occur primarily along the access ramps, and the modelled flow lines shown on Figure 7-2 reflect this.

The WRLs are primarily located over higher elevations within the upper portions of the island's catchments, and constitute a combined total disturbance area of approximately 200 ha. The percentage of each catchment that is disturbed varies greatly by catchment, but ranges from 20-100%. As disturbed surfaces generally contribute more sediment to runoff water than undisturbed surfaces, increased sediment load is therefore the primary concern with respect to the WRLs contribution to surface water flows.

Catchments 1 and 7 currently drain into mine pit voids and Catchment 2 drains into a sumpland (SWC, 2014a). Therefore any sediment entrained in surface water flows in these catchments does not reach the ocean, resulting in no risk to the marine environment.

Figure 7-2:: Catchment Delineation

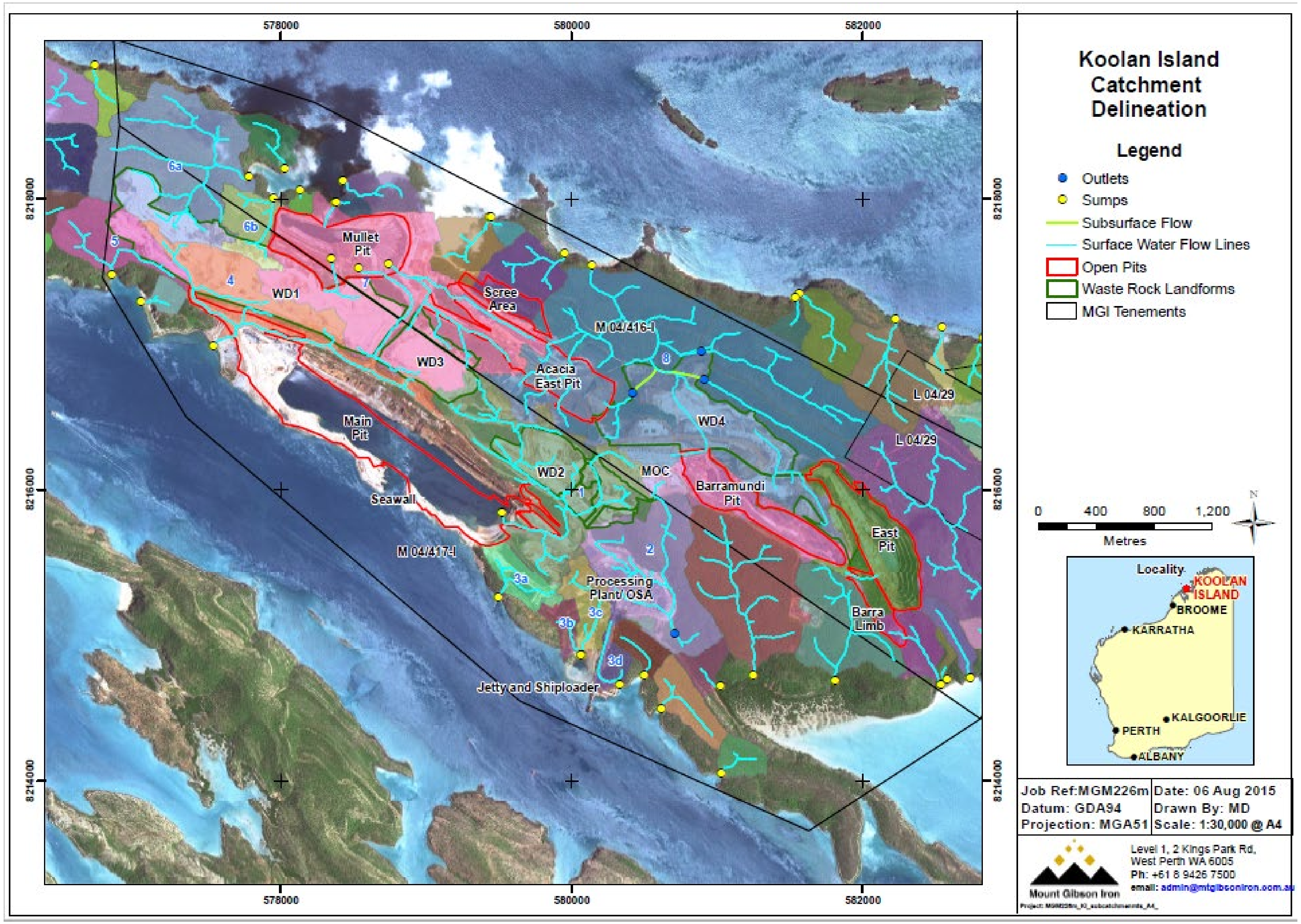

Koolan Island
Catchment
Delineation
Legend
Outlets
Sumps
Subsurface Flow
Surface Water Flow Lines
Open Pits
Waste Rock Landforms
MGI Tenements
578000
580000
582000
8218000
8216000
8214000
Mullet Pit
Scree Area
WD1
WD3
WD4
WD2
MOC
Acacia East Pit
Main Pit
Seawall
Barramundi Pit
East Pit
Barra Limb
Processing Plant/ OSA
Jetty and Shiploader
M 04/416-I
M 04/417-I
L 04/29
6a
6b
5
4
7
8
1
2
3a
3b
3c
3d
0
400
800
1,200
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref:MGM226m
Datum: GDA94
Projection: MGA51
Date: 06 Aug 2015
Drawn By: MD
Scale: 1:30,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au

Table 7-2: Summary of the primary "disturbed" surface water catchments in the as-built environment.

Catchment	Area (ha)	Percent disturbed	Description
1	92	60%	50% steep hills, and 50% flat infrastructure area Includes WD2, flows into Main Pit
2	72	33%	60% steep hills, and 40% flat infrastructure area Flows to the southeast into a sump
3a–3d	41	85%	4 small catchments draining the ROM Pad / Crusher Mostly flat infrastructure area
4	49	100%	Flows down western side of WD1, along Main Pit ridge Enters ocean just north of Main Pit
5	29	33%	30% runoff from NW corner of WD1, rest “native” Outlet is in its natural location
6a–6b	100	20%	20% runoff from NE side of WD1, rest “native” Outlets is in its natural location
7	139	80%	35% runoff from E side of WD1, 35% Mullet Pit (cuts off catchment) and Acacia East Pit (top of the catchment)
8	243	33%	25% runoff from WD4, rest of catchment is undisturbed Outlet is in its natural location WD4 cuts off two major drainage lines (~40 ha)

Catchments 3, 4, 5, 6 and 8 discharge directly to the ocean, and while sediment and water quality monitoring is conducted in the receiving waters, no additional sediment control measures are known to exist in these catchments. Of these catchments, 3 and 4 are highly disturbed but occupy a much smaller area in comparison to 6 and 8. Due to the low percentage of disturbance within catchments 5, 6 and 8, the relative potential risk on the receiving environment is low. Whilst catchments 3 and 4 are highly disturbed, catchment 3 consists mainly of flat infrastructure areas thereby reducing the potential risk of erosion or liberation of suspended sediment associated with surface runoff. The outlet for catchment 4 enters a highly modified marine environment due to former historical mining operations and the added control of placing non-erosive materials on the batters of WD1 (quartzite) reduces the relative risk to the receiving environment.

7.5.3 Peak Flow Analysis

Peak flow analysis was conducted to estimate design event flows (e.g. the 1:100-yr peak flow) at selected locations within the as-built and proposed post-mine landscape (SWC, 2014a). The following generalised locations were analysed:

- All surface water outlets into the Ocean;
- All surface water channels flowing into open cut pits; and
- Two surface water channels intersected by sumplands adjacent to WD4

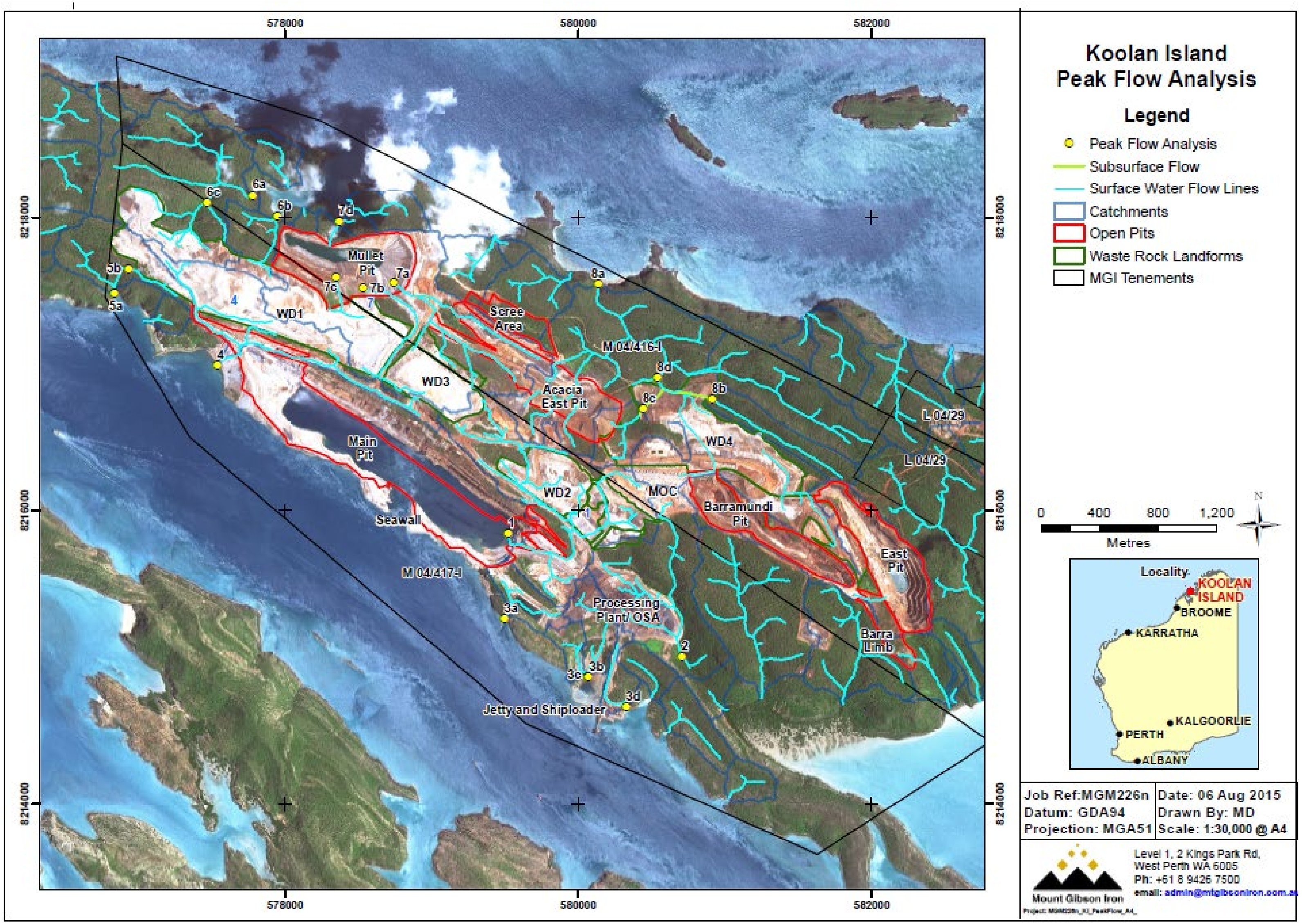
The specific locations analysed for each of the as-built scenarios is presented in Figure 7-3. Peak flow analysis at these locations provided estimates of design flow rate for a range of storm sizes that can be used for a number of purposes relevant to management and closure of the mine site, including (but not limited to) pit in-flow volumes, sediment loads, and diversion sizing requirements.

The Rational and Index Flood Methods were utilised for this analysis, according to the guidelines presented in Australian Rainfall & Runoff – A Guide to Flood Estimation (ARR) (Pilgrim, 2003). Input parameters for the "Kimberley" region of Western Australia were adopted, as recommended in the ARR (Book II, Section 3 and Book IV, Section 1).

Some of the key results of this analysis include:

- The peak flow rate predicted to enter the Main Pit during a 1:100-yr peak flow event is 19 m^3/s using the Index Flood Method, and 45 m^3/s using the Rational Method. The large discrepancy between the results from the two methods is typical, and highlights the need for more detailed hydraulic modelling for areas where accurate flow rate predictions are necessary (e.g. design and reconstruction of a waterway). More weight should be placed on the results obtained by the Index Flood Method, as the regression equation on which it is based has a stronger correlation with field data measured in the Kimberley Region (Pilgrim, 2003).
- The peak flow rate predicted to enter Mullet Pit during a 1:100-yr peak flow event is 19 m^3/s and 49 m^3/s using the Index Flood and Rational Methods (respectively).
- The peak flow rate predicted to enter each of the sumps adjacent to WD4 during a 1:100-yr peak flow event is 5 m^3/s and 14 m^3/s using the Index Flood and Rational Methods (respectively).
- Analysis of peak flow rate in catchment 8d could not be calculated as part of this analysis, as the effects of subsurface flow are not accounted for by the Rational or Index Flood Methods. Subsurface flow is addressed as part of the HYDRUS model discussed in Section 7.5.7.

Figure 7-3: Location of Peak Flow Estimates


Koolan Island
Peak Flow Analysis
Legend
Peak Flow Analysis
Subsurface Flow
Surface Water Flow Lines
Catchments
Open Pits
Waste Rock Landforms
MGI Tenements
0 400 800 1,200
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref:MGM226n
Datum: GDA94
Projection: MGA51
Date: 06 Aug 2015
Drawn By: MD
Scale: 1:30,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au
578000
580000
582000
8218000
8216000
8214000
Mullet Pit
Scree Area
WD1
WD3
Acacia East Pit
M 04/416-I
WD4
L 04/29
Main Pit
WD2
MOC
Barramundi Pit
East Pit
Seawall
M 04/417-I
Processing Plant/ OSA
Barra Limb
Jetty and Shiploader
5a
5b
6a
6b
6c
7a
7b
7c
7d
8a
8b
8c
8d
4
1
2
3a
3b
3c
3d

7.5.4 Storm Runoff Volumes

Basic storm runoff volume analysis was conducted to estimate the volume of runoff water that may be expected to accumulate at key locations onsite for design storm events of different sizes (SWC, 2014a). This analysis used the rainfall Intensity-Frequency-Duration data published by the Bureau of Meteorology (BOM, 2014b), and assumed an initial storm loss of IL=15 mm, based on site observations which indicates that unsaturated conditions predominate for storm events smaller than 25 mm (pers. comm. C. Hamence, 2014). After the initial 15 mm, a continuing loss of CL=10 mm/hr was applied, based on saturated hydraulic conductivity measurements conducted on a range of onsite soil materials as part of the WRL design process (SWC, 2014a).

Stantec (2019) modelled the catchment reporting to Mullet Pit and determined the pit capacity required to store runoff generated during 1% AEP and PMP 72 hour storm events. The surface water assessment involved delineation of catchment area draining to the pit and determining the pit stage storage curve, rainfall excess generated during the designated storm events, and the volume of runoff collected in Mullet Pit during the designated storm events. The Stantec (2019) study reported that:

- A catchment area of 61.27 ha drains towards Mullet Pit;
- The volume of Mullet Pit at 14 m Australian Height Datum (**AHD**) (i.e. the height of the outfall to Mullet Bay) is 2,296,500 m^3;
- Runoff volume draining to Mullet Pit during the 1% AEP 72 hour storm is 189,000 m^3; and
- Runoff volume draining to the pit during the PMP 72 hour storm event is 1,629,860 m^3.

7.5.5 Surface Water Runoff

The Hydrological Investigation report (SWC, 2014a) further identified a number of areas of the site that may require surface water channel realignments so the primary surface water flow pathways reach the intended final outlet. Options are proposed for implementation at site closure and are discussed further in Section 7.5.8:

7.5.6 Sediment Control

A marine monitoring program commenced in 2007 to monitor the potential effects of sediment on the receiving environment (section 7.12). The results for turbidity in near coastal waters have been variable in time and do not indicate a chronic effect from runoff. While the most recent marine monitoring detected slightly elevated turbidity at the wharf sites (4 NTU) relative to the south reference sites (3 NTU), MScience (2019) did not attribute the elevated levels to Project activities. This is a strong indication that no additional effect on the surrounding environment is likely to occur from erosion of constructed landforms post closure, so long as no further major changes are made to the existing surface water. Sediment exported in surface runoff is expected to decrease with time post-closure as rehabilitation of the Island progresses..

Following the collapse of the Seawall a post event marine monitoring program was developed and agreed to by both the EPA and DMP. This involved monitoring of both water quality and benthic habitat and a comparison of the results, before and post event. No impacts were identified, however further monitoring is to be conducted in conjunction with annual marine monitoring required by the marine management plan to further support these findings (KIO, 2015).

7.5.7 HYDROLOGY OF THE WD4 "SPUR" AREA

Version 4 of the MCP discussed modification of the upper areas of Catchment 8 by construction of the northern "spur" of WD4. The section of the northern spur impeding surface flows from Catchment 8 was excavated in 2015 and the catchment hydrological regime re-established and its operations reported in Annual Environment Reports.

7.5.8 CONSIDERATIONS FOR MINE CLOSURE PLANNING

The management of erosion and sedimentation are the primary closure-related concerns highlighted by the surface water assessment. Marine monitoring would continue for a limited period post closure (section 10.1.1).

Mullet Pit will be mostly backfilled, leaving a 280,000 m^3 storage sump for runoff retention at its base (section 8.5). Constructed drainage lines to reduce sediment yields from the WRL face will be considered; they may not be required, however, as batter slopes will be constructed from competent rock at an average slope ≤ 20° (sections 8.5 and 8.5). Alternative surface water management around the WD1 tow / Main Pit crest would be required if the WD1 airfield (section 8.1.3.2) is constructed, as per the approved MP Reg ID 79171.

A constructed surface water channel may be required to direct surface water runoff from Catchment 2 to the desired outlet point (presently a sump adjacent to the Crusher / ROM Pad) to avoid undue erosion or uncontrolled surface water flows after the disturbance areas have been ripped and rehabilitated. This may involve rock armouring of constructed drainage with competent rock to ensure it is adequate for the purpose (SWC, 2014a). A similar arrangement may be necessary for catchment 1 and due to the requirement for abandonment bunding the structures will require sufficient consideration in regards to stability post closure.

With regard to the crusher and ROM pad, in order to avoid undue erosion of these areas and facilitate drainage, some re-grading and channel construction may be necessary. This may allow Catchments 3a, 3b, 3c, and 3d to continue flowing to the desired outlet points (SWC, 2014a).

7.6 GROUNDWATER HYDROLOGY

7.6.1 SUMMARY

A baseline groundwater survey focused on developing a groundwater abstraction program was conducted by Aquaterra (2005). Previous work and drilling conducted by BHP on the Island has shown that there are three broad hydro-geological provinces, corresponding with the three main structural geology elements underlying the Island (i.e. the South Syncline, the Central Anticline and the North Syncline). The southern synclinal basin can be divided into two zones; an inland zone (which is used as a water supply area) and the ore body zone. These two zones are hydraulically isolated by an impermeable siltstone formation. An overview of the aquifers present on the Island is presented in Table 7-3.

Groundwater resources are highly-localised within fractured-rock aquifers. These aquifer systems, as seen from previous exploration, have a high degree of variability and the success of water supply is dependent on encountering one or more structure-related features. The localised and poorly-resolved extent of the fracture systems means that these aquifers can be difficult to locate, manage and monitor (Hydroconcept, 2013).

Large-yielding bores (more than 20 L/s) are rare owing to the tightness of the geological structure and lack of significant fracture development. This is also highlighted with many drill holes, only metres away from yielding bores, being effectively dry as they did not encounter a permeable feature (Hydroconcept, 2013).

Table 7-3: Properties of Koolan Island Aquifers.

Formation	Unit/Member	Lithology	Hydrogeology
Pentecost Sandstone	Pentecost sandstone (footwall of Main Pit formation)	Sandstone inter-bedded with siltstone and schist; some conglomerate horizons	Main aquifer in Southern syncline; strongly fractured along regional bedding resulting in moderate to high permeability. Contains fresh groundwater over most of the Island
	Ore body (mineralised Yampi member)	Hematite enriched sandstone and siltstone	Moderate to high permeability along joints in sandstone unit. Originally a fresh water aquifer now likely to contain seawater
Elgee Siltstone	Elgee Siltstone (hanging wall of Main Pit formation)	Siltstone, schist to phyllite	Effectively impermeable, acts as a hydraulic isolation unit between North and South synclines and South syncline and the sea
Warton Sandstone	Arbitration cove quartzite	Inter-bedded quartzite and schist	Moderate to high permeability along bedding in quartzite. In direct hydraulic connection with the sea and contains brackish to saline water

As there is potential for fracture systems to be readily dewatered, ongoing water-level monitoring is critical for assessing resource condition. This monitoring can be challenging as it requires the monitoring bore to be positioned within the same fracture system as the production bore for observing changes in the same aquifer (Hydroconcept, 2013).

Despite the broad-scale geological structure on Koolan Island being well resolved, there are localised structures that influence aquifer extent and development. This complexity requires careful consideration in the design of a representative and meaningful groundwater monitoring network and program (Hydroconcept, 2013).

Potable water supply is currently obtained from three groundwater aquifers. The Northern Syncline (abstracted through Bore V01) is used for potable water supply to the mine accommodation village. The Southern Syncline (abstracted through Bore I01) is used predominately for industrial purposes but does also supply potable water to the MOC. Monitoring Bore K3, located in the Central Anticline (originally constructed by BHP) was re-developed and in July 2011, becoming the primary potable water supply for the accommodation village.

In 2013 KIO engaged a hydrogeologist to undertake a review of groundwater monitoring and data (Hydroconcept, 2013). Conclusions that relate to Project operations drawn from this review include;

- Contamination risk is very low owing to the tight and low-permeable nature of the hydrogeology;
- Groundwater resources are associated with a localised, fractured-rock aquifer preventing the development of a meaningful, regional groundwater monitoring network;
- Groundwater monitoring should focus on collecting frequent basic water quality and levels from production bores;

- Saline intrusion and / or upconing could potentially impact water quality as one of the water supply aquifers (KL104) is hydraulically connected with the sea;
- The Southern Syncline is the most at risk of seawater intrusion owing to progressive deepening of the Main Pit. The northward movement of seawater will be minimal, however, as there is limited permeability across and between the stratigraphic units. There is some potential along the direction of the bedding (west to east); this is also considered a low risk owing to the tightness of the geological structure; and
- There is potential for dewatering of fractured-rock aquifers as the fractures are highly localised and contain finite groundwater storage. While low rates of groundwater abstraction suggest that the risk of overexploitation is minimal, it is important to monitor water levels in the production bores as a protective measure.

These potential impacts cease or largely reduce upon cessation of operations or closure of the site. The risk to ambient groundwater quality on Koolan Island is considered very low due to the depth of aquifers and associated geology (ref. Koolan Island Water Management Plan 2018).

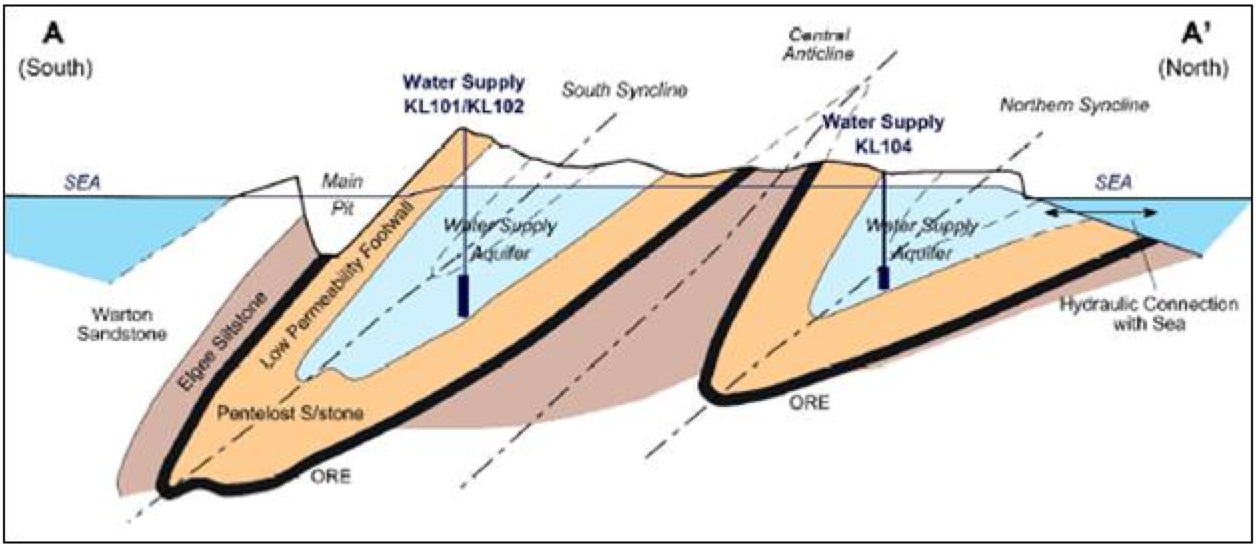


Figure 7-4:: Hydrology of Koolan Island

7.6.2 GROUNDWATER MANAGEMENT

A Koolan Island Water Management Plan (**WMP**) (v2) and Groundwater Operating Strategy (v2) informed by the Hydroconcept (2013) study were submitted to the OEPA in June 2015, receiving approval for implementation on 25 September 2015, and a revised WMP was provided to DWER with the 2018 Compliance Assessment Report. KIO is currently implementing Version 2 of the WMP.

Bore and surface water quality testing is a requirement of both the EP Act Licence and the WMP. The Annual Aquifer report submitted in 2016 documented further changes to monitoring and reporting to align the WMP to groundwater monitoring conditions under the Environmental Operating Licence (L8148/2006/4) and the Koolan Island Drinking Water Quality Management Plan.

There are no targets, limits or conditions specified within Licence L8148 or the WMP relating to emissions to groundwater. Groundwater aspects are managed under a Groundwater Operating Strategy and Water Management Plan approved by

DWER EPA Services. The Project is not located within a "proclaimed area" under the *Rights in Water and Irrigation Act 1914* and is therefore not regulated by the Water Division of the DWER. Monitoring is undertaken to identify any potential changes to groundwater quality that may potentially impact on subterranean fauna.

The monitoring regime was adjusted in March 2016 to reflect the low risk of groundwater from site abstraction and operations on groundwater quality once the site entered C&M. Water quality monitoring is undertaken annually. Additional monitoring of production bores was undertaken in accordance with Groundwater Operating Strategy commitments approved by the DWER EPA Services. Licence L8148/20016/4 groundwater monitoring requirements are listed in Table 7-4 and bore locations are shown in Figure 7-5.

Table 7-4: Licence L8148 / 2006 / 4 Groundwater Monitoring Program including bores sampled, and water quality parameters

Monitoring Bores	Water Quality Parameters		
V01 (M1)	Standing Water Level	Arsenic	Manganese
K9 (M3)	Electrical conductivity	Barium	Mercury
K3 (M4)	pH	Boron	Molybdenum
K2 (M5)	Total Recoverable Hydrocarbons	Cadmium	Nickel
K1 (M6)	Hardness	Calcium	Nitrate
K9 (M3)	Total Alkalinity	Chromium	Potassium
I01 (M10)	Total Nitrogen	Copper	Sodium
	Total Phosphorous	Iron	Sulphate
	Bicarbonate	Lead	Selenium
	Carbonate	Magnesium	Zinc
	Aluminium		

7.6.3 GROUNDWATER LEVEL MONITORING

Groundwater levels are currently monitored at 9 bores around the Island. Levels have fluctuated across and between years in response to abstraction and recharge associated with rainfall events (MGX, 2014). Water abstraction was higher in 2018 compared with previous reporting years due to the increased water demands of the seawall rebuild and re-commencement of operations. There were no anomalies reported within groundwater monitoring results for 2018.

KIOP abstracted water for industrial and domestic purposes from production bores I01 (South Syncline Aquifer), V01 (North Syncline Aquifer) and K3 (Central Anticline) during the 2018-2019 monitoring period. Total Abstraction from production bores was 91,289kL during 2018. Table 7-5 presents water usage data from 2014 to 2018. Changes in standing water levels from the base year to 2018 are shown Table 7-6.

Figure 7-5: Location of Production Bores (red) and Monitoring Bores (blue).

Table 7-5: Groundwater abstraction volumes 2014 - 2018

Years	Volume (m³)			
	I01 (M10)	V01 (M1)	K3 (M4)	Total
2014	62,678	888	48,053	113,633
2015	31,485	10,998	30,003	74,501
2016	11,978	11,081	20,759	45,834
2017	25,611	20,654	23,107	71,389
2018	41,567	17,124	30,580	91,289

Table 7-6: Groundwater bore standing water levels – base year and 2017

Bore Id	Coordinates		Elevation – RL	Base SWL - RL	2017 SWL - RL
	mN	mE	(mAHD)	(mAHD)	(mAHD)
I01 (M10)	8216509.31	579433.03	136.5	24.1	12.4
K8 (M9)	8216906	578608	136.1	75.3	84.2
V01 (M01)	8216185. 11	583445.18	137.1	17.1	16.2
K9 (M3)	8216263	583047	145.8	28.3	32.0
K3 (M4)	8216860	580563	38.7	22.3	28.7
K1 (M6)	8217612	579148	97.6	13.9	13.8
K2 (M5)	8217331	579676	107. 5	18.6	26.6

7.6.4 GROUNDWATER QUALITY MONITORING

Historical groundwater quality data is limited in its availability. Salinity was measured in previous groundwater resource exploration work conducted by Tahal Consulting from 1978 to 1981 in both the northern and southern syncline aquifers (GHD, 2010), reported mg/L of chloride. The water encountered was essentially fresh with chloride concentrations ranging from 60 mg/L to 240 mg/L. An exploration bore interpreted as intercepting the fresh water mound / saline sea water interface reported 1,500 mg/L of chloride.

Groundwater quality results for the 2018 monitoring period were typical for all aquifers, and similar to the 2017 monitoring period. There were no results indicating a significant change in aquifer chemical quality characteristics triggering monitoring requirements for potential effects on subterranean fauna and stygofauna, or requiring other investigation.

The Southern Syncline Aquifer is naturally acidic – 2018 monitoring period pH was 4.1 - 5.4, which is consistent with previous years. Electrical conductivity (**EC**) of 1,100 – 1,500 microsiemens per centimetre (**μS/cm**) and total suspended solids were relatively consistent from 2015 to 2018, suggesting that groundwater in the Southern Syncline remains fresh. There has been a slight trend for pH and conductivity to increase. The aquifer is separated from the ocean by an impermeable layer of siltstone, and the low conductivity proves seawater is not being drawn in and it remains isolated. Despite the inundation of the Main Pit in 2014 there has been no evidence of any salt water intrusion into the aquifer.

In 2018, geochemistry results for metals and organics were unremarkable and characteristic of past conditions for the Southern Syncline aquifer. Nitrate was recorded at 73 mg/L, 140 mg/L, 110mg/L, and 130 mg/L in 2015, 2016, 2017 and 2018, respectively. Nitrate was also elevated in years previous to 2014. The cause is not known but appears to fluctuate.

The Southern Syncline Aquifer meets the Australian Drinking Water Guidelines (**ADWG**) potable criteria for metals with the exception of Barium, which is above 5mg/L in all years measured (Mean: 5.8mg/L) and attributed to surrounding geology. Lead was also above the ADWG (0.01mg/L) at 0.06mg/L in 2018, compared to 0.04mg/L in 2017.

The Village domestic water supply switched to the Northern Syncline aquifer in 2016 with the transition to C&M, continuing until July 2018. Northern Syncline Aquifer pH values were consistent from 2015 – 2018 (pH 5.4 - 5.6). EC was higher in 2018 (1,300 μS/cm) compared with previous years (840 – 990 μS/cm). 2018 geochemistry results for metals were unremarkable and characteristic for this aquifer. Mercury (0.0012mg/L), Nickel (0.16mg/L), Lead (0.046mg/L) and Manganese (0.69mg/L) exceeded the ADWG potable criteria, and were higher than previously recorded. The presence of metals may be attributed to the high abstraction rates imposed on the bore during the June 2017 to July 2018 period.

Central Anticline Aquifer quality showed no significant changes during the 2018 – 2019 reporting period. This aquifer is characteristically slightly acidic, measuring pH 4.3 - 5.9 in 2018 compared with pH 5.4 in previous years. EC also remained consistent in 2018 compared to previous years, the aquifer remaining characteristically fresh. Manganese in K3 (M4) exceeded ADWG potable criteria (0.5mg/L) at 0.95mg/L. Manganese in K1 (M6) and K2 (M5) was 0.09mg/L and 0.33mg/L respectively. This does not vary from previous years and is associated with surrounding mineralogy.

7.6.5 CONSIDERATIONS FOR MINE CLOSURE PLANNING

Monitoring of groundwater levels and quality to date demonstrates the groundwater resource has not been adversely affected by groundwater abstraction and dewatering associated with mining operations.

KIO will continue to monitor ground water levels and quality in accordance with the approved Water Management Plan under MS 715 and the planned ground water monitoring schedule.

7.7 SOIL AND OVERBURDEN

The aim of investigations and assessment was to identify the potential source, volumes and characteristics of material for rehabilitation.

A baseline soil and overburden investigation was conducted by Outback Ecology Services in 2008 (Outback Ecology Services (**OES**), 2008). Representative soil and waste samples were collected from:

- Naturally vegetated areas, or analogue sites (n=2);
- Previously rehabilitated areas (n=2);
- Overburden (waste) stockpiles (n=5); and
- A topsoil stockpile (n=1).

Further investigations of soil and overburden were also conducted by Soilwater Consultants in 2012 and 2013 (SWC, 2014d, 2014e). A total of 22 sites were investigated (Figure 7-6) using a combination of shallow and deeper trench excavations, with material collected from each site for laboratory analysis. In addition a number of topsoil stockpiles were sampled to provide chemical and physical data. Sites were located in:

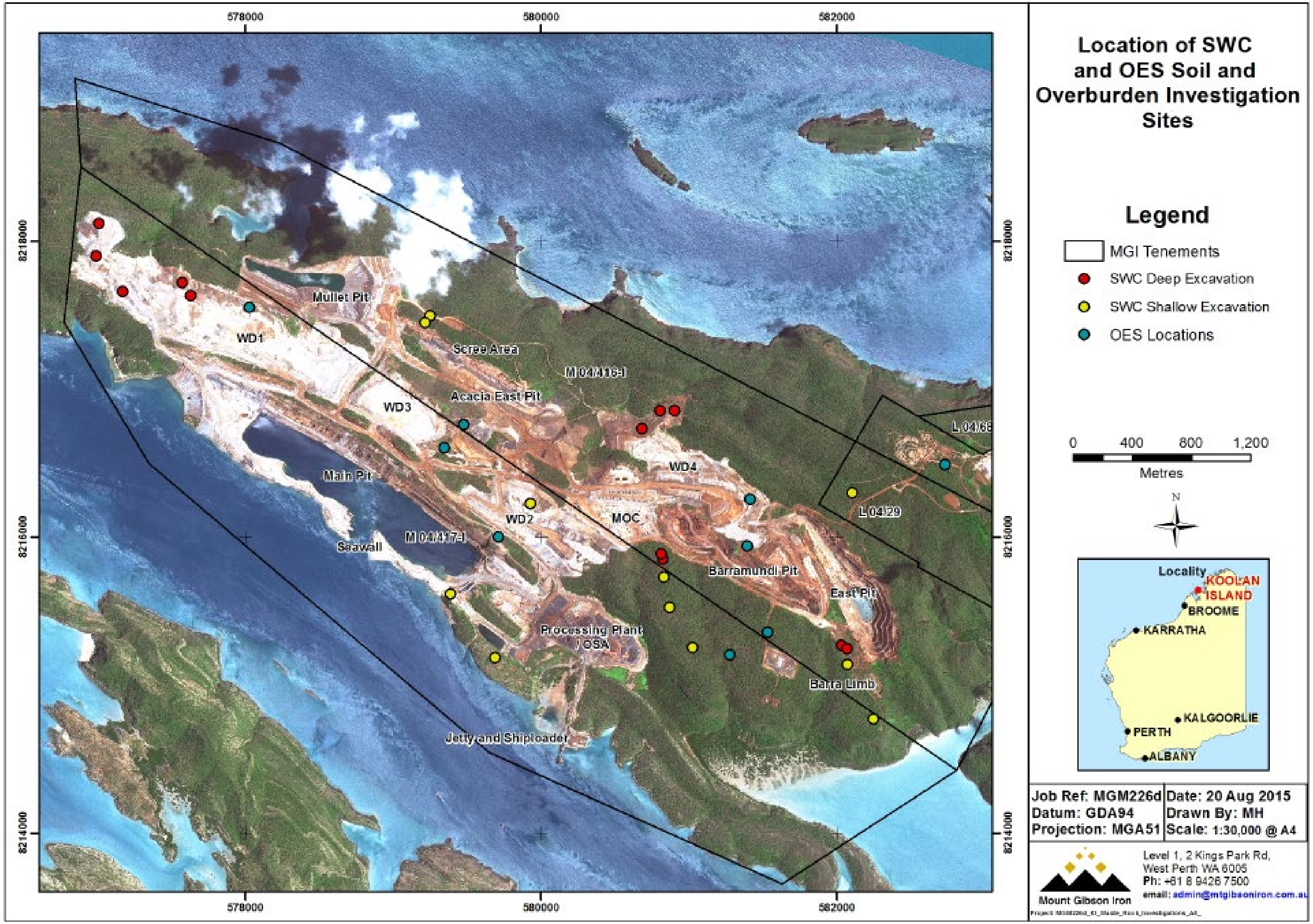
- Naturally vegetated areas, or analogue sites (n=10);
- Previously rehabilitated areas (n=4);
- Overburden (waste) stockpiles (n=8); and
- Topsoil stockpiles (n=4).

7.7.1 SUMMARY

Physical and chemical properties: Properties were different for the sandstone and siltstone materials sourced from mined waste, with a higher coarse (gravel and rock) fraction for sandstone and a higher silt and clay content for siltstone resulting in a higher water holding capacity (43.5 % versus 31.2 % v/v). Siltstone materials were moderately to highly saline (>100 mS/m), whereas all other materials were non-saline, although there appeared to be no physical or chemical restrictions to root exploration, with roots observed on exposed faces to extend deep into the siltstone materials of historic rehabilitated sites.

Erosion and Stability: Soils within analogue sites display ‘self-armouring’ properties; fine silt and clay particles naturally leaching down the profile resulting in coarse, gravelly topsoils that exhibit a high surface roughness and are likely to be resistant to erosion under field conditions. Conversely, rehabilitated or waste stockpile slopes showed evidence of excessive erosion rates, with OES (2008) reporting visual observations of tunnel and gully erosion within historic rehabilitation areas. Overall, the fine nature of the siltstone waste (54 % of the <2 mm soil fraction silt sized or smaller), the sodicity of the material (ESP of 26 %), and the high annual rainfall received (Section 7.1), result in potentially high rates of erosion in the field. OES (2008) recommended “erodibility assessment of the siltstone and sandstone waste materials and assessment of slope and armouring effects on the rate of soil loss be conducted.”

Figure 7-6: Location of SWC and OES Soil and Overburden Investigation Sites


Location of SWC and OES Soil and Overburden Investigation Sites
Legend
MGI Tenements
SWC Deep Excavation
SWC Shallow Excavation
OES Locations
0 400 800 1,200
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Mullet Pit
WD1
Scree Area
M 04/416-I
Acacia East Pit
WD3
Main Pit
WD4
WD2
MOC
L 04/29
L 04/68
Seawall
M 04/417-I
Barramundi Pit
East Pit
Processing Plant / OSA
Barra Limb
Jetty and Shiploader
578000
580000
582000
8218000
8216000
8214000
Job Ref: MGM226d
Datum: GDA94
Projection: MGA51
Date: 20 Aug 2015
Drawn By: MH
Scale: 1:30,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au

7.7.2 Rehabilitation Material Volumes

A database of volumes for different material types available for rehabilitation was developed to enable rehabilitation planning. The database is based on mine plans (i.e. planned waste material movements) and the various topsoil stockpiles located on site. Main Pit waste material makes up the vast majority of material available for use in rehabilitation as the continued expansion of the Main Pit has constituted the majority of mining activity within the mine plan. A breakdown of the material movement by pit stage of waste lithologies from the Main Pit is provided in Table 7-7. Waste material types are broken into four categories: siltstone, quartzite, schist and sandstone. The siltstone and quartzite are the more abundant materials, together comprising over 80% of the total waste material scheduled to be moved from the Main Pit (and 90% towards the end of the mine plan). This is beneficial as siltstones are suitable for a cover medium for rehabilitation and quartzite can be used to armour slopes.

Table 7-7: Main Pit waste volume movements by stage

Lithology	Siltstone	Quartzite	Schist	Sandstone
Mine Stage	Volume (m^3)	Volume (m^3)	Volume (m^3)	Volume (m^3)
1	0	0	0	422,831
2	0	0	0	273,316
3	60,297	1,293	0	55,680
4	478,114	340,432	28,272	99,157
5	610,410	994,758	0	2,417
6	2,137,401	4,449,923	849,294	1,600,524
7	3,739,657	7,453,638	1,715,042	150,011
8	4,670,588	4,429,259	482,445	929,915
Total	11,696,469	17,669,305	3,075,055	3,533,854

Note: Volumes are as at February 2014

Other rehabilitation material which is currently stockpiled and available for the rehabilitation of land (typically WRLs) consists of topsoil reclaimed during clearing activities and a range of other material reclaimed opportunistically. The limited volume of topsoil due to natural conditions has inspired alternative and innovative approaches to the reclamation of topsoil (or growth media) and resourceful management practices. KIO will continue to seek out and identify opportunities to increase topsoil and growth media resources throughout the life of the Project. Examples of those approaches so far include:

- Acacia East Backfill – as mining operations commenced in Acacia East a mixture of weathered sandstone and clay material backfilled by previous operators was identified as potential rehabilitation material. This material was reclaimed and stockpiled on WD2 for later use in rehabilitation and has subsequently featured in rehabilitation trials (Section 7.7.4).
- WD4 Spur –KIO undertook significant drainage works within the area known as the WD4 spur in 2014. These works enabled the reclamation of material with demonstrated capacity to support vegetation and relative erosion resistance if surficial treatment such as deep ripping is applied. It has been utilised to cap saline sediments and it will support vegetative growth across these areas. If necessary it could be reclaimed, provided there is other mine waste rock material available to cap the saline sediments.
- Topsoil east of WD3 – whilst preparing an area for clearance to the east of WD3, which included the translocation of a previously known volume of topsoil, it was identified that a higher volume of resource was available which

displayed characteristics similar to that necessary for topsoil / growth media. This resource was removed and relocated using appropriate plant and equipment, with some 20,000 - 30,000 m^3 more reclaimed than initially anticipated.

- Crusher stockpile – with minor increases in the approved disturbance area during 2014 and 2015, a potential resource and considerable volume of caprock / growth media was identified adjacent to the product stockpile area.
- Scree area –the area was mined for a surficial deposit of iron ore. Following the completion of stripping for iron ore, it was identified that respreading of topsoil was not required as a layer of topsoil supporting vegetation lay beneath the ore. The area was rehabilitated immediately with no need to draw on existing topsoil or growth media resources.

Topsoil and subsoil material (April 2015) was reported as approximately 39, 500 m^3 of topsoil located at the Mullet topsoil stockpiles and 52,500 m^3 of subsoil located on WD2, 87, 900 m3 of capping material (located adjacent to product stockpile area) and approximately 160, 000 m^3 reclaimed from the area known as the WD4 spur.

7.7.3 Summary Investigations

Physical and chemical properties: Topsoil and overburden materials sourced from various locations (e.g. high and low grade topsoil stockpiles, analogue and waste stockpiles etc.) were sampled for physical and chemical analysis. These are summarised as:

- Topsoils: Several differences between high-grade and low-grade topsoil stockpiles including: salinity; nutrient contents and fines particle size. Analogue topsoils were coarse textured and free-draining, likely retaining lower nutrients and water in comparison to the stockpiled materials; and
- Overburden: Major difference between overburden material is particle size, with siltstone weathering to create a <2 mm fraction with high silt content (similar to low grade topsoil). This is highlighted by the higher PAW contents within the siltstone when compared with quartzite and weathered sandstone materials.

Stability and erosion testing: Erosion testing has been conducted on bulk samples of topsoil, siltstone, quartzite, schist and weathered sandstone sourced from Acacia East Pit and WD4 landform. The laboratory testing provides several key parameters such as infiltration rate and critical shear stress (detachment rate) which are used as inputs into a Water Erosion Prediction Project model to predict average annual erosion runoff rates for any landform design:

- Topsoils: A composite of high and low grade materials was highly erodible under moderate slope angles, with increasing sediment yields at longer slope lengths; and
- Overburden: The erosion testing shows that appreciable erosion rates were modelled for all materials excepting the schist and quartzite samples (SWC, 2014e) which, due to a combination of increased infiltration rates (leading to lower surface runoff) and material competency, showed significantly reduced erosion potential. The siltstone fines exceeded predicted sediment yields for the topsoil, which was consistent with extensive gullying of this material under field observations. Quartzite waste rock had negligible erodibility due to a high hydraulic conductivity (>80 mm/hr as a result of lower fines content) and high competency.

Siltstone Salinity Trials: Siltstone has been identified as a source of rehabilitation material and the primary source of this material has previously received inundation by seawater so the aim of a trial was to investigate the rate at which salinity would leach and thereafter not affect native species germination. Prior to the trials, 100 kg of siltstone was immersed in seawater for 48 hours and then air dried (SWC, 2015a). The two trials conducted were:

- Rainfall simulator trial – six 40 cm freely draining buckets were filled with siltstone, four of which were seawater treated siltstone and two untreated. The buckets were treated with a rainfall simulator with applied intensity of 100 mm/hr each day for 5 days, and salinity testing conducted following each rainfall event (SWC, 2015a).
- Breakthrough pore volume trial – three separate cores of siltstone were subjected to a permanent 7 cm head of deionised water or tap water for 48 hrs. Two cores were seawater treated siltstone and one core was untreated (SWC, 2015a).

The results indicated that leaching of accumulated salts from siltstone can occur rapidly. 250 mm of high intensity rainfall was adequate to reduce salinity to levels capable of supporting germination for native species on Koolan Island (≤50 mS/m) (SWC, 2015a).

7.7.4 Monitoring of WRL Surface Treatment Trial

A rehabilitation trial to test the rehabilitation success and response over time of different cover materials and surface treatments was initiated by KIO in November 2013. The trial was established to provide data on what material type and volume (depth of return):

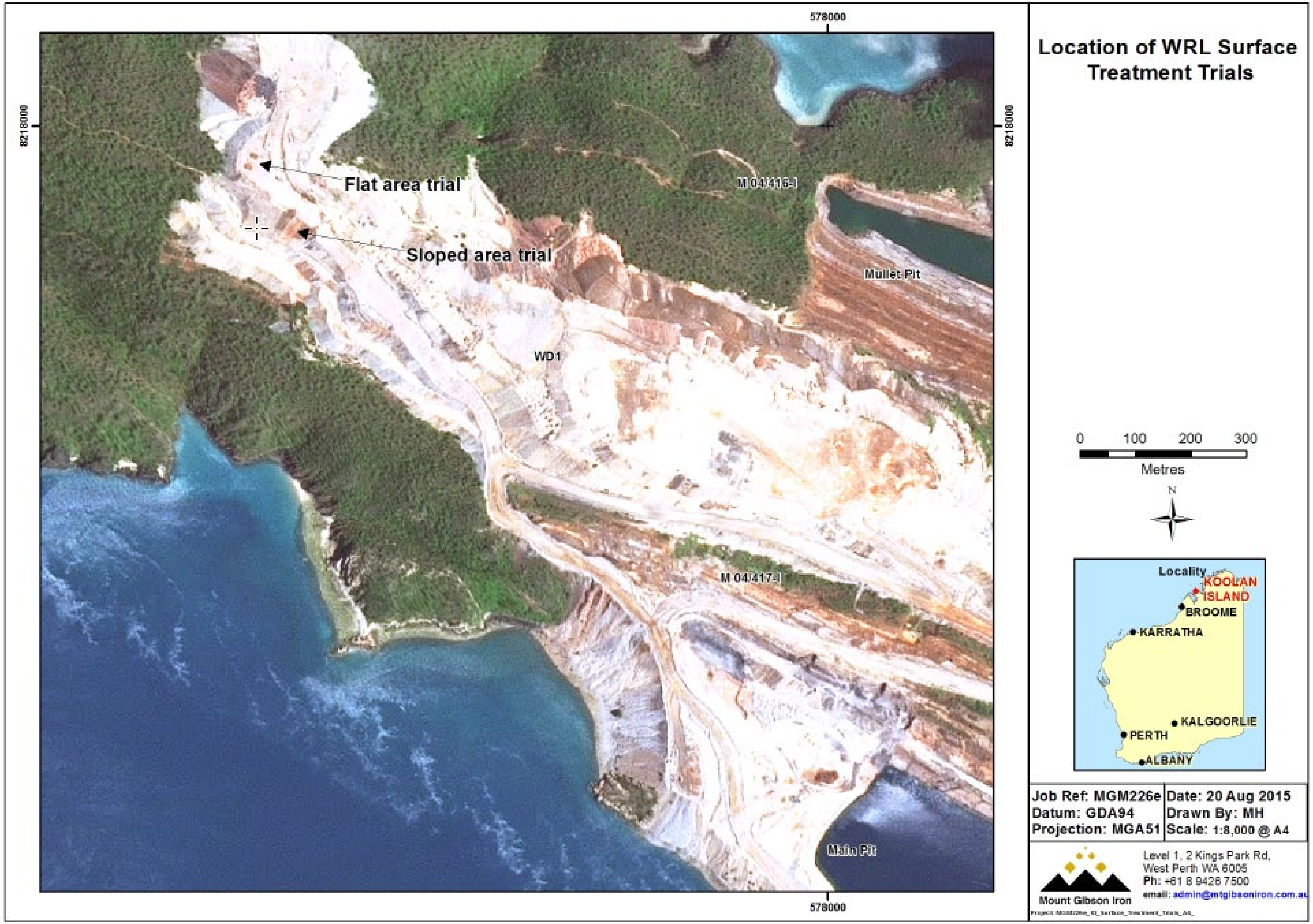
- Will remain stable on proposed landform slope angles; and
- Provide sufficient growth resources for vegetation establishment and growth.

Surface treatment trials were established in two areas (Figure 7-7), each with plots for five surface treatments (Figure 7-7):

- 'Slope' - Southern face of the western section of WD1, to measure the viability of surface treatments on 20° WRL batter slopes; and
- 'Top' – on top of WD1, to the north west of the 'slope' plots.

P1: Control (no treatment)	P2 – No covering material, ripped on contour to ≈ 0.5 m	P3: 0.1 m layer of topsoil, ripped on contour to ≈ 0.5 m	P4: 0.5 m layer of siltstone, ripped on contour to ≈ 0.5 m	P5: 0.5 m layer of weathered sandstone and sediments sourced from Acacia East backfill material, ripped on contour to ≈ 0.5 m

Figure 7-7: Surface treatment trial plots, media and preparations


Location of WRL Surface Treatment Trials
578000
8218000
Flat area trial
Sloped area trial
M 04/416-I
Mullet Pit
WD1
M 04/417-I
Main Pit
0 100 200 300
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref: MGM226e
Datum: GDA94
Projection: MGA51
Date: 20 Aug 2015
Drawn By: MH
Scale: 1:8,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au

Initial monitoring scans (i.e. baseline) of the plot trial area were collected directly after construction earthworks and direct seeding in December 2013. Figure 7-9 shows the slope as a photo draped digital elevation model (**DEM**). The photo and DEM together provide an illustration of the different surface treatments applied to the separate plots. The two plots on the far left (P1 and P2) of the trial area did not have additional surface material placed on them, and are therefore a mixture of waste rock (likely excavated from the Main Pit as they are dominated by quartzite). The DEM clearly shows the ripping which has occurred on the four plots which received surface treatments and the remaining track marks from the dozer pushing down the batter during earthworks on the control plot (P1).

Following the earthworks, direct seeding of the quadrats and slope trial plots was carried out at an approximate rate of 5 kg seed/ha utilising the following species seed mix (no seed pre-treatment was used);

- *Acacia colei*;
- *Acacia hippuroides*;
- *Acacia monticola*;
- *Acacia stigmatophylla*; and
- *Acacia tumida*.

The trials were documented photographically in 2015 and again in 2019 (sections 7.7.4.1 to 7.7.4.5). Comparison between the 2015 and 2019 photographs shows encouraging evidence of successful revegetation across all treatments, which is supported by annual LFA surveys of other rehabilitated areas. Of particular interest and relevance are the 'flat' treatment 4 and 'sloped' treatment 5 plots as these represent the landform rehabilitation strategy proposed to be most widely used (i.e. siltstone matrix on the tops and berms, and an armouring quartzite matrix on batter slopes). The differences in floristic composition visually evident between these two treatments are analogous to the differences observed between natural topographies across the Island, and indicate the development of a mosaic of habitats over time, which will likely support native fauna (e.g. the rocky quartzite slopes are likely to provide quoll nesting habitat).

While floristic diversity within the surface treatment trial plots is not yet equivalent to undisturbed analogues, the presence of *Triodia* and *Eucalyptus* species, and native grasses, indicates that successional colonisation is underway. The dominant *Acacia* species likely sprouted from the applied seed mix; *Triodia* and *Eucalyptus* seeds, however, were not applied and establishment of these species and the grasses present is potentially correlated with edge effects (the trials are within 200 m of undisturbed vegetation) and diffusion of endemic species across ecological boundaries. This bodes well for overall site rehabilitation prospects, as the landforms to be rehabilitated are all within 250 m of undisturbed vegetation.

The work of APM (2019) and eMapper (2019) considered the effectiveness of the trials in relation to LFA, EFA and photogrammetric analyses (section 7.8.4.7).

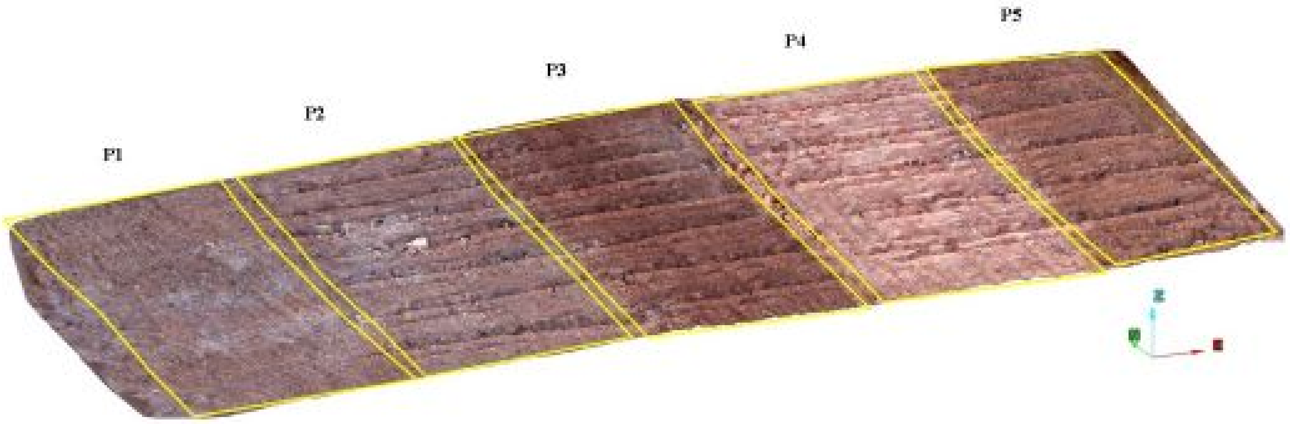


Figure 7-8: Ground based lidar scan of trial plot area (December, 2013) shown with photo overlay

Some erosion was visually evident in 2015. A catchment berm proved effective at retaining sediment eroded from the trial plots (Plate 7-2). Encouragingly, the erosion did not significantly advance by 2019, indicating that the rate of erosion reduced over time as vegetation established.

Plate 7-2: Accumulation of sediment in catchment berm (2015)

7.7.4.1 P1: Control (no treatment)

2015

Plate 7-3: 2015 P1 Sloped area

2019

Plate 7-4: 2019 P1 Sloped Area

Plate 7-5: 2019 P1 Flat Area

7.7.4.2 P2 – No Covering Material, Ripped on Contour

2015

Plate 7-6: 2015 P2 Sloped Area

Plate 7-7: 2015 P2 Flat Area

2019

Plate 7-8: 2015 P2 Sloped Area

Plate 7-9:2019 P2 Flat Area

7.7.4.3 P3: 0.1 m Topsoil, Ripped on Contour

2015

Plate 7-10: 2015 P3 Sloped Area

Plate 7-11: 2015 P3 Flat Area

2019

Plate 7-12: 2019 P1 Flat Area

Plate 7-13: 2019 P1 Flat Area

7.7.4.4 P4: 0.5 m Siltstone, Ripped on Contour

2015

Plate 7-14: 2015 P4 Sloped Area

Plate 7-15: 2015 P4 Flat Area

2019

Plate 7-16: 2019 P4 Sloped Area

Plate 7-18: 2019 P4 Sloped Area

Plate 7-17: 2019 P4 Sloped Area

Plate 7-19: 2019 P4 Flat Area

7.7.4.5 P5: 0.5 m Acacia East Backfill Material, Ripped on Contour

2015

Plate 7-20: 2015 P5 Sloped Area

Plate 7-21: 2015 P5 Flat Area

2019

Plate 7-22: 2019 P5 Sloped Area

Plate 7-24: 2019 P5 Flat Area

Plate 7-23: 2019 P5 Sloped Area

7.7.5 CONSIDERATIONS FOR MINE CLOSURE PLANNING

The amount of topsoil available on site is limited due to its inherent scarcity (i.e. shallow soil profiles) and compromised by *Passiflora foetida*. Also given difficult operational environments (i.e. high relief of landforms), careful management and handling of this resource will influence optimal final rehabilitation outcomes.

Siltstone, which is high in abundance, has been demonstrated to be a viable surrogate / growth medium for seed germination and establishment of vegetation. Erosion testing and modelling has shown that siltstone performs poorly on constructed landform slopes (SWC, 2014e). It will therefore only be utilised for rehabilitation on flat areas. Where it is known that the siltstone is saline, it will be allowed to flush with rainfall prior to the application of native seeds to allow for germination in optimal conditions. Soil EC tests can establish suitability for use. Quartzite is resistant to erosion (SWC, 2014e) and will be used as a surficial medium on slopes. The WD1 surface treatment trials show that both siltstone and quartzite matrices are viable growth media. Ongoing LFA studies, proposed to be undertaken biennially post-2019, will continue to assess the success of progressive rehabilitation at the Project and provide further surety that the preferred rehabilitation strategy meets environmental objectives.

7.8 FLORA AND REHABILITATION

Early flora inventories were compiled by Keighery *et al*. (1995) following closure of the BHP operations. APM (2018a) mapped conservation significant flora (Figure 7-10) and vegetation communities (Figure 7-11), and Ecologia (2005a) mapped weeds (Figure 7-12) at Koolan Island.

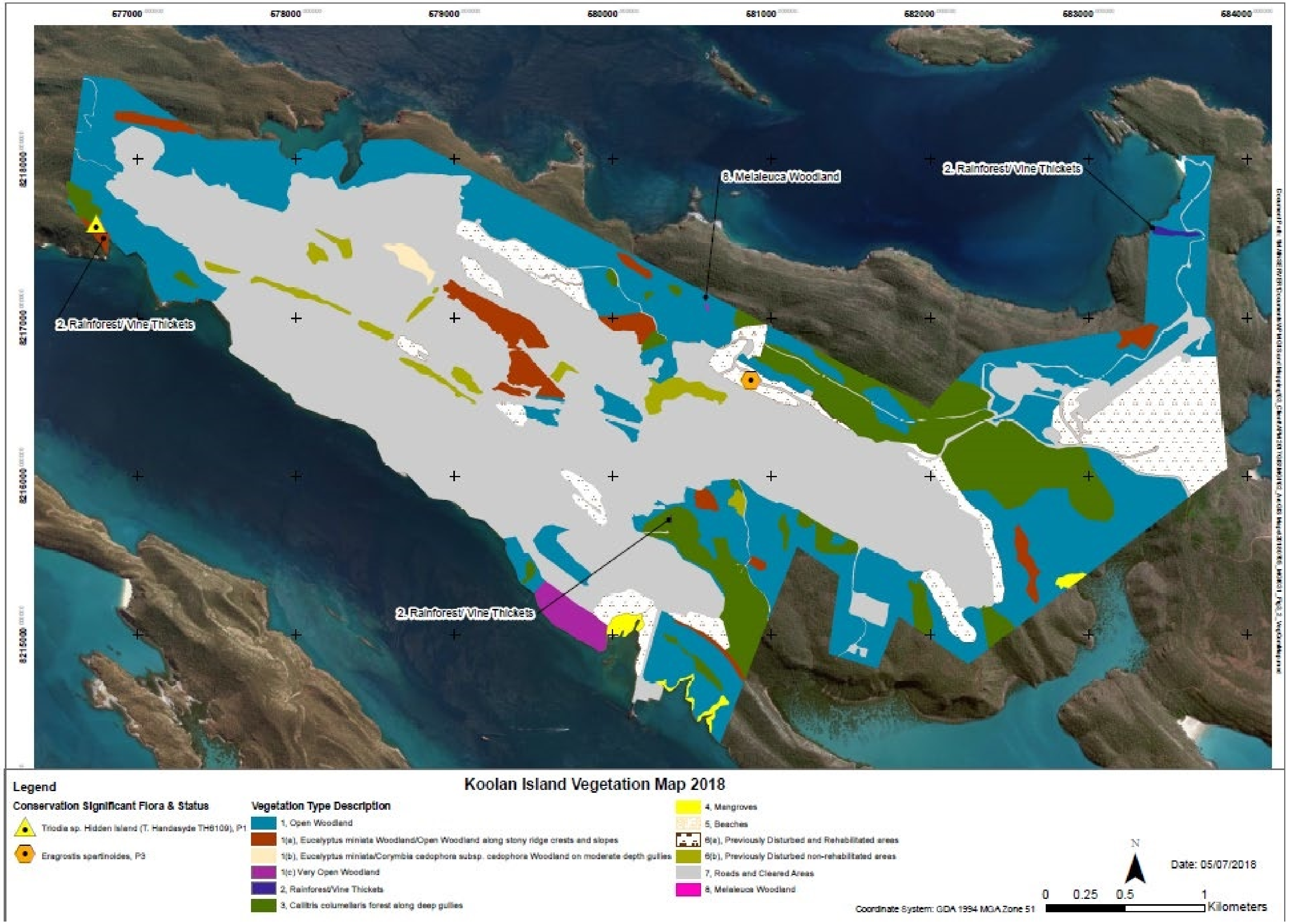
7.8.1 BASELINE FLORA DATA

- Keighery *et al*. (1995) identified a total of 282 species from 79 families forming five major vegetation units, including: open woodland, very open woodland, vine forest, mangroves and beach. 12 new naturalized alien flora species were identified post-closure of the BHP mine-site operations.
- The dominant *Eucalyptus miniata* - *Corymbia* spp. open woodlands over *Triodia* hummock grassland covers > 80 % of the non-disturbed area of the Island and is a common vegetation unit on the mainland (Beard, 1979). The understorey was composed of a diverse herb layer with species such as *Tacca leontopetaloides* and *T. maculata* being common. The density of shrubs in this community is variable but several species of *Terminalia* and *Acacia* are common.
- Ecologia (2005a) noted the floristic communities of Koolan Island are well represented on the mainland, and fairly uniform across the Island. Noxious weeds were a problem, with several highly invasive weeds, most notably *Passiflora foetida* (Stinking Passionfruit) which is invasive in moist habitats of naturally vegetated gullies, and across rehabilitated areas (see Section 7.8.3).
- The local variation in floristic composition within the dominant *E. miniata* open woodland (e.g. *Callitris intratropica* groves) does not appear to be correlated to slope, aspect or underlying soil materials across the Island.
- Subsequent surveys by KIO have confirmed several priority species ‘sightings’ of past surveys, including *Eucalyptus kennealiyi* (P1) and have reconciled previously misidentified *Acacia* spp. (e.g. *A. pyrifolia*).

Figure 7-9: Conservation Significant Flora at Koolan Island (as of 2018)

Conservation significant flora - previous records and new records of Triodia sp. Hidden Island and Eragrostis spartinoides

Figure 7-10 Vegetation communities on Koolan Island (as of 2018)


577000
578000
579000
580000
581000
582000
583000
684000
8218000
8217000
8216000
8215000
8. Melaleuca Woodland
2. Rainforest/ Vine Thickets
2. Rainforest/ Vine Thickets
2. Rainforest/ Vine Thickets
Koolan Island Vegetation Map 2018
Legend
Conservation Significant Flora & Status
Triodia sp. Hidden Island (T. Handasyde TH8109), P1
Eragrostis spartinoides, P3
Vegetation Type Description
1, Open Woodland
1(a), Eucalyptus miniata Woodland/Open Woodland along stony ridge crests and slopes
1(b), Eucalyptus miniata/Corymbia cadophora subsp. cadophora Woodland on moderate depth gullies
1(c) Very Open Woodland
2, Rainforest/Vine Thickets
3, Callitris columellaris forest along deep gullies
4, Mangroves
5, Beaches
6(a), Previously Disturbed and Rehabilitated areas
6(b), Previously Disturbed non-rehabilitated areas
7, Roads and Cleared Areas
8, Melaleuca Woodland
N
Date: 05/07/2018
0 0.25 0.5 1
Kilometers
Coordinate System: GDA 1994 MGA Zone 51

7.8.2 Species Selection

Species selection for revegetation is to be comprised of those that provide a mix of functions including colonisation, stabilisation, organic enrichment and soil nutrition, and tolerance to low water and high desiccation. One long term plant monitoring trait is height, however the establishment of species in emerging areas is also important. Areas subjected to progressive rehabilitation and fire activity provide valuable indicators of species which proliferate in emerging areas (SWC, 2015b).

The selection of framework species for use in progressive rehabilitation has considered the following:

- Species mix which provides a range of plant growth forms;
- Species present in rehabilitation trials provides confidence that germination within disturbed waste rock material is plausible;
- Inclusion of species selected for trait analysis monitoring (which underwent similar selection processes) to extract maximum value from the database being built upon through ongoing monitoring; and
- Species which are known to have adapted to conditions similar to those which will exist in areas targeted for rehabilitation.

Based on this, species selection at Koolan Island is biased towards those which have adapted to thin soil cover and low water requirements (SWC, 2015b). This has led to the following target species list:

- *Eucalyptus miniata*
- *Acacia stigmatophylla*
- *Acacia multisiliqua*
- *Dodonaea hispidula*
- *Templetonia hookeri*
- *Grevillea agrifolia*
- *Petalostigma quadriloculare*
- *Triodia spp.*
- *Acacia colei*
- *Senna goniodes*
- *Acacia monticola*
- *Acacia tumida*
- *Cajanus marmoratus*
- *Cleome viscosa*
- *Grevillea pyramidalis*

This species list may alter in time depending on the abiotic factors for specific areas subjected to rehabilitation trials.

7.8.3 Invasive Species

Figure 7-12 shows weed Locations prior to KIO operations. As part of requirements under MS 715 and the KIO Quarantine Management Plan, an annual Island wide survey for weeds has been undertaken since the commencement of operations. The 2018 annual weed survey (MGX, 2018) provides the latest information on the presence of weeds and is used by KIO to map the distribution of weeds for management and control.

The 2018 annual weed survey did not record any of the three Declared Pest target species (*Jatropha gossypiifolia* (Bellyache Bush), *Senna alata* (Candle Bush) and *Cryptostegia madagascariensis* (Rubber Vine)). Five of the seven other target species were recorded: *Arundo donax* (Giant Reed), *Leucaena leucocephala* (White Lead Tree), *Passiflora foetida* var. *hispida* (Stinking Passion Flower), *Cenchrus pedicellatus* subsp. *unispiculus* (Annual Mission Grass), and *Hyptis suaveolens* (Hyptis).

Prior to 2015 the BHP town site area had been surveyed on an annual basis. The town site is known to be the origin of the majority of the weed species present on the Island. As the total eradication of these weeds is unlikely to ever be achieved, ongoing monitoring of the site is unnecessary. Instead, the periphery of the town site has become the focal point for monitoring weed spread and has been designated as Weed Monitoring Zone 1. In the 2016 survey the BHP town site was revisited to validate weed source identifications. In 2018 it was decided to bypass the Weed Monitoring Zone 1 as intensive work had been undertaken in that area and any other management controls were considered unlikely to be practicable or effective. MGX has not created any disturbance to the old BHP town site and therefore has no legal responsibility to manage the land or the weeds within the area.

The key weed species associated with mine closure for successful rehabilitation outcomes is Stinking Passionflower (*Passiflora foetida)*. The 2018 annual weed survey indicates the weed is abundant at various sites , with the report finding the species to be “has spread significantly since 2007, most notably in Zone 9 where it was previously recorded in only two locations” (MGX, 2018).

Stinking Passion Flower is generally constrained by soil moisture. Following rains the plants grow vigorously and tend to form monocultures where moisture is abundant through the year. The distribution of Stinking Passion Flower also appears to be very strongly correlated with the presence of artificial barriers to natural water flow: Windrows along roadsides, moonscape legacy rehabilitation and abandonment bunds around the mine pits. These artificial mounds of unconsolidated material hold water for longer than the normally skeletal soils and give the passion vine soil medium in which to establish a more robust root mass. BHP legacy areas including old stockpiles, waste dumps and rehabilitated areas tend to present the highest occurrence of Stinking Passion Flower.

Stinking Passion Flower is spread by *Cacatua sanguinea* (Little Corella) and *Dasyurus hallucatus* (Northern Quoll) feeding on the fruit, and also vehicle movement. The number of West End populations increased significantly following exploration drilling in 2012.

Webber *et al*. (2014) published a report which included data collection from research plots established on Koolan Island. This report concluded that control of Stinking Passion Flower is unlikely to be effective using conventional methods such as spraying and manual removal while conditions remain favourable for regeneration. CSIRO are currently trialling a biological agent to act as a control on Stinking Passion Flower in Northern Australia. The agency was contacted in early 2018 and Koolan Island offered as a potential trial location to further assess the control.

Targeted control of weeds using herbicides and manual removal is undertaken at Koolan Island in areas of infestation, focussing on infrastructure and areas under rehabilitation. Target species include declared weeds species near the airport and environmental weeds such as annual grasses, *Passiflora foetida* and *Leucaena leucocephala* in the Mining areas and Village.

CSIRO research into biological control of *P. foetida* is expected to commence on Koolan Island during the last quarter of 2019. The current proposal is the establishment of a trial plot on Koolan Island as well as other locations in the Kimberley Region. KIO will provide in-kind support during the project. Outcomes shall be reported to the DEE and DWER EPA Services.

Research into Northern Quoll dietary requirements shows evidence in scat samples that *P. foetida* fruit is a source of food and moisture. Research opportunities to provide further data on a potential relationship between Northern Quoll and weeds on Koolan Island is being considered. Bird life is often observed feeding on the *P. foetida* fruit, contributing to the spread of the weed seeds.

Mount Gibson Iron

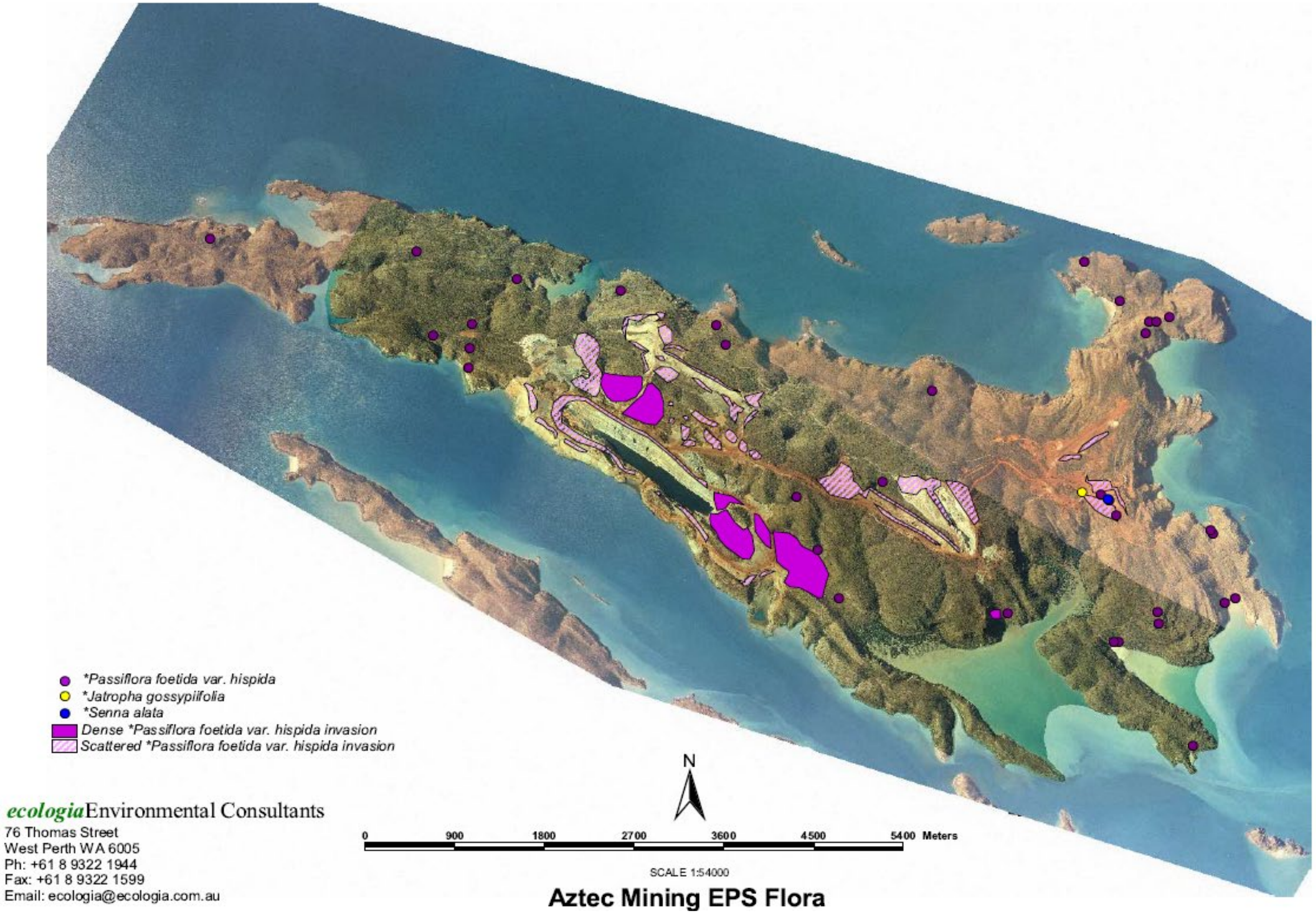


Figure 7-11 Weed Locations (2005) prior to mining under MS 715

7.8.4 REVEGETATION AS PART OF REHABILITATION

The majority of cleared land has been active for mining purposes and due to limited access and the footprint of active mining, rehabilitation of MGX disturbance is restricted to WD4 Bay 4, Barra Limb, WD4 and Scree (Figure 7-13). KIO first established rehabilitation trials in 2009 with stage 1 of Barra Limb rehabilitation, followed by the WD4 Bay 4 rehabilitation trial in 2010, and the expansion of Barra Limb rehabilitation to include stage 2 in 2011. The different rehabilitation trial areas received similar treatments, with slopes battered down to approximately 20°, covered with approximately 100 – 400 mm of topsoil, and ripped on contour. In addition to these rehabilitated areas of MGX disturbance, some areas historically disturbed by BHP were rehabilitated prior to MGX activities, generally by moonscaping then seeding. Revegetation has also occurred on a smaller trial scale at the WD1 surface treatment trials (section 7.7.4).

A brief summary of the background and methodology applied for the rehabilitation of these areas is provided below:

- Comprehensive photographic herbarium was compiled by KIO staff, with baseline data collected on numbers and species of plants growing in 10 different analogue habitats across the Island. Seedling databases were developed for the purpose of identifying plant species early in rehabilitation monitoring.
- Data from the analogue quadrats was used to guide seed mix for the rehabilitation areas (section 7.8.4), with Barramundi Limb Stage 2 and WD4 direct seeded. Barramundi Limb Stage 1 rehabilitation was not direct seeded, with all subsequent plant growth either from the residual seed bank within the topsoil or transported seed from other areas carried by wind or fauna.
- Monitoring has been carried out within quadrats (approximately 10m x 10m) set up within the five rehabilitation areas (including the WD1 cover trial), with plant species and numbers recorded along with general observations and photo monitoring. LFA has been utilised to monitor revegetation since 2012.
- Seed collection is biased towards those which have adapted to thin soil cover and low water requirements. The selected species mix is based on those which been observed to establish and grow in rehabilitated areas, areas subjected to re-establishment of vegetation (i.e. subjected to naturally occurring bushfires) and the species selected for traits analysis (section 7.8.2). A database of seed weights has been developed for the purpose of designing seed mix volumes. Seed is stored in self-contained, temperature controlled facilities on site. Based on site investigations the optimum conditions for seed storage are low light, low oxygen, temperature of 15°C and 15% humidity. The facility on the Island stores seed at 23°C and humidity is controlled by air conditioners which maintain the facility at this temperature. Vacuum packaging is also used and seed viability testing has been undertaken by external providers previously.

In 2018/19 the scope of the rehabilitation monitoring was expanded from previous years. The LFA was repeated on the sites that have been previously monitored, new sites were added, including older rehabilitation areas, rehabilitation trials and analogue sites, increasing the total number of transects from 8 to 16. Erosion monitoring and vegetation structure measures were also expanded to all sites. Photo monitoring, floristic diversity and vegetation structure monitoring was resumed from a hiatus since 2014 and expanded to all LFA sites in order to generate EFA information. A methodology for assessing the habitat for terrestrial vertebrates was also developed and applied. The scope of the APM (2019) LFA / EFA report was expanded relative to previous years to include recommendations for remedial action on progressively rehabilitated sites and inform the rehabilitation methodology for future works.

The APM (2019) study findings and progress of the rehabilitation undertaken so far are detailed below.

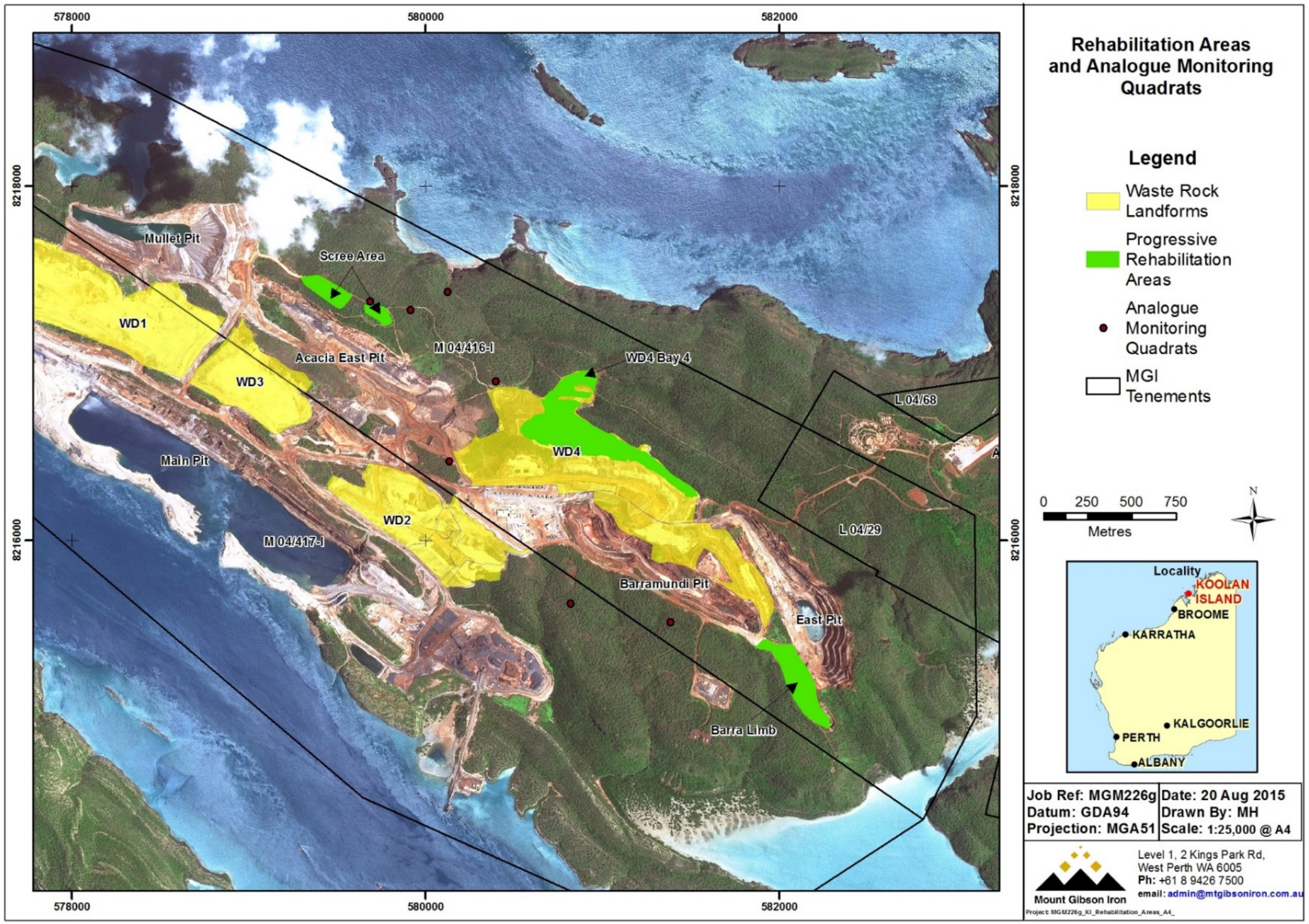


Figure 7-12 Rehabilitation Areas & Analogue Monitoring Quadrats

The areas surveyed by APM (2019) for EFA / LFA results and trends are shown in Figure 7-14. Particularly, investigation areas were:

- Analogues (assessed to inform natural or undisturbed settings);
- BHP rehab area (BHP Moonscaping Area near MGX ROM);
- Barra Limb rehab area;
- WD 4 area;
- Bay 4 rehab area on WD 4 "Spur";
- Scree rehab area; and
- WD 1 Rehabilitation Trials

Furthermore, for a subset of these areas investigated on the ground and reported by APM, eMapper Pty Ltd also did satellite image analysis of the same areas to generate rates of recovery of vegetation. Analysis was undertaken using high spatial resolution satellite imagery for five selected years (2000, 2004, 2015, 2018 and 2019) and for a time-series of Landsat imagery between 1993 and 2019. Vegetation cover was analysed within assigned 20 m quadrats and compared within the identified target rehabilitation areas. The analysis indicated good recovery in all of the assigned Koolan Island areas analysed, and that recovery was either on par, or exceeding rates observed in the historic BHP rehabilitation.

The full set of these parameters gives a synthesis of:

- The contemporary rehabilitation condition of target areas to determine their suitability for closure; and,
- Based on the applied treatments, evidence that adopted methods and treatments might also be applied elsewhere.

7.8.4.1 Analogue Areas

Floristic Diversity

Three Analogue areas selected for EFA are in the same locations as representative Open Woodland slopes for the target seed mix used in rehabilitation of Bay 4 and Barra Limb Stage 2. The 10 x 10 m quadrats recorded between 15 and 21 (average 18.3) native species. No weed species were recorded. By structural class there was an average of 0.3 climbers, 3.3 groundcover species, 5.7 shrub species, 4.3 tall shrub species and 4.7 tree species.

Vegetation Structure

Analogue site vegetation structure is summarised in Table 7-8.

Table 7-8: Key Open Pit Characteristics

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	11,070	10358	865	584	22,877
Canopy Volume (m^3) per hectare	1,599	268	958	2,189	5,105

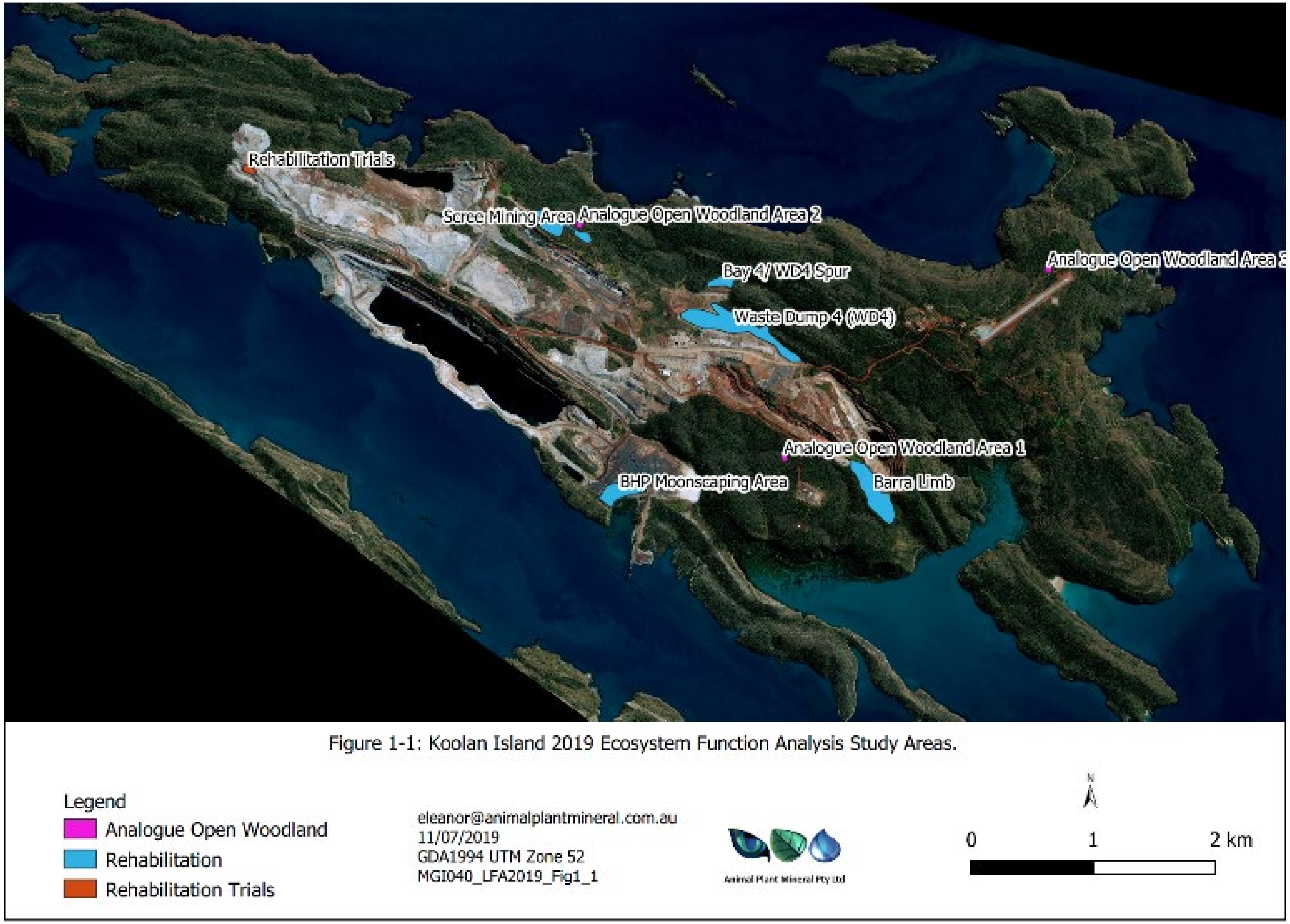


Figure 1-1: Koolan Island 2019 Ecosystem Function Analysis Study Areas.

Figure 7-13 APM (2019) LFA / EFA Survey Sites

7.8.4.2 BHP Moonscaping Area

Site Description and History

BHP rehabilitated areas before relinquishing in the 1990s. Most of these areas have been re-disturbed by the Project, but some rehabilitated areas remain, such as the moonscaped area east of the ROM (Figure 7-14). No records exist about prior use of the area by BHP, rehabilitation methodology or whether seed was applied. Moonscaping has been applied and the slope is approximately 20° overall with the upper slope shallower and the lower slope steeper. The soil hummocks remain intact in 2019 and are ≈800 mm high in most places. The surface soil texture and appearance indicates crushed siltstone was used in the surface preparation. It is not known whether siltstone was only used on the surface or as a subsurface layer also. It appears a thin layer of topsoil was spread at some point and the existing surface soil is a mixture of topsoil and siltstone.

No monitoring of this rehabilitation had been conducted prior to 2019. One 50 m LFA transect, 4 photo sites and 3 floristic monitoring sites were established in 2019 (Figure 7-15). It is estimated the site was rehabilitated in 1993, providing information about longer term rehabilitation performance, and the use of siltstone is informative for the rehabilitation planning process.

Landscape Organisation Index

Landscape Organisation Index (**LOI**) values for the area are approaching or exceeding those of the Analogue sites (Figure 7-16) as the vegetation cover is unbroken in the location of the LFA transect. Other parts of the site have open ground and a second LFA transect may need to be installed in 2020 to achieve better coverage of the site. No large rocks occur at the surface, as in the Analogue sites.

Soil Surface Indices

The Stability Index is within 10 % of typical Analogue values (Figure 7-16) due to good rain splash protection provided by the high cover of vegetation under 0.5 m, consistent litter cover reaching 100 mm depth in places, no evidence of erosion or deposited materials, good surface resistance to disturbance and a soil crust that maintains structure when wet.

Other Indices

The infiltration and nutrient indices for the BHP site were equal to the Analogue sites (Figure 7-16), due to the high perennial vegetation cover, deep and well distributed litter cover, and the high surface roughness (resulting from BHP's moonscaping). Erosion was not evident at the BHP site. The moonscaping or hummock dumping is intact and contains rainfall within the bunded sections, preventing lateral surface flows.

Floristic Diversity

Fifteen species were present; by structural class there were 0 climbers, 8 groundcover species, 2 shrub species, 4 tall shrub species and 1 tree species. Analogue sites contained an average of 18.3 species.

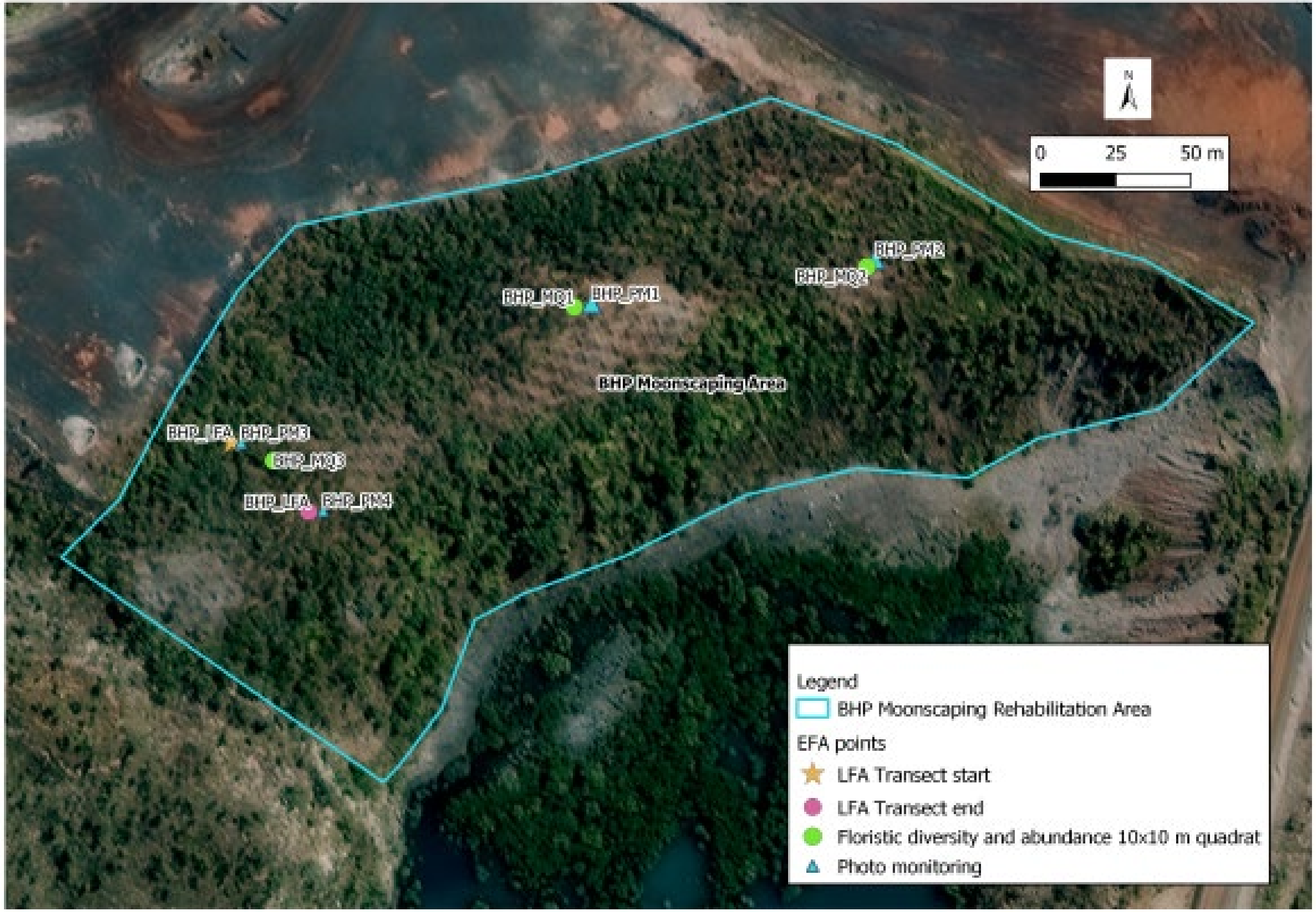


Figure 7-14 BHP Moonscaping rehabilitation area monitoring layout. Inset photo taken from BHP_PM2 facing west

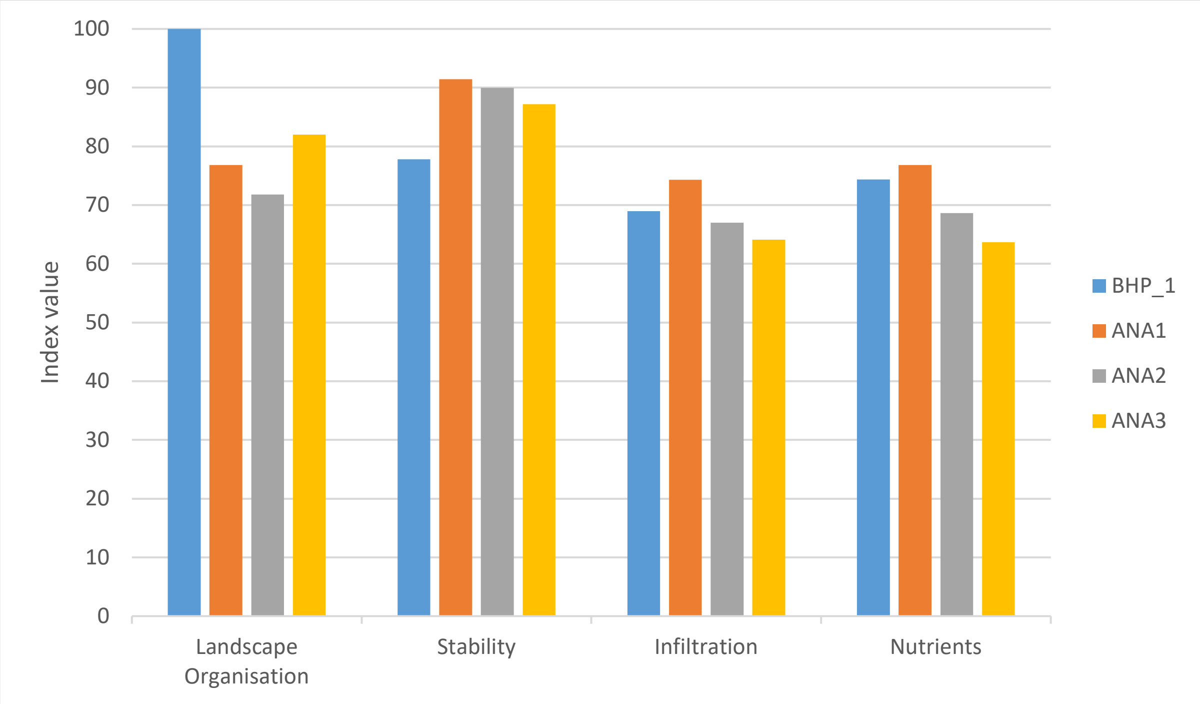


Figure 7-15: Landscape Organisation, Stability, Infiltration and Nutrient Index values of the BHP Moonscaping transects compared to the Analogue transects

Vegetation Structure

The BHP area far exceeded the mean analogue value for the number and canopy volume of groundcover plants (Table 7-9). For shrubs and tall shrubs the number of individuals is less than the mean analogue but the canopy density exceeds the mean analogue value, indicating there are fewer but larger plants in these strata. Whilst one tree species was recorded in the transect, the number and canopy volume is insignificant.

Table 7-9: Vegetation Structure of the BHP area

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	11,070	10358	865	584	22,877
% of Analogue	1,167	12	89	0	**293**
Canopy Volume (m^3) per hectare	1,599	268	958	2,189	5,105
% of Analogue	251	102	176	0	**288**

7.8.4.3 WD4 Bay 4

Site Description and History

Rehabilitation earthworks at Bay 4 on the WD4 Spur were completed in 2011. Slopes were battered down to ≈ 20°, covered with 100 – 400 mm of topsoil and ripped on the contour. Bay 4 was direct seeded with 2.06 kg ha^{-1} of seed mix containing 31 species developed from 10 analogue quadrats located in undisturbed Open Woodland across the Island. Soil testing by SWC (2015b) indicated that the surface of the Bay 4 landform is constructed from highly weathered, variably mineralised sandstone and siltstone materials.

Monitoring commenced in mid-2011 with eight 10 x 10 m floristic diversity and abundance monitoring quadrats and photo monitoring points. One transect was installed and repeated measurements were taken in 2012, 2015, 2016, 2017 and 2019. Recently two of the historic monitoring sites were selected for continued monitoring, and a third new site was added to ensure coverage of the varying floristic composition and density across the site (Figure 7-17).

Landscape Organisation Index

Following high rainfall from the cyclone in late 2013, large amounts of vegetation growth occurred which in combination with the troughs increased the LOI to 80% (Figure 7-18). Weathering of the bank / trough system between 2015 and 2016 and death of short-lived perennial species led to a reduction in LOI in 2016. The distribution of litter on the ground is important in defining the LFA 'Patch' areas and it is likely that large litter accumulation post the cyclone-induced growth was present in 2015 but by 2016 erosion had restricted its distribution to the troughs. From inspection of the photo monitoring it is likely that the area occupied by troughs on landscape formation was greater than 20%. Between 2016 and 2019 LOI has steadily increased to within 15 % of the mean Analogue value. In 2019 perennial hummock grasses are frequent in the gully area and have spread a small distance up the slope to the bottom of the transect. The introduced *Passiflora foetida* vine is also in the lower gully area.

LOI of B4_S2 transect is just under 60%. This is predominantly influenced by the intact bank and trough system. Although there is perennial woody vegetation cover on the transect it is of lower density than B4_S1. A bare section occurs in the middle of the B4_S2 transect where large rocks occur at the surface and there is no soil cover. This situation is not dissimilar to the rocky outcrops that occur in the Analogue sites, however the proportional cover is approximately double in this transect.

Other Indices

The Stability Index values for the Bay 4 transects in 2019 is within 30% of the Analogue sites (Figure 7-19).

Infiltration Index values are at approximately 60% of analogue values, and the index value has increased at B4_S1 in 2017 and in 2019 from the previous year (Figure 7-20). The increase over time is due to the increase in the LOI raising the proportional influence of the zones on the overall transect values and an increase in litter cover and decomposition. The lower than analogue value is due to a lower vegetation and litter cover, and a reduction in the soil surface roughness measure in places where the bank and trough landform has evolved to a slope without rock armouring or vegetation cover.

Nutrient Index values at Bay 4 are 50-60% of analogue values, but the time series data at B4_S1 shows and increase, particularly between 2017 and 2019 (Figure 7-21). The change over time is driven by the accumulation of litter and the positive effect that is having on the level of decomposition. As the litter accumulates to depth, moisture is trapped and decomposition is accelerated.

Floristic Diversity

Sixteen different species were recorded at Bay 4. On average there are just under 7 species per quadrat at the Bay 4 rehabilitation area in 2019. Although there have been some minor seasonal fluctuations over time, and some species turnover, the number is relatively constant (Figure 7-22).

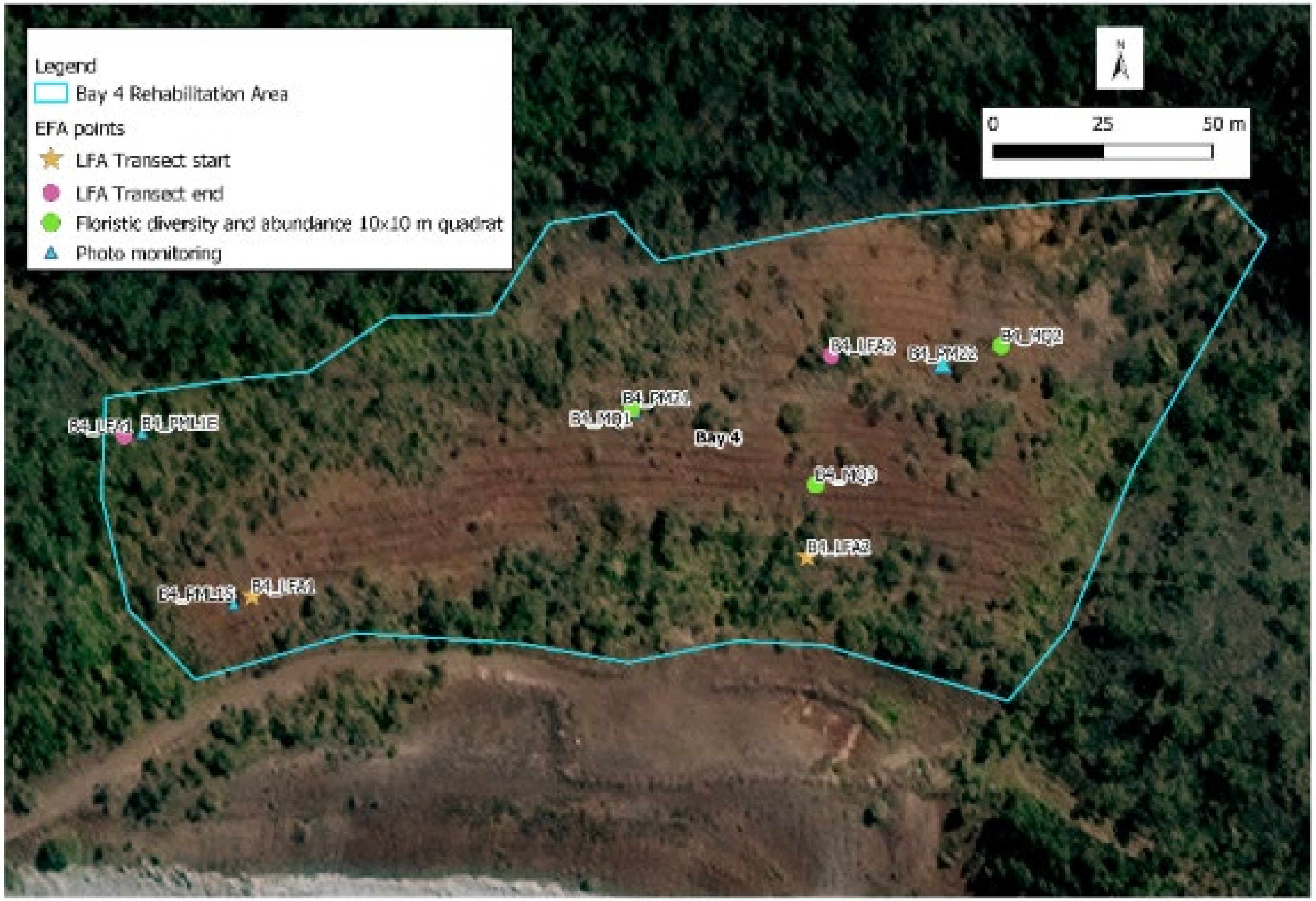


Figure 7-15 Bay 4 Rehabilitation Area (on the WD4 Spur) monitoring site layout

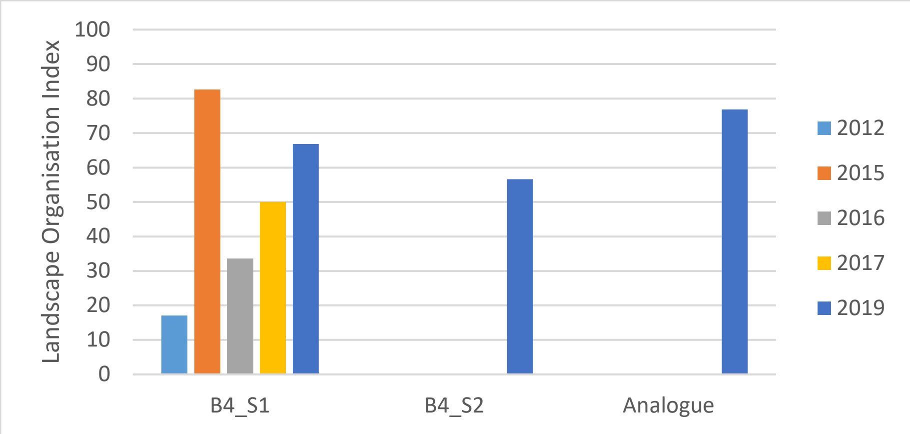


Figure 7-16: Landscape Organisation Index at the Bay 4 Transects compared to the mean of the Analogue transects

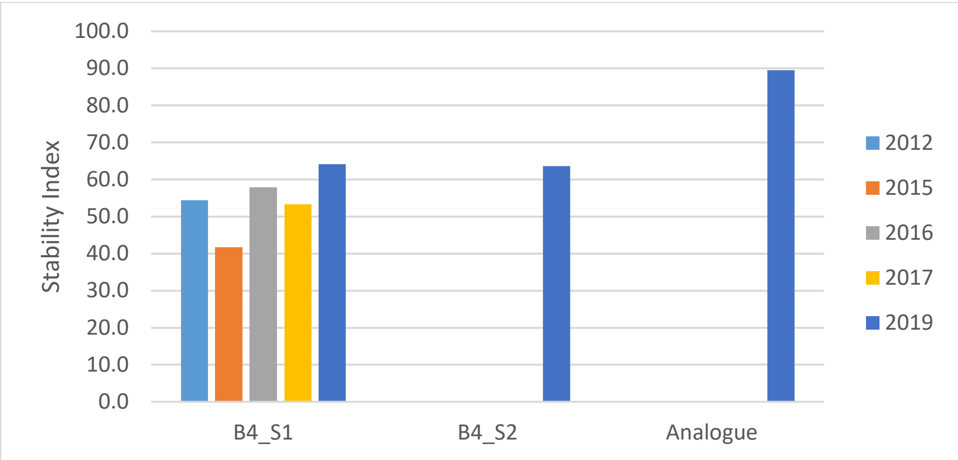


Figure 7-17: Soil Stability Index at the Bay 4 Transects compared to the mean of the Analogue transects

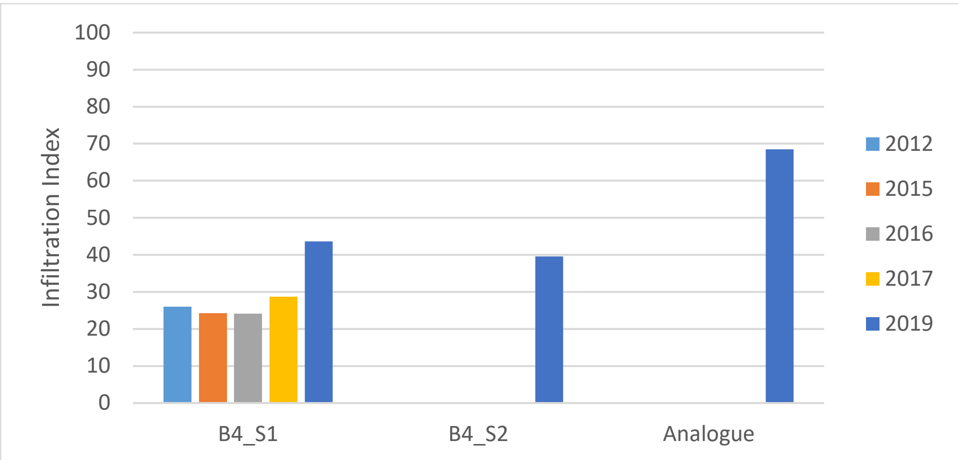


Figure 7-18: Infiltration Index values at the Bay 4 Transects compared to the mean of the Analogue transects

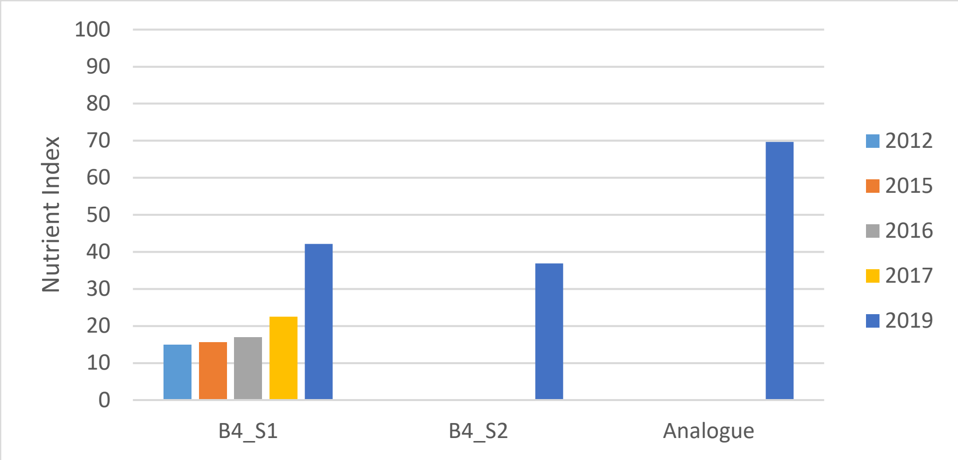


Figure 7-19: Nutrient cycling Index values at the Bay 4 Transects compared to the mean of the Analogue transects

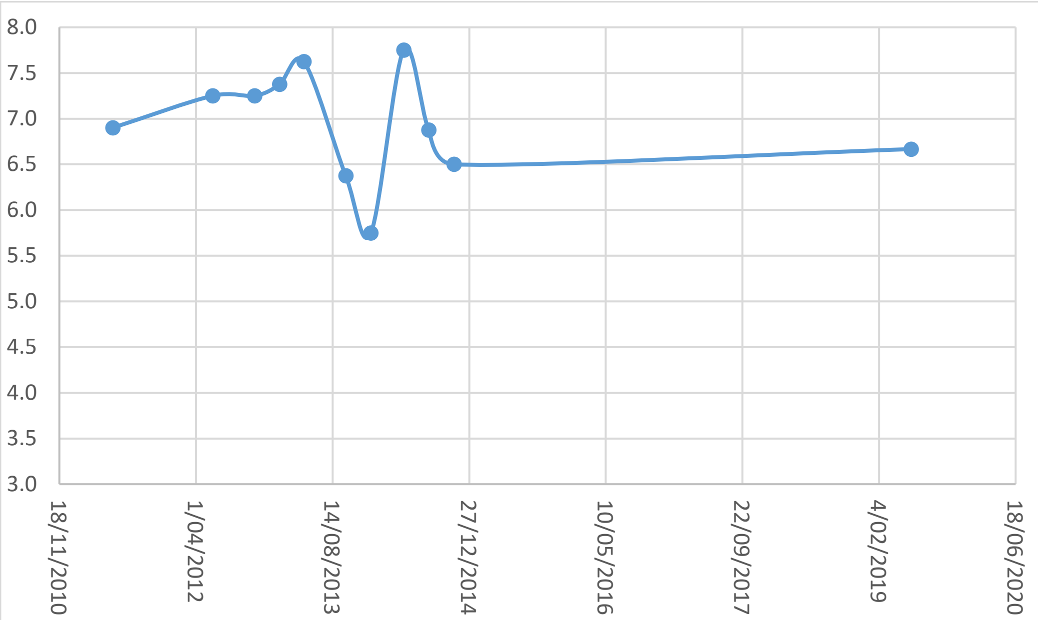


Figure 7-20: Average number of species present in the monitoring quadrats at Bay 4 over time

In 2019, three representative quadrats were selected. By structural class there were on average 0 climbers, 2.7 groundcover species, 1.7 shrub species, 2 tall shrub species and 0.3 tree species; on average 6.7 species per quadrat. In comparison of the seed mix applied at Bay 4 in 2011 and the species present in the monitoring quadrats in 2019, 9 species are present from the seed mix and 7 species are present that were not. This may represent diffusion of seed across the edges between the rehabilitated and undisturbed areas. Eight of the target species defined by SWC (2015b) were present at Bay 4.

Vegetation Structure

Bay 4 transect vegetation structure is summarised in Table 7-10. The number of plants and the volume of the groundcover strata is very low compared to the Analogues. In the shrub layer, there are far fewer individuals but their size is large in comparison and as such they approach the analogue canopy volume for that strata.

Table 7-10: Vegetation Structure of the Bay 4 site

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	2,193	766	531	352	3,843
% of Analogue	20	7	61	60	**17**
Canopy Volume (m^3) per hectare	113	208	2,479	1,278	4,077
% of Analogue	7	77	259	58	**81**

Erosion

Very little erosion is evident on Bay 4. The trough and bank system is intact over much of the landform and where it has evolved into a slope there are very few rills or gullies present. The most recent erosion measurements taken on the B4_S1 transect are from 2017 where 11 rills and 2 gullies were recorded, totalling 5,596 m^2. The reduction between 2017 and 2019 in erosion rates is a result of the landscape evolution towards a slope and vegetation and litter filling the older erosion features and stabilising them.

Weeds

A scattering of *Melinis repens* (red natal grass) occurs at Bay 4 and is common in low densities across the disturbed areas of Koolan Island. *Passiflora foetida* is common at Bay 4 and is a target weed in the Koolan Island Quarantine Management Plan, which details control actions for the invasive vine species. The species was present on Koolan Island prior to MGX ownership and commonly inhabits disturbed areas with elevated soil moisture.

Vegetation Cover

The work of eMapper (2019) shows vegetation cover in the Bay 4 area adjacent the re-instated Pindan Drainage (Figure 7-23). The area has shown good recovery between 2015 and 2018. There is also evidence of further recovery between 2018 and 2019, with decreases in areas of sparser vegetation cover.

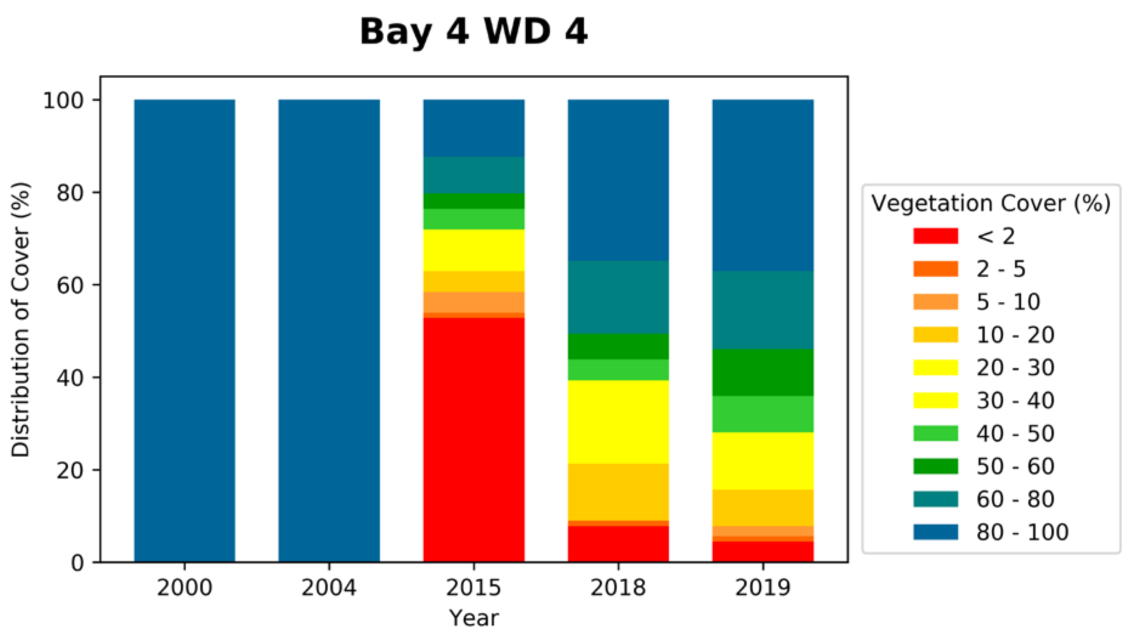


Figure 7-21: Distribution of vegetation cover for Pindan Drainage rehabilitation site

7.8.4.4 Barra Limb

Site Description and History

Barra Limb Waste Dump was rehabilitated in two stages (Figure 7-24). Barra Limb Stage 1 earthworks were completed in 2009 with slopes battered down to ≈ 20°, covered with approximately 100 – 400 Mm of topsoil and ripped on the contour. Stage 1 rehabilitation was not direct seeded. Plants growing on Stage 1 likely originate from the stored seedbank in topsoil that was respread or have diffused across the boundary with undisturbed areas. Barra Limb Stage 2 rehabilitation earthworks were completed in 2011. Slopes were battered down to ≈ 20°, covered with approximately 100 – 400 mm of topsoil and ripped on the contour. On the steeper southern slope light moonscaping was applied to reduce the risk of erosion. Barra Limb Stage 2 was direct seeded with 7.1 kg ha^{-1} of seed mix contained 105 species developed from 10 analogue quadrats located in undisturbed Open Woodland across the Island. Soil testing by the Soil Water Group (SWC 2015b) indicates that Barra Limb Stage 2 surface is siltstone.

Landscape Organisation Index

The area has been monitored on up to 7 occasions between 2012 and 2019 (Figure 7-25).

Ripping on the contour at Barra Limb provided a landscape with troughs recorded in 2012 as occupying over 30% of the slope. Weathering of the bank / trough system between 2012 and 2016, led to a reduction in LOI to 2015. In 2019, LOI has rapidly increased to exceed the mean Analogue value. The bank / trough system is still in place over both of the transects, and perennial vegetation cover is high. A lack of consistent groundcover vegetation is an important factor in the litter flux. Groundcover vegetation such as perennial grasses and low shrubs trap litter during climatic events and prevent high wind speeds at the ground surface.

Soil Surface Indices

The Stability Index values for the Barra Limb transects in 2019 is within 30% of the Analogue sites (Figure 7-40). Factors with a positive influence on the Stability score are the increased LOI, good litter build up and decomposition in the patch zones, intact soil crusts and very little evidence of erosion.

Other Indices

Infiltration Index values for the Barra Limb transects in 2019 are within 65 -80% of the Analogue sites (Figure 7-27). Factors with a positive influence on the Infiltration score that have increased between 2018 and 2019 are the increased LOI and the increased litter cover and extent of decomposition. Unchanged factors are the high scores for surface roughness and the good soil texture and structure.

Nutrient Index values for the Barra Limb transects in 2019 are within 55 -80% of the Analogue sites (Figure 7-28). The trends in the Nutrient Index score emulate those in the other indices at Barra Limb where the consistency of the litter cover, the depth of the litter and the extent of decomposition drive the patterns. If the litter that is present in 2019 is maintained there will be a steady increase in the Index values although loss of the litter through high winds or heavy rainfall may see the index values decline in the future.

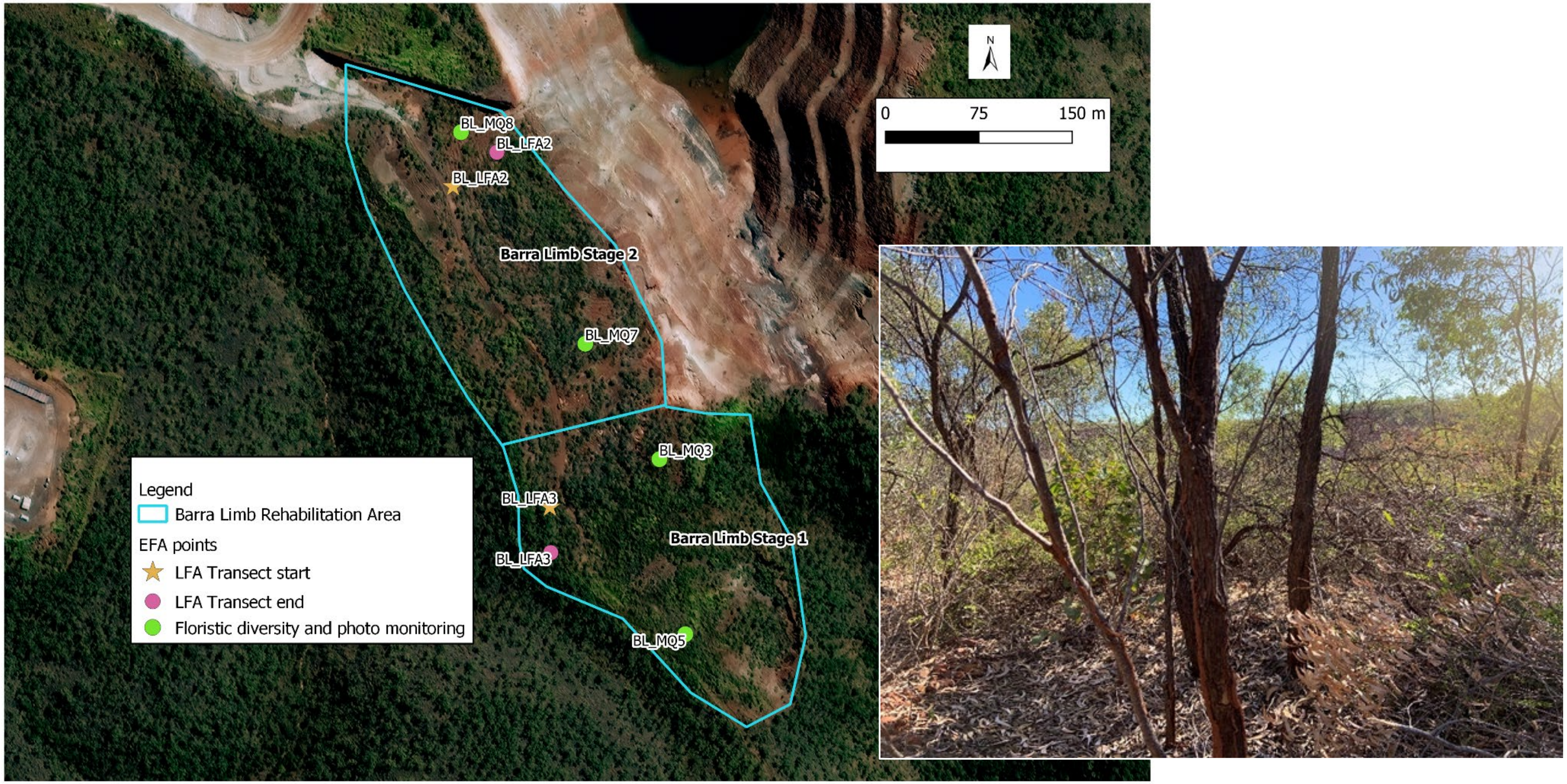


Figure 7-22: Barra Limb Rehabilitation monitoring layout. Inset photo taken from BLMQ7 facing east

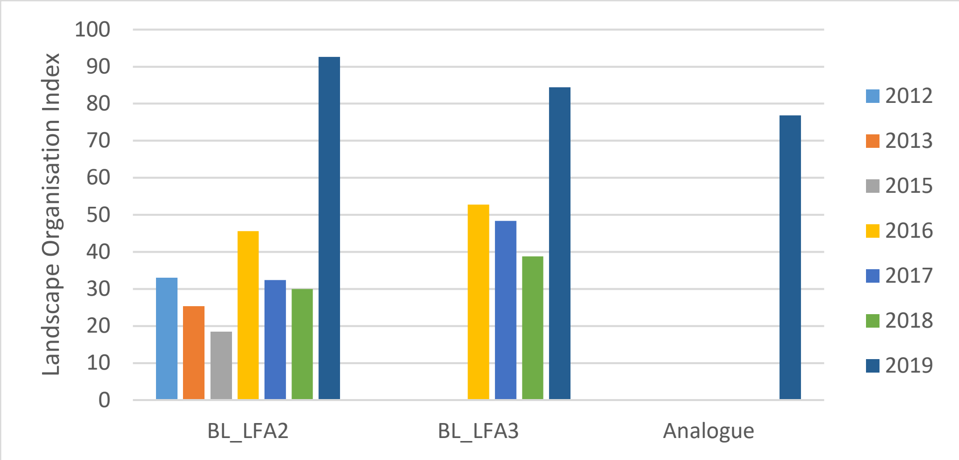


Figure 7-23: Landscape Organisation Index at the Barra Limb Transects compared to the mean of the Analogue transects

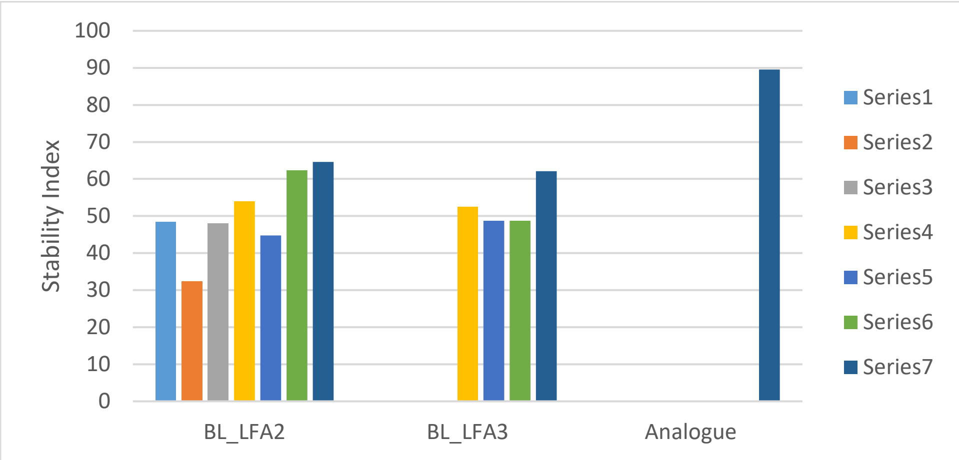


Figure 7-24: Stability Index at the Barra Limb Transects compared to the mean of the Analogue transects

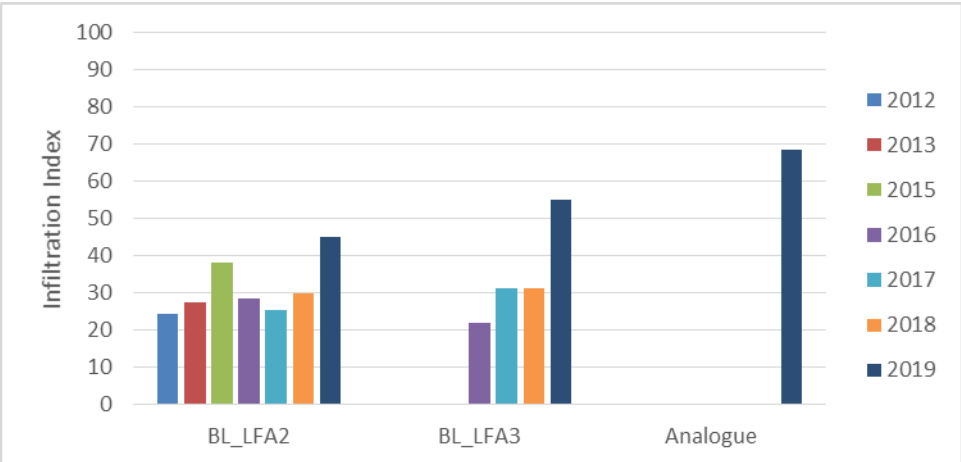


Figure 7-25: Infiltration Index at the Barra Limb Transects compared to the mean of the Analogue transects

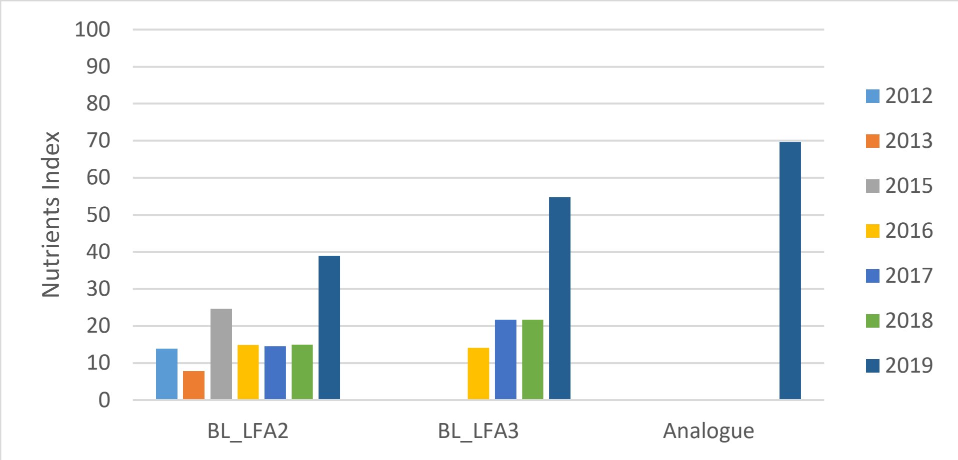


Figure 7-26: Nutrient Index at the Barra Limb Transects compared to the mean of the Analogue transects

Floristic Diversity

Eighteen species were recorded on Barra Limb. On average there are just over 7 species per quadrat in 2019 (Figure 7-29). There was an initial increase in number of species from the end of 2012 to the end of 2013, followed by a decline then recovery in 2019 to the level previously reached in 2013. Interestingly, the decline follows the cyclone in late 2013, so is unlikely to be due to insufficient soil moisture in that period. While Stage 2 (seeded) was richer than Stage 1 (unseeded) up until the end of 2014 (there was 2 more species present compared to the unseeded area), by 2019 the unseeded quadrats recorded greater richness.

Up to the end of 2014, ten quadrats were monitored. In 2019 four representative quadrats were selected, two from each Stage. By structural class, there were on average 0.5 climbers, 0.75 groundcover species, 1 shrub species, 3.5 tall shrub species and 1.5 tree species. Seven of the target species defined by SWC (2015b) were present at Barra Limb.

APM (2018) recorded 20 local provenance species in the 2,500 m^2 quadrat at Barra Limb Stage 2.

Vegetation Structure

Barra Limb transect vegetation structure is summarised in Table 7-11. The number of plants and the volume of the groundcover strata is very low compared to the Analogues. In the shrub layer, there are far fewer individuals but their size is large in comparison and as such they approach the analogue canopy volume for that strata.

Erosion

Despite records of erosion, the intact bank and trough system is containing instances of concentrated surface flow to a maximum of one to two meters, generally one or two trough intervals at most. All recorded erosion features had vegetation and/or rock armour, but many had a significant amount of litter suggesting they are active but stable.

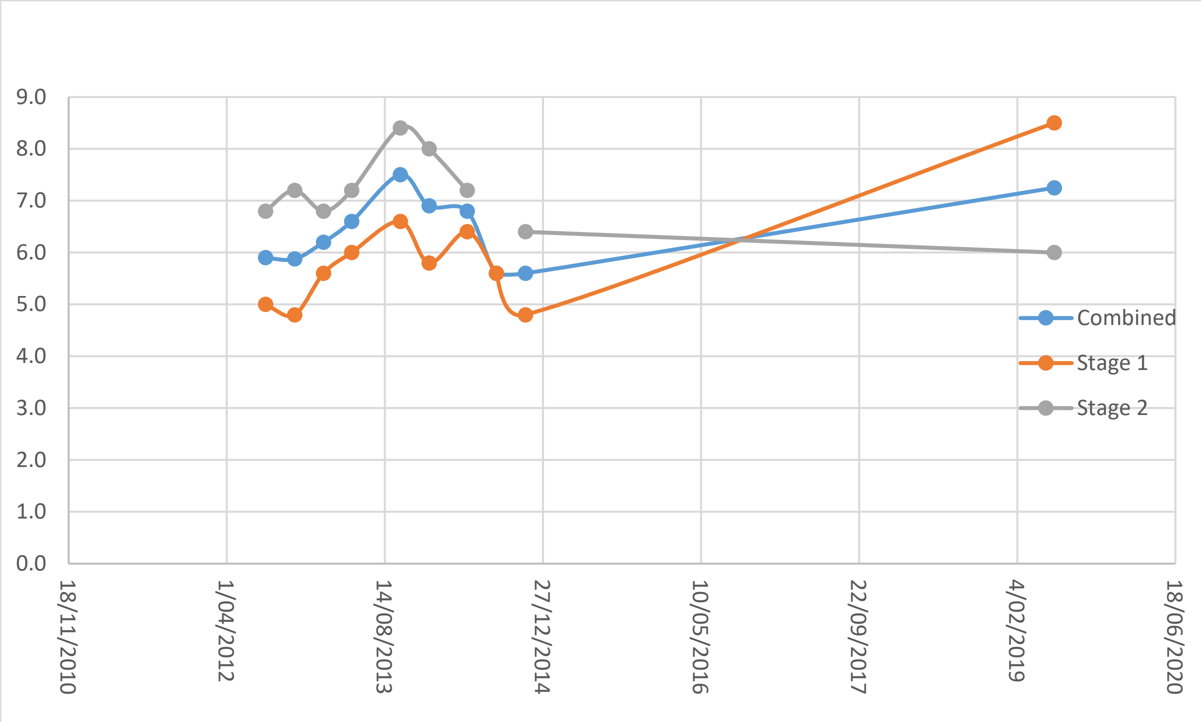


Figure 7-27: Number of species present in the monitoring quadrats at Barra Limb over time

Table 7-11: Vegetation Structure of the Bay 4 site

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	11,941	3,036	1,833	2,890	19,700
% of Analogue	108	29	212	495	**86**
Canopy Volume (m^3) per hectare	201	1,346	5,192	4,531	11,271
% of Analogue	13	502	542	207	**225**

Weeds

A small number of *Melinis repens* (red natal grass) occurs at Barra Limb and is common in low densities across the disturbed areas of Koolan Island. *Passiflora foetida* is common at Barra Limb, often as small individual plants scattered throughout the rehabilitation area. There are also dense pockets where the vegetation is completely obscured by vines. A small number of Pilbara *Acacia* species are found on the Barra Limb rehabilitation area from BHP revegetation works in the 1990s.

Vegetation Cover

The work of eMapper (2019) shows that there was strong recovery of densely vegetated areas (cover >80%) from 2015 to 2018 (Figure 7-30). The amount of sparsely vegetated area (<2%) is also approaching the baseline values from 2000 to 2004 in the 2019 result.

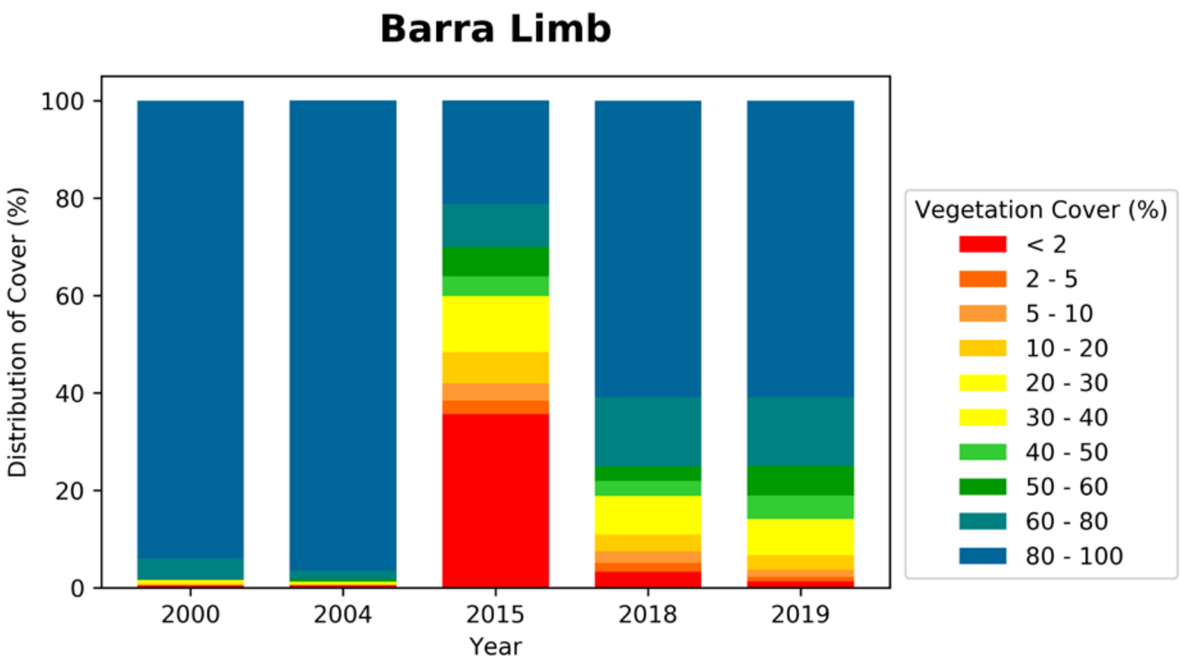


Figure 7-28: Distribution of vegetation cover for Barra Limb rehabilitation site

7.8.4.5 WD4

Site Description and History

Rehabilitation earthworks at WD4 were completed in 2015 in areas of the WD4 landform where waste rock dumping was complete. Slopes were battered to 14-20° and berms 3 – 10 m wide were installed where possible. Topsoil was spread between 150 – 200 mm depth. Deep ripping on the contour was applied. No direct seeding was applied. Layout of the monitoring locations is displayed in Figure 7-31.

Soil testing by SWC (2015b) indicates that the surface of the WD4 landform is constructed from highly weathered, variably mineralised sandstone and siltstone materials.

Landscape Organisation Index

The WD4 transects have been monitored 4 times since 2016 (Figure 7-32).

Ripping on the contour at WD4 provided a baseline landscape with troughs recorded in 2016 as occupying approximately 45% of the slope. The bank and trough system has quickly evolved to a slope in most parts of the WD4 slope by 2019, but steady increase in vegetation cover has seen the LOI steadily increase over time, without the same effect as at Bay 4 and Barra Limb. In 2019, LOI has rapidly increased to within 10% of the mean Analogue value. The perennial vegetation cover is high and the distribution of litter is a strong factor in the increased LOI from 2018 to 2019. The patches of litter extend beyond individual canopies, linking up plants that are adjacent. A lack of groundcover makes the accumulation of litter in 2019 vulnerable to erosion.

Figure 7-29: WD4 Rehabilitation Area monitoring site layout. Inset photo taken at WD4_LFA1 end facing south.

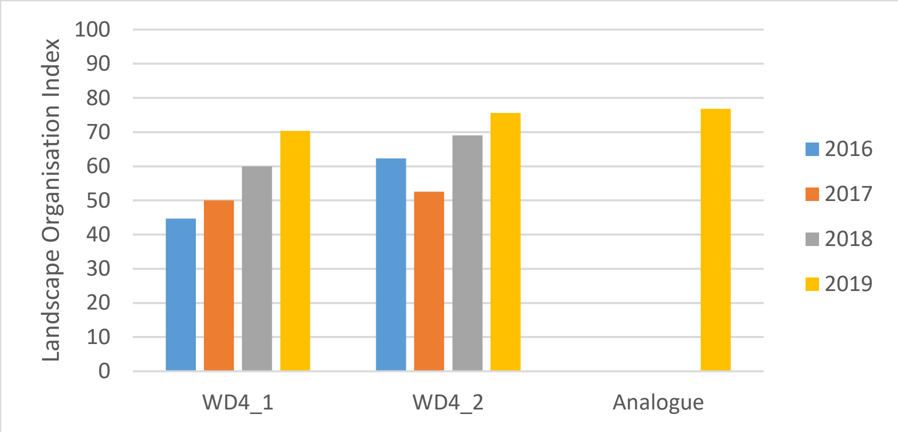


Figure 7-30: Landscape Organisation Index at the WD4 Transects compared to the mean of the Analogue transects

Soil Surface Indices

The Stability Index values in 2019 are within 30% of the Analogue sites. Factors with a positive influence on the Stability score are the rock armouring providing good rain splash protection, maintenance of good soil surface roughness despite the loss of the trough/bank system which is also a result of the rock armouring, intact soil crusts and very little evidence of erosion.

Other Indices

The Infiltration Index values in 2019 are within 40% of the Analogue sites. Factors with a positive influence on the Infiltration score are the high perennial vegetation cover, high soil surface roughness, intact soil crusts and good soil texture. The variable and mostly low level of litter decomposition has a negative impact on the Infiltration Index values at WD4 compared to the Analogues.

The Nutrient Index values for the WD4 transects in 2019 are at 50% of the Analogue sites. The variable and mostly low level of litter decomposition and evidence that some has been recently transported through runoff erosion has a negative effect on the Index compared to the Analogues.

Floristic Diversity

Seventeen species were recorded at WD4. On average, there are 5.75 species per quadrat at the Barra Limb rehabilitation area in 2019. The richness data is highly variable with one quadrat recording 10 species and another recording only 1 species. This is low compared to the average of 18 species recorded in the Analogue sites. By structural class, there were on average 0.5 climbers, 1.5 groundcover species, 1.25 shrub species, 2.5 tall shrub species and 0 tree species.

Seven of the target species defined by SWC (2015b) were present at Barra Limb. APM (2019) recorded 15 local provenance species on the Bay 4 landform using a 2,500 m^2 quadrat.

Vegetation Structure

The structure of the vegetation measured at the WD4 transects is detailed in Table 7-12. The WD4 vegetation structural class values exceed the number of plants in the groundcover strata and canopy volume in the tall shrub strata compared to the mean Analogue values. All other values are lower, particularly the complete lack of tree strata. Despite the high number of groundcover plants the canopy volume is only 3% of analogue, conversely, despite the number of shrubs being

5% of analogue the canopy volume is 61%. Despite the imbalance, in the early years of rehabilitation this high shrub cover will produce high volumes of litter and woody debris that improve the landscape function.

Table 7-12: Vegetation Structure of the Bay 4 site

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	12,172	565	511	0	13,247
% of Analogue	110	5	59	0	**58**
Canopy Volume (m^3) per hectare	54	164	3,940	0	4,158
% of Analogue	3	61	411	0	**83**

Erosion

There is evidence of erosion at the WD4 landform with one gully occurring right on one monitoring transect (Plate 7-4). Records were made in June of the extent of the erosion and plans were in place for the gully to be filled with competent rock for armouring against future erosion.

Plate 7-4: Erosion Gully at the Top of the WD4 LFA2 Transect – Poor Performance

The erosion transects measured comparatively larger number of erosion features but they were very small and shallow in size. This shows there is still landscape reorganisation occurring and while more rills have appeared, some have filled and become more stable.

Weeds

A small number of *Melinis repens* (red natal grass) occurs at WD4 and is common in low densities across the disturbed areas of Koolan Island. *Passiflora foetida* is common on WD4, only as small individual plants scattered throughout the rehabilitation area. Additionally a scattered few individuals of *Malvastrum americanum* are present. A large number of *Stylosanthese hamata* are present in localised areas on the WD4 landform, whilst in 2019 they were very small due to poor seasonal conditions, they may become more dominant in the wetter years.

Whilst not present on the landform in June 2019 due to seasonal conditions *Leucaena leucocephala* was recorded on the roadsides of the track in the centre of the WD4 rehabilitation area. The species is a Target weed in the Koolan Island Quarantine Management Plan and the approach to management of that introduced shrub is detailed in the Plan.

Vegetation Cover

The work of eMapper (2019) shows the distribution of cover values for WD4 (Figure 7-33). Recovery of this area has been slower than for Barra Limb, however recovery is progressing well. There is a significant reduction in sparsely vegetated area (<2% cover) between 2015 and 2018. The percentage of moderately vegetated areas has also increased between 2018 and 2019, indicating continued revegetation is occurring.

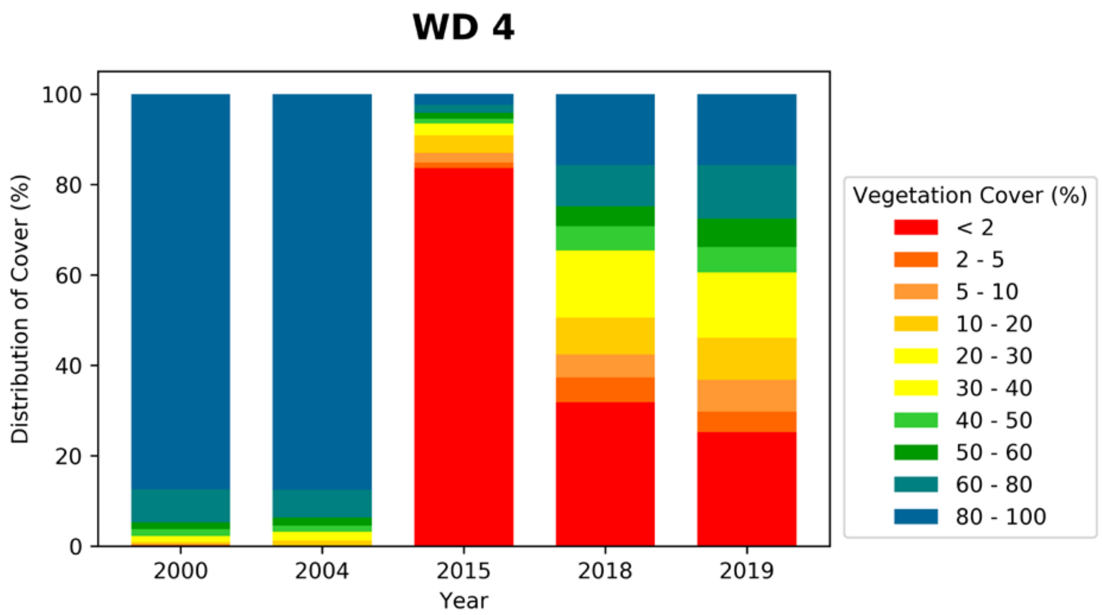


Figure 7-31 Distribution of vegetation cover for WD4 rehabilitation site

7.8.4.6 Scree

Site Description and History

The area was mined for shallow detrital deposits of iron ore and rehabilitation was completed in 2015. Topsoil and vegetation was stripped, stockpiled and respread in less than 1 year. Deep ripping on the contour was applied after topsoil was respread. Cleared woody vegetation was respread with the topsoil, creating frequent pockets of coarse woody debris. Soil testing by SWC (2015b) indicates the soil profile at Scree is derived from siltstone.

Landscape Organisation Index

The Scree LFA transects (Figure 7-34) have been monitored on 4 occasions between 2016 and 2019 (Figure 7-35).

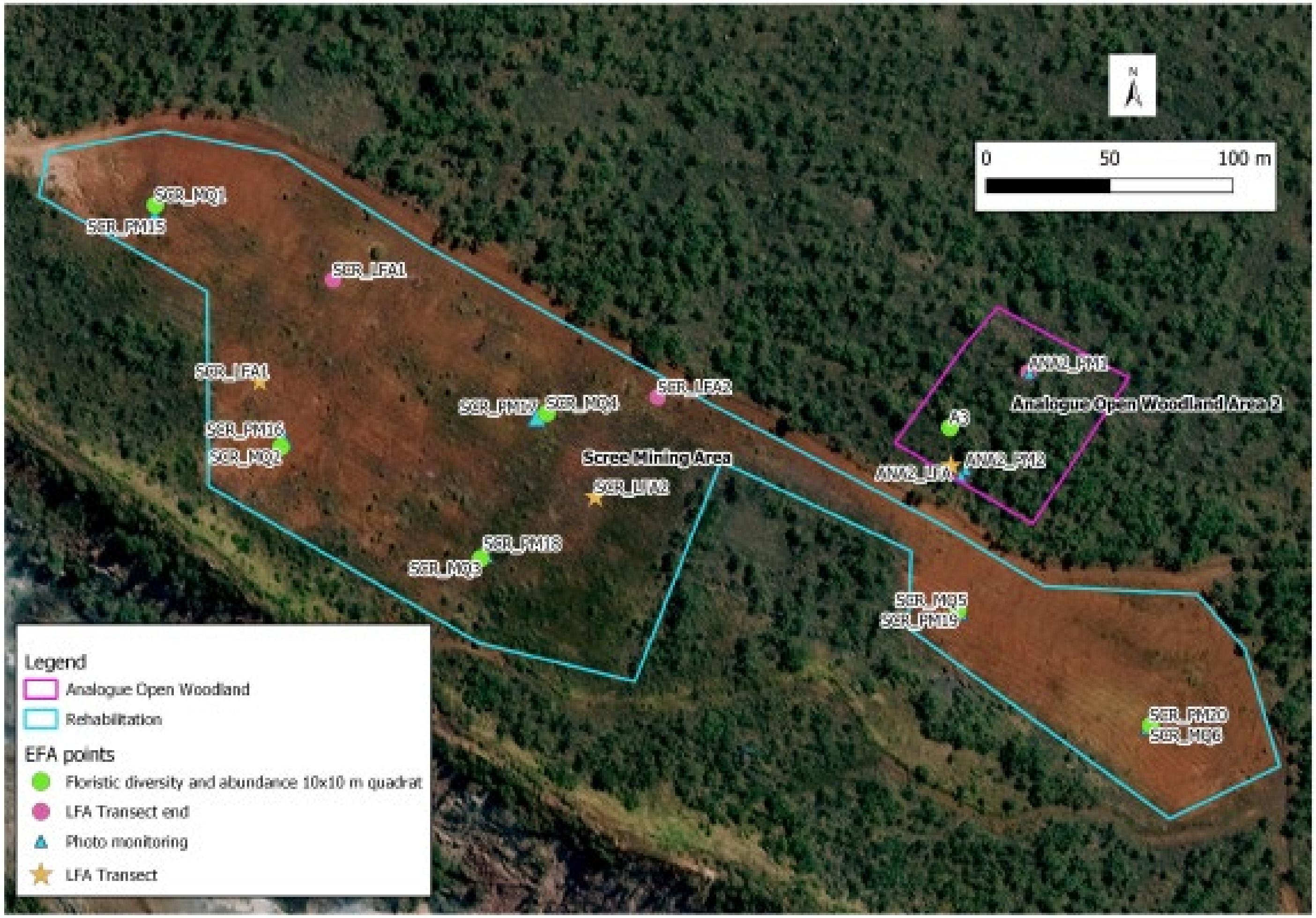


Figure 7-32 Scree rehabilitation area monitoring layout

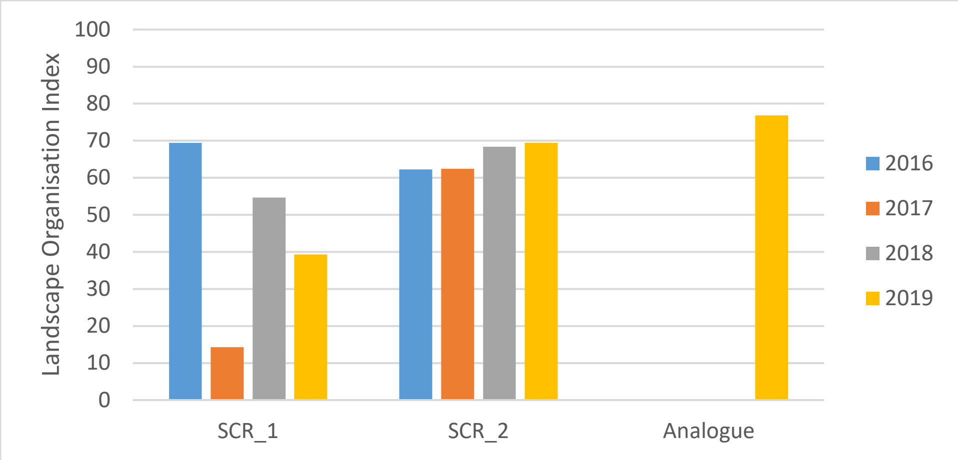


Figure 7-33: Scree rehabilitation area monitoring layout

The ripping on the contour of the Scree slope and the placement of coarse woody litter provided a baseline landscape with troughs and areas of woody litter recorded as occupying 60 - 70% of the transect in 2016. Between 2016 and 2017 rapid landscape evolution occurred at SCR_LFA1, where the bank and trough system eroded and some erosion features appeared on the top half of the transect where the soil profile was deep and rock content was low. Subsequent vegetation growth increased the LOI back up over 50% following the wetter than average wet season in 2017/18. For the SCR_LFA2 transect, LOI has slowly but steadily increased from 60 to 70% between 2016 and 2019. This is predominantly influenced by the intact bank and trough system throughout the transect and good growth of perennial woody vegetation cover.

Soil Surface Indices

The Stability Index at the Scree transects declined between 2016 and 2017 but in 2019 was approximately 60% of Analogue levels. One factor influencing the decline and later recovery is rain splash protection measure – on slope construction rocks and logs were placed at the surface, initial erosion changed the organisation then further reorganisation of fine materials exposes additional rock and logs at the surface. A number of factors have supressed the Stability Index from reaching the analogue levels. Lack of rock armour and erosion is the main factor for the difference in stability values between two transects. In places there is also very little litter accumulation, and the low litter build up limits the rate of decomposition.

Other Indices

The Infiltration Index values at the Scree transects are below 50% of analogue values. The lack of litter and the breakdown of the bank and trough system are the most prominent factors in the low scores. The bank and trough system is quickly evolving towards a slope and this reduces the surface roughness score and affects the infiltration index. The growth of perennial vegetation with the ability to slow water flow, such as dense perennial grass cover, would ameliorate this situation, as would the accumulation of litter. The Nutrient Index follow the same pattern, with values unlikely to increase without the increase in perennial vegetation cover, increased litter accumulation and decomposition and increased infiltration.

Floristic Diversity

Thirty-one species were recorded on the Scree rehabilitation areas, with an average of 8.3 species per quadrat. The diversities were highly variable with 2 sites recording 15 species and three sites with 3 or less species. Fifteen species in a quadrat is approaching the mean diversity of the Analogue sites at 18 species.

By structural class there were on average 0.3 climbers, 2 groundcover species, 4.2 shrub species, 1.7 tall shrub species and 0.2 tree species. Ten of the target species defined by SWC (2015b) were present at Scree.

APM (2019) recorded 17 species in the 2500 m^2 quadrat recorded for vegetation mapping.

Vegetation Structure

Scree transect vegetation structure is summarised in Table 7-13. Vegetation structural class values exceed the mean Analogue values for the canopy volume of shrub, large shrubs and the number of trees. Despite the high number of tree plants, and given the age of rehabilitation, the cover is only 3% with the majority being saplings. Mortality of these saplings may still occur if they do not have access to sufficient stored soil water to survive dry seasons, particularly following a drier than average wet season in 2018/19. Groundcover species are at 24% of analogue in numbers and 10% of canopy volume. Increase in the number and canopy volume of this strata may be beneficial for the capture and retention of litter.

Table 7-13: Vegetation Structure of the Scree site

	Groundcover	Shrubs	Tall Shrubs	Trees	Total
Number of plants per hectare	2,670	4,216	720	1,009	8,616
% of Analogue	24	41	83	173	**38**
Canopy Volume (m^3) per hectare	153	2005	1,5487	71	3,817
% of Analogue	10	748	166	3	**76**

Erosion

Erosion features were evident where 49 rills and 5 gullies were recorded totalling 11.6 m2 in cross sectional area on one transect. Remedial action is required as represented by results at SCR_LFA1 (Plate 7-5).

Weeds

A very small scattering of *Melinis repens* was recorded at the Scree area and one individual of *Malvastrum americanum*.

Plate 7-5: Erosion features at the top of the SCR_LFA1 transect

7.8.4.7 Surface Treatment Trials (Plots at WD1)

Site Description and History

Rehabilitation Trials plots are located at WD1 and were set up in November 2013. Five 20 x 25 m trial plots were established on a 20° slope, allowing a 2 m gap between each trial plot (Figure 7-36). The experimental design is:

T1: Control - no treatment

T2: No covering material, ripped on the contour only

T3: 0.1m deep layer of topsoil, ripped on the contour

T4: 0.5m deep layer of Acacia East sub-soil, ripped on the contour

T5: 0.5m deep layer of Main Pit silt-stone, ripped on the contour

Local provenance seed collected in 2011 was applied at 5kg seed/ha with the species mix of *Acacia holosericea* (10%), *A. colei* (10%), *A. monticola* (20%), *A. oligoneura* (20%), *A. tumida* (20%) and *Templetonia hookeri* (20%). Seed was weighed out into batches for Trial 2 to Trial 5. No seed was applied to Trial 1.

Landscape Organisation Index

The LOI at trial sites is highly variable, indicating substantial differences in the outcomes of the different treatments (Figure 7-37). The LOI at T1 has barely changed from the initial score of zero at landscape formation, indicating that a do-nothing approach will result in very little change over time. Trial plots 2 and 3 are discussed because they are similar to Analogue situations.

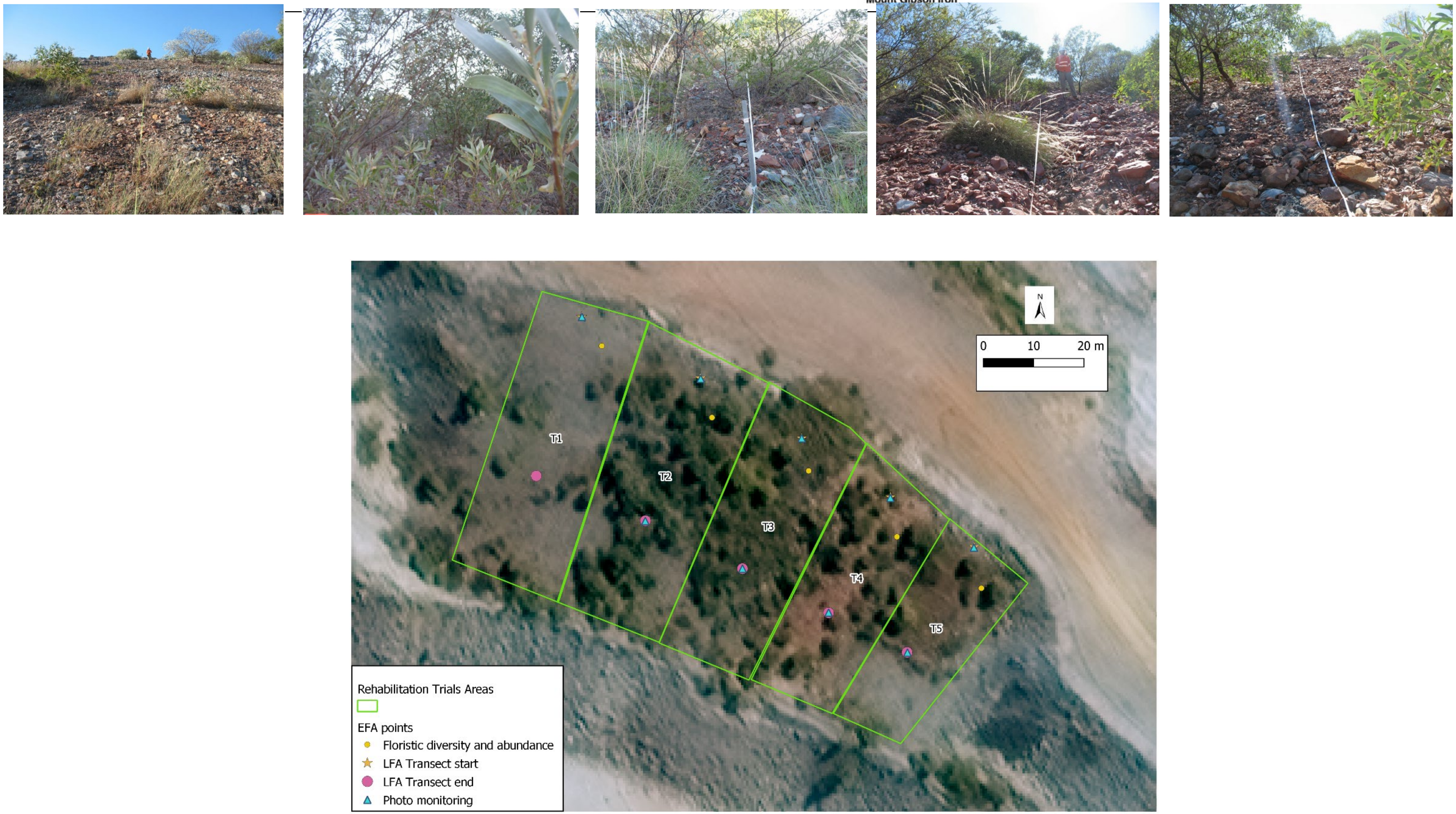


Figure 7-34 Rehabilitation Trials monitoring layout in 2019. Inset photos T1 to T5 (left to right)

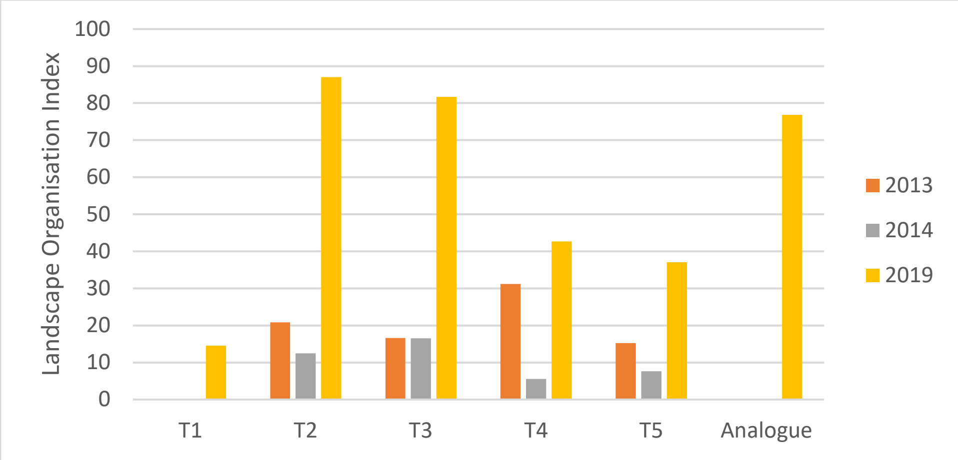


Figure 7-35: Landscape Organisation Index values at Trials Transects compared to the mean of the Analogue transects

The LOI at T2 shows at landscape formation there was 20% of the transect occupied by troughs. This proportion decreased by the following year, as very little vegetation had emerged and the bank and trough system had rapidly evolved towards a slope as seen in the photo monitoring (Appendix C). By 2019 the LOI approaches 90% and exceeds the analogue value. This is due to a high canopy cover of tall shrubs and a consistent litter layer that extends beyond the canopies to connect up adjacent plants. There is no longer evidence of the bank and trough system, having evolved into a consistent slope.

A few extra open spaces at the T3 transect leaves the LOI at just over 80% and close to the mean analogue value in 2019. Earlier in the landscape development, no change in LOI occurred between 2013 and 2014. APM's (2019) photo monitoring shows this was a combination of a small loss in trough area due to landscape evolution and a small gain in perennial vegetation growth. *Triodia* seedlings were quick to emerge from the fresh topsoil on the T3 transect.

Soil Surface Indices

In 2019, the stability index values at the trial sites are all within 50% of the Analogue value (Figure 7-38), as all of the sites have high rainsplash protection due to the good rock armouring, moderately good surface resistance to disturbance, very little evidence of erosion and deposition and intact soil crusts where present.

By 2019, the Stability Index values of T2 and T3 are within 20% of the mean analogue value and values for T4 and T5 are within 40% of the mean. The difference between the T2/3 and T4/5 stability indices are the former having a greater cover of perennial vegetation, particularly hummock grasses and a much greater litter accumulation both in cover and depth.

Other Indices

The Infiltration Index values have increased at all of the trial sites between 2013 and 2019 and range from 45 to 65% of the mean analogue value. For T2 to T5 an increase in perennial vegetation cover, litter cover and degree of decomposition and surface roughness have all contributed to the increase, with the T2 and T3 transects showing the greatest positive changes.

The Nutrient Index scores show a similar trend to the Infiltration Index with T2/3 having the strongest values. Both the Infiltration and Nutrient Index scores are dampened by the slow rates of decomposition on the Trials areas. The difference between T2 and T3 for the nutrient index score is driven by a higher surface roughness and higher LOI in T2, obscuring the higher levels of decomposition in T3.

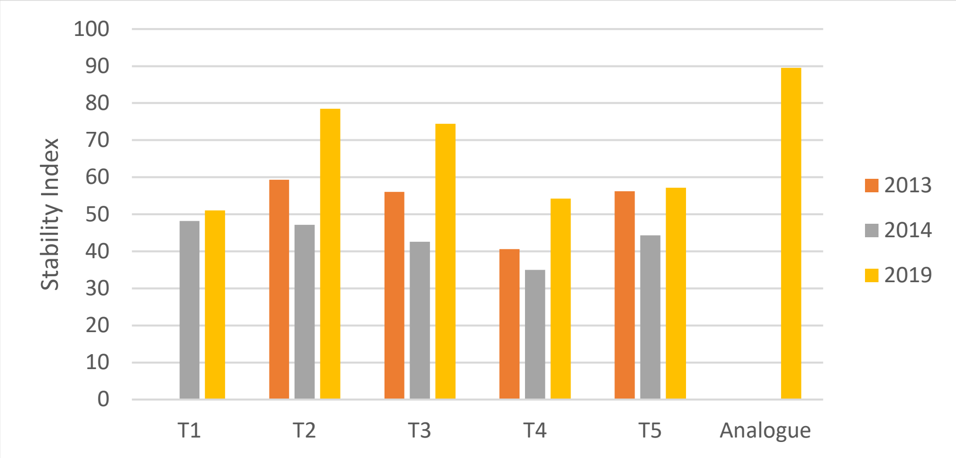


Figure 7-36: Stability Index values at the Trial Transects compared to the mean of the Analogue transects

Floristic Diversity

Three species were recorded on the T1 plot, including 2 groundcover species and 1 tall shrub species. One of the target species defined by SWC (2015) was present at T1.

Five species were recorded at the T2 plot, including 1 groundcover species, 1 shrub species and 2 tall shrub species. Four of the target species defined by SWC (2015) was present at T2. Three of the species included in the seed mix were present at T2.

Six species were recorded on the T3 plot, including 2 groundcover species, 1 shrub species and 3 tall shrub species. Five of the target species defined by SWC (2015) was present at T3. Three of the species included in the seed mix were present at T3.

Only four species and two species were recorded on the T4 and T5 plots respectively.

Vegetation structure

The structure of the vegetation measured at the Trials transects is detailed in Table 7-14. The treed stratum is absent from the Trial plots.

In T1, there is a very small number of groundcover and shrub plants, reaching only 4% and 11% of the number of plants per hectare and canopy volume per hectare of the Analogue sites respectively. Annual grasses were also present but were of the weedy species **Melinis repens* and are not included in the analysis.

The T2 plot has no groundcover, shrub or tree species. Tall shrubs are far more frequent and larger than at the Analogues.

T3 plot contains a good mixture of groundcover, shrubs and tall shrubs, with the groundcover and shrub strata having fewer but larger individuals than analogue values and the tall shrubs far exceeding in both number and canopy volume.

T4 plot has tall shrubs only but the number and canopy volume exceed the mean analogue total.

T5 plot has shrubs and tall shrubs with the number and canopy volume exceeding the mean analogue total.

Table 7-14: Vegetation Structure of the Trial Plots

Plot	Parameter	Groundcover	Shrubs	Tall Shrubs	Trees	Total
T1	Number of plants per hectare	28	925	0	0	953
	% of Analogue	0	9	0	0	4
	Canopy Volume (m^3) per hectare	13	558	0	0	571
	% of Analogue	1	208	0	0	11
T2	Number of plants per hectare	0	0	2,341	0	2,341
	% of Analogue	0	0	271	0	10
	Canopy Volume (m^3) per hectare	0	0	5,231	0	5,231
	% of Analogue	0	0	546	0	104
T3	Number of plants per hectare	6,760	3,906	2,675	0	13,342
	% of Analogue	**61**	**38**	**309**	**0**	**58**
	Canopy Volume (m^3) per hectare	2,934	4,054	28,442	0	35,429
	% of Analogue	**183**	**1,511**	**2,968**	**0**	**706**
T4	Number of plants per hectare	0	0	2,867	0	2,867
	% of Analogue	0	0	331	0	13
	Canopy Volume (m^3) per hectare	0	0	10,230	0	10,230
	% of Analogue	0	0	1,068	0	204
T5	Number of plants per hectare	0	486	539	0	1,025
	% of Analogue	0	5	62	0	4
	Canopy Volume (m^3) per hectare	0	5,130	3,768	0	8,898
	% of Analogue	0	1,913	393	0	177

Erosion

No erosion was found at T1, T2, T3 or T5. Shallow rills at T4 were 22 in number and total 3.4 m^2 in cross sectional area.

Weeds

T2 and T4 have a scattered distribution of *Passiflora foetida* and *Melinis repens*. T1 has a scattering of *P. foetida* and approximately 25% of the site covered by *Melinis repens*. T3 has a scattering of *Chenchrus* sp. which was too senesced to identify to species level.

Vegetation Cover

Recovery has progressed significantly between 2018 and 2019, with reduction in the area of sparse vegetation cover (Figure 7-39). The trial plots are sloped, and more severely affected by the poor satellite horizontal alignments between the 2018 and 2019 datasets. Note given the small area of the plots the satellite image analysis has been summarised for the overall trial (i.e. five plots aggregated).

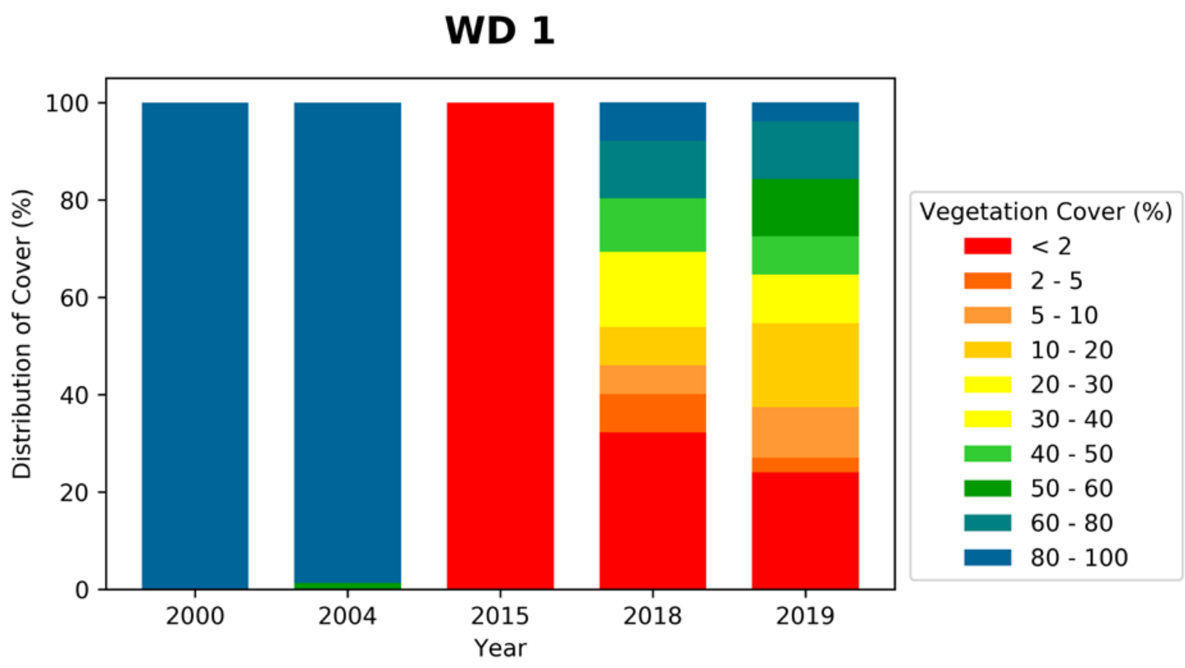


Figure 7-37: Distribution of vegetation cover the entire WD1 trial site (note: some trial treatment are more effective than others)

7.8.5 Seed Program

Supplementary seeding with pelletised seeds may be an appropriate strategy to address underperforming vegetation in some already rehabilitated areas. The seed mix would be likely to focus on groundcover species as this stratum is substantially lower in representation than the shrub, tall shrub and tree strata in rehabilitated areas, as well as the analogue target. Advantages of pelletised seed include a lower quantity of seed required and higher recruitment success achieved. Seed will be preferentially collected on Koolan Island and pelletised by an external specialist. The seed program will include:

- Development of a target list of plants suitable for seed harvesting;
- Field collection of available seed at optimal times based on a collection calendar;
- Seed selection for pelletisation;
- Review of MGX seed management documents and procedures and update to align with completion criteria;
- Soil stockpile audit;
- Nursery seed collection stocktake; and
- Design and implementation of a seed pellet trial to be undertaken on established rehabilitated areas, untreated WRL, WD1 surface trial, and nursery.

7.8.6 Considerations for Mine Closure Planning

The APM (2019) LFA / EFA survey reported that the revegetation at existing rehabilitated areas and the WD1 surface trials meets the majority of applicable completion criteria (Table 7-15). These results indicate rehabilitation so far has generally been effective, and support KIO’s preferred revegetation strategy (siltstone surface media and ripping). APM (2019) assessed and tabulated overall performance of the various LFA / EFA survey sites, which is reproduced as Table 7-16. LFA, EFA, and erosion were rated for each site out of 10, and each site was given an overall rating out of five stars (with consideration given to key risks and benefits of each). While the treatment analogous to KIO's revegetation strategy (T4) was not rated the highest for revegetation performance, APM (2019) noted early establishment of vegetation cover, litter, and structural diversity – key priorities for WRL rehabilitation. The revegetation performance of Scree, which also features a surficial siltstone matrix, further supports the potential for successful revegetation using a surficial siltstone growth medium.

Site	Plants / ha	Plants / ha Target	Canopy Volume (m^3) / ha	Canopy Volume (m^3) / ha Target	LOI	LOI Target	Stability	Stability Target
Analogue	22877	5719	5105	1276	77	19	90	22
BHP Moonscaping	66912		14444		100		78	
WD 4 Bay	3843		4077		62		63	
Barra Limb	19700		11271		93		63	
WD 4	13247		4158		73		61	
Scree	8616		3817		54		55	
WD 1 Trial T2	2341		5231		87		79	
WD 1 Trial T3	13342		35429		81		74	
WD 1 Trial T4	2867		10230		42		54	

Table 7-15: Revegetation Performance of Existing Rehabilitated Areas and Surface Trials (Orange = completion criteria not met)

Area	LFA	EFA	Erosion	Key benefits	Key risks	Overall rating
BHP Moonscaping	9	6	10	Abundant vegetation and litter No erosion	Overabundance of vegetation Imbalanced species and structural diversity	****
Barra Limb	8	8	4	Abundant vegetation and litter	Imbalanced species and structural diversity Minor erosion	****
Bay 4	5	9	5	Good early establishment of vegetation cover and litter Near-balanced species and structural diversity	Minor erosion	****
WD4	6	7	2	Good early establishment of vegetation cover and litter	Frequent minor erosion, infrequent major erosion Imbalanced species and structural diversity	***
Scree	4	10	1	Near-balanced species and structural diversity	Frequent minor erosion Lack of litter build up Vulnerability of young plants to climatic stress	***
T1	1	1	10	No erosion	Lack of vegetation and litter	*
T2	10	4	10	Good early establishment of vegetation cover and litter No erosion	Imbalanced species and structural diversity Lack of litter decomposition	***
T3	7	5	10	Good early establishment of vegetation cover and litter Best establishment of Groundcover No erosion	Imbalanced species and structural diversity	****
T4	3	3	3	Some early establishment of vegetation cover and litter and structural diversity	Frequent minor erosion Patchy vegetation and litter Imbalanced species	**
T5	2	2	10	No erosion	Patchy vegetation and litter Imbalanced species and structural diversity	**

Table 7-16: Rehabilitation Success Rating (APM, 2019)

Additional key points for consideration regarding revegetation are listed below:

- Floristic diversity, measured as species per quadrat, at the rehabilitated areas (BHP Moonscaping (50 x 50 m) = 15, WD4 Bay 4 $\approx$ 7, Barra Limb = 7, WD4 = 5.75, scree = 8.3) is in the order of 40 – 50 % of Analogue sites (18.3). These results indicate rehabilitation so far has been effective and underscores the efficacy of topsoil application in conjunction with direct seeding (WD4, with the lowest diversity, was not direct seeded).
- Some open areas where soil is sparse may be desirable, as they are similar to rocky outcrop areas at the Analogue sites.
- Areas with soil cover lacking in vegetation could be supplementary seeded from with pelletised seeds, particularly focusing on groundcover species as the strata is substantially lower in representation than the shrub, tall shrub and tree strata and the analogue target.
- In large open areas shrubs and tall shrubs may be beneficial to increase litter cover and stabilise topsoil. Seed distribution of shrub, tall shrub and tree species should focus on increasing the species richness.
- The vegetation and litter cover at Barra Limb are tracking towards the analogue values, however the groundcover strata is lower than analogue. Whilst Barra Limb has groundcover individuals they are very small and the cover is low. Supplementary seeding using pelletised seeds could be trialled at Barra Limb for groundcover species.
- Seed distribution of shrub, tall shrub and tree species should focus on increasing species richness. Placement of pelletised seed should focus on eroded areas to reduce surface water energy.
- Rock armouring and good vegetation cover rehabilitated the WD4 landform rapidly into a reasonably stable slope.
- The large erosion feature at WD4 is to be rehabilitated in 2019 and will be monitored towards closure.
- Whilst the trajectory towards analogue values is good given the young age of WD4, supplementary pelletised tree seeding in unvegetated areas may be beneficial. Groundcover species and low shrubs would also be beneficial to increase the litter accumulation and the species and structural diversity.
- LOI and the Soil Surface Indices at Scree are steadily increasing towards the Analogue value. The greatest inhibiting factor at Scree is a slow accumulation of litter. This is due to the better than average diversity and the lower contribution of large Acacia shrubs to the canopy volume. As the rehabilitation is only 4 years old and is showing a steady trajectory in the direction of the analogue values, the majority of the area is heading towards rehabilitation success.
- The Scree slope has some areas of erosion where thick topsoil with little rock content occurs at the surface. There is also a lack of vegetation in these areas. Targeted pelletised seeding with all strata may be beneficial to hold the surface soils in place and control further erosion.
- Tree species present at Scree have not yet gained significant canopy volume. Following a drier than average wet season in 2018/19, MGX will consider watering individuals if water stress is significantly impacting survivorship.
- The deep ripping on the contour has a positive effect on the build-up of litter and the development of a soil profile through the decomposition of litter. It contributes positively to the surface roughness, having a positive impact on infiltration of rainfall.
- Of the surface trials, treatments T3 (0.1 m deep layer of topsoil, ripped on the contour) and T4 (0.5 m deep layer of Acacia East sub-soil, ripped on the contour) were the most successful in terms of vegetation cover, species richness, structural diversity, and surficial stability. This highlights the rehabilitative benefits associated with topsoil application.
- The presence of topsoil has a positive influence on the presence of cryptograms on open soil surfaces and the rate of decomposition in litter accumulations. Lack of topsoil hinders these processes as seen at the Trial sites T2, T4 and T5 where despite deep litter accumulation in some places there is little decomposition. Including local

soils in the pelletised seeds may ameliorate this – MGX is considering applying pelletised seed to the trial areas to test this theory.

- Rock armouring has a positive effect on rainsplash protection. Self-mulching soils with a significant rock content will continue to be utilised for rehabilitated landform surfaces.
- The floristic diversity and structural diversity of additional sites will be measured using % cover in 2,500 m^2 quadrats up to closure, with continuation of 10 x 10 m quadrats for compatibility with historical data.

7.9 VERTEBRATE FAUNA

Terrestrial vertebrate fauna surveys of Koolan Island were carried out by Ecologia (2005b) and APM (2018b).

7.9.1 SUMMARY

A total of 93 species of vertebrate fauna were recorded within the project area. These species comprised of 6 mammal, 60 bird, 25 reptile and 2 amphibian species. A desktop literature review was also conducted and yielded 169 vertebrate fauna species. These species comprised 18 mammals, 116 birds, 1 amphibian and 35 reptiles.

Several fauna species of conservation significance have been recorded on Koolan Island, such as the Red Goshawk (*Erythrotriorchis radiatus*), Ghost Bat (*Macroderma gigas*), Saltwater Crocodile (*Crocodylus porosus*), Northern Quoll (*Dasyurus hallucatus*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and the Eastern Reef Egret (*Egretta sacra*) (Ecologia, 2012). Of these species three mammal species of conservation significance listed by the International Union for Conservation of Nature and Natural Resources were recorded including the Northern Quoll (*D. hallucatus*) (Endangered), the Red Goshawk (*E. radiatus*) (near Threatened), and the Ghost Bat (*M. gigas*) (Vulnerable).

The Orange Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as vulnerable under the EPBC Act. This species was caught on Koolan Island in 1965 in the Japanese sea tunnels which have since been destroyed. Further survey work by McKenzie and Fontanini *et al.* (1995) and Ecologia (2005b) failed to record this species and it is unlikely this species is still found on the Island. The Gouldian Finch (*Erythrura gouldiae*) is listed as endangered under the EPBC Act. The range of this species has declined significantly in recent years and previous records on Koolan Island are from a single observation in 1978 (McKenzie *et al.*, 1995). Therefore it is unlikely that this species is still found on the Island.

The project area encompasses habitats and vegetation associations which are widespread throughout the region. Some of the species listed in the CALM Priority are considered regionally significant because of limited knowledge about their distribution and / or poor representation within existing conservation reserves.

Condition 9 of MS715 required KIO to develop a Northern Quoll Management Plan. In accordance with this plan, an Island wide annual monitoring program of the Northern Quoll (*D. hallucatus*) has been carried out since 2007 on the Island. At the time of writing this plan, the latest annual monitoring results, indicated the population to be healthy and stable with population levels above the threshold of baseline conditions (APM, 2015). MS 715 also requires the development and implementation of a Significant Fauna Management Plan and pre-clearance surveys for conservation significant fauna species be conducted prior to ground disturbance to identify the presence of conservation significant fauna species within the clearance footprint.

KIO has formed a partnership with Murdoch University to undertake a PHD program for studies related to the Northern Quoll. This project may hold significant outcomes for mine closure in relation to habitat use, artificial den creation, cane toad aversion techniques, and population estimates which take into consideration the advantages and / or disadvantages of human occupation at Koolan Island.

7.9.2 Considerations for Mine Closure Planning

There are no specific considerations for fauna in relation to mine closure planning. Note:

- Ongoing fauna monitoring and re-location of significant species prior to ground disturbance is undertaken on Koolan Island (Ecologia, 2012);
- Closure goals require the existing habitat values of the Island to be maintained, and rehabilitation designs to encourage fauna visitation; and
- Continued research to better understand the population dynamics of the Northern Quoll on Koolan Island.

7.10 SHORT RANGE ENDEMIC FAUNA

7.10.1 Summary

Short-range endemic (SRE) fauna species that are known to occur on Koolan Island include land snails, earthworms, and the blind snake *Ramphotyphlops yampiensis*. Two species of land snails (*Kimboraga koolanensis* and *Amplirhagada astute*) and the blind snake (*R. Yampiensis*) are protected under Western Australian wildlife legislation. Other fauna groups such as spiders and schizomid species may occur as short-range endemics on the Island; however, the presence of these species is currently unknown.

The main potential risk to SRE fauna species on Koolan Island from mining activities is disturbance of natural habitat. There may be a perceived risk of mining activities influencing the local populations of the specific SRE taxa. However, there is a lack of knowledge on the extent of endemism among invertebrates on Koolan Island. This risk, however, is relatively low due to the fact that mining activities by KIO occur largely in previously disturbed areas (45 % of development area was occupied by BHP before 1993) or in large patches of adjacent land not known to support short-range endemics. Short-range endemics on Koolan Island are likely to occur in habitats such as caves, vine thickets and rainforest patches. Also, biannual snail monitoring which has occurred since the inception of operations in 2007 has identified the presence of SRE species outside proposed disturbance areas.

In 2013 KIO sought advice from the EPA regarding the continuance of biannual snail monitoring as required by Schedule 2 of MS 715 and the Significant Fauna Species Management Plan. KIO determined that the requirements of MS715 had been met and biannual snail monitoring was no longer necessary. This was confirmed and approved by the EPA with the revision and approval of the revised Significant Fauna Species Management Plan. Biannual monitoring for snails ceased as of January 2014. Surveys for SRE species mentioned within the Significant Fauna Species Management Plan will continue as part of any necessary pre-clearance surveys for proposed disturbance areas.

7.10.2 Considerations for Mine Closure Planning

There are no specific considerations for mine closure planning for SRE in relation to mine closure planning. Note, certain SRE monitoring prior to ground disturbance is undertaken on Koolan Island (Ecologia, 2012).

7.11 STYGOFAUNA

7.11.1 Summary

Stygofauna are communities of stygobites – animals that live in and are wholly dependent on subterranean or “stygal” aquatic habitats. They are micro- and macroscopic invertebrates rarely more than 5 mm long, and are mostly from the subphylum Crustacea. The stygofaunal assemblages may also include gastropod molluscs, water mites, tubellarians, and several other groups.

A Stygofauna sampling programme, comprising four sampling rounds, was undertaken following the identification of three species of stygofauna during a pre-sampling assessment in January 2006 (MBS, 2009c; 2011c). Three stygofauna taxa have been recorded at Koolan Island:

- *Atopobathynella* sp. B2 (Family: Parabathynellidae; Order: Syncarida).
- *Crenisopus* n. sp. (Family: Phreaticoidea, Order: Isopoda).
- *Mesocyclops brooksi* (Family: Cyclopidae, Subclass: Copepoda).

The review and revision of the Subterranean Fauna Management Plan in 2013 determined that mining operations have not adversely affected stygofauna habitat or species assemblages, based on subterranean fauna and ground water monitoring. Therefore, no specific management actions were deemed necessary. The approval of the revised plan by the EPA confirmed that ongoing subterranean fauna monitoring was not necessary. Should mine dewatering operations change, the monitoring plan within the Subterranean Fauna Management Plan will be revised and agreed upon with the EPA (MGI, 2013).

7.11.2 Considerations for Mine Closure Planning

There are no specific considerations for stygofauna in relation to mine closure planning. Note, during operations:

- KIO will monitor Stygofauna in accordance with the approved Subterranean Fauna Management Plan under MS 715; and
- KIO will continue to monitor groundwater quality and quantity in accordance with the Water Management Plan, and therefore the habitat which subterranean fauna occupy.

Findings will inform mine closure planning.

7.12 MARINE ENVIRONMENT

7.12.1 Summary

A MMP was established to assess the construction and operational effects of the Mine outside the predicted footprint on the ecological integrity and biodiversity of the area (MGX, 2015). The waters surrounding Koolan Island were initially recommended for inclusion within a multiple use marine park (CALM, 1994) and consequently warranted a high level of protection. Recently, the Lalang-Garram Camden Sound Marine Park was established to be jointly managed by the Department of Parks and Wildlife and the DAC, but well north and east of Koolan Island (DPAW, 2013). Much of the southern shoreline of Koolan Island adjacent to the project infrastructure has been substantially modified by past mining activities. Waste rock landforms were constructed towards the southern coast leading to degradation of marine habitats and ongoing effects to water quality. This area was assigned a moderate level of ecological protection, with a low level of ecological protection being assigned to the mixing zone around the pit dewatering discharge. To allow separation of the project effects from natural changes or previous disturbance, baseline surveys have previously been undertaken to establish the pre-start condition of the marine environment. As part of the approved MMP under MS 715, water quality, sediment quality, habitat condition and wildlife are monitored throughout the life of mine and following mine closure.

In 2014 MGI approached the EPA in regards to the level of protection which had been afforded to the Island during the project approval stages in 2006, specifically the assignment of Category B of EPA '*Environmental Assessment Guideline No.3 Protection of benthic Primary Producer Habitats (BPPH) in Western Australia's Marine Environment*'. This level of protection allowed for 1% of BPPH to be disturbed within a Local Assessment Unit. With the exclusion of the Koolan Island waters from the Camden Sound Marine Park (DPAW, 2013), this warranted a reassignment of the protection level applied for environmental assessments in relation to BPPH. Category E of the aforementioned guideline was confirmed as suitable by the EPA, which allows for the disturbance of up to 10% of BPPH within a Local Assessment Unit. This change has been endorsed by the EPA through the approval of Version 19 of the MMP. Version 20 of the MMP was applied to the Seawall rebuild and capital dewatering up until early 2019.

7.12.2 WATER QUALITY

Water quality monitoring has been undertaken at four locations and two reference sites around the Island since 2014 in accordance with the MMP. MScience (2019) summarised physical water quality parameters for the 2019 monitoring event:

7.12.2.1 Physical Water Quality Parameters

Turbidity

- Southern Sites: Uniformly high with individual readings ranging from 2.7 - 5.1 Nephelometric Turbidity Units (**NTU**). Turbidity at the reference site exceeded the MP trigger criterion. Median turbidity at the Wharf site was above the MMP triggers, exceeding the Reference 80th percentile for both the surface and bottom depth strata.
- Northern Sites: Relatively high at the reference site, Pindan Bay and Mullet Bay, varying from 3.6 – 8.1 NTU, exceeding the MMP trigger for both depth strata.

Temperature

- Southern Sites: Highly consistent, varying by < 0.3° C across all sites (29.9 – 30.2° C). Reference site samples were consistently colder than test site samples, resulting in median test site temperatures exceeding the 80th percentile of Reference sites across all depths. In addition, median water temperatures recorded at the Wharf sites exceeded the Environmental Quality Criteria (**EQC**) 80th percentile trigger and comparison with the Reference site. When compared to annual variability, MScience (2019) reported that these temperatures were unlikely to be ecologically significant.
- Northern Sites: monitoring sites showed little variability, ranging from 30.0 – 30.2 °C. Pindan Bay and Mullet Bay median temperatures exceeded the MMP 80th percentile triggers. The median temperature at these test sites, however, was less than the 80th percentile of the reference site. MScience (2019) reported that the exceedance of the EQC was likely due to seasonal conditions.

Salinity

- Southern Sites: very little variance, ranging from 34.77 - 34.81 parts per thousand. Test site median values at both depth strata were below the 20th percentile of the long term MMP trigger. Median salinity at test sites across all depth strata, however, were between the 80th and 20th percentile range of the Reference sites measured in 2019. Exceedance of the salinity trigger therefore appears due to an overconservative trigger value.

- Northern Sites: only small variance, ranging from 34.77 – 34.82 parts per thousand. Median salinity at both Pindan Bay and Mullet Bay at both depth strata were between the 80th and 20th percentile range of Reference sites for both the 2019 survey and long term data.

Dissolved Oxygen

Dissolved oxygen (DO) ranged from 94.8 – 101.2% at the Southern sites and 94.5 – 99.6% at the Northern sites. Medians at all Reference and Test sites were above the 90% dissolved oxygen saturation threshold - no trigger exceeded.

7.12.2.2 Chemical Water Quality Parameters

MScience (2019) summarised chemical water quality parameters for the 2019 monitoring event:

Metals

Concentrations of all metals, except copper, were below trigger levels. Copper concentrations, however, were elevated above the trigger at both the southern reference and test sites, with 95th percentile concentrations at the Wharf (0.56 µg/L) and reference site (0.5 µg/L) exceeding the ANZECC and ARMCANZ (2000) derived trigger value (0.3 µg/L). MScience considered that the elevated copper levels may be related to higher sediment loads at the time of survey.

Nutrients

The median nitrate and nitrite concentration at the Wharf (31.0 µg/L) exceeded the long term MMP trigger (10.0 µg/L), and was similar to, but slightly higher than, the daily median and 80th percentile at the reference site. Nitrate / nitrite concentrations at the Wharf have historically been elevated, with exceedances of the daily reference triggers reported for a number of previous earlier surveys. The median orthophosphate concentration recorded at the Wharf (12 µg/L) in the 2019 survey exceeded the 80th percentile of the southern reference site (11 µg/L) and the MMP long term trigger (10 µg/L). MScience (2019) did not consider these exceedances to be biologically relevant in the context of reference site concentrations and seasonal changes in nutrient concentrations experienced at Koolan Island.

7.12.3 Marine Sediment Quality

A baseline sediment quality survey was conducted to establish whether any sediment parameters were previously elevated from natural changes or previous disturbance (Ecologia, 2005c). Potential effects to sediment quality during life of mine may include:

- Increased sedimentation levels, including increased metal loads, as a result of construction, ship loading, discharge of sediment in dewatering and runoff,
- Disturbance and re-suspension of sediment from ship movement,
- Spillage of ore or fuels, and
- Ship antifouling residue potentially in sediment and biota.

Sedimentation monitoring has been undertaken triennially since 2015 and will do so for a period following closure in accordance with the MMP (MGX, 2015). Results of the MScience (2018a) marine sediment survey are summarised:

- Metals: There were no exceedances of metal guidelines at any site. Median aluminium concentrations at the Southern Reference site were above the 80th percentile of reference sites. Since these elevations occurred at the reference site and not the test site, however, it was concluded that these increases were unrelated to mining operations.

- Organics: There were no exceedances of Total Recoverable Hydrocarbon guidelines at any site.
- Metalloids: There were no exceedances of Tributyltin guidelines at any site.

7.12.4 Benthic Habitat

Pilot and supplementary base line marine benthic habitat surveys were conducted to document the distribution of habitats of conservation significance around areas along the southern shore of Koolan Island (MScience, 2007).

Habitats were divided into five classes (Table 7-17) and their distribution mapped. Habitat distribution was determined by bathymetry with low biodiversity reef flats stretching from the shoreline to a steep drop off containing a rich coral community on the upper slopes which graded into rubble and filter feeder dominated lower slopes before reaching the sandy channel floor (Ecologia, 2005c). On the more turbid south side, the Island Reef flats were better developed. On the northern side of the Island reef flats were absent in many areas and shorelines met hard bottom communities with drop-offs much closer to shore.

Table 7-17: Habitat classes mapped at Koolan Island (Modified from Koolan Island Environmental Referral Document - (Ecologia, 2005c)

Habitat	Description
Reef Flat	Sand, silt mud flats from the shoreline becoming broken hard bottom at the seaward extent: inner flats are dominated by burrowing organisms while outer flats contain encrusting biota, including small corals
Coral Slope	Abundant cover of living coral in a narrow fringe from the seaward edge of the reef flat to around 5m down the steep reef slope – usually sloping at >45°
Lower Slope	Broken rubble and filter feeding sessile biota such as sponges and gorgonians from the lower edge of the coral zone to the channel floor
Channel Floor	Sand to silt bottom with a sparse cover of filter feeders and burrowing molluscs, fish and crustaceans
Pool Corals	High cover of living coral similar to the Coral Slope but with a different mix of species – essentially fewer branching Acropora

Reef slope was determined to be the principal benthic primary producer that may be affected during life of mine (MScience, 2007).

Annual coral monitoring by assessment of remote video underwater survey records has been undertaken since 2014 in accordance with the MMP. In 2018, coral cover at two test sites, Pindan Bay and Arbitration Cove, was significantly below that of their respective reference sites and 2014 baseline levels, exceeding the EQC for benthic habitat (MScience, 2018b). As a result of that exceedance, KIO commissioned a further survey of coral cover (MScience, 2018c) and a desktop assessment of patterns of coral cover over the total monitoring history at Koolan Island (MScience, 2018d).

MScience (2019) summarised coral cover trends as of 2019:

- Northern Sites: Coral cover at Mullet Bay and the Reference site remains similar to that recorded in the 2014 and 2015 surveys. Coral cover at Pindan was significantly lower than both that of its reference site for this survey and the levels recorded in 2014/2015. However, coral cover at this site has shown a consistent small upward trend since the low levels recorded in 2016 (Figure 7-40). The low coral cover appears to be largely due to persistently low levels at Pindan Bay East rather than Pindan Bay West.

- Southern Sites: Coral cover at the Wharf and Coral Reference sites remains similar to that recorded before 2016. Live coral cover at Arbitration Cove in 2019 remains substantially below that of baseline surveys and the Reference site, but has increased slightly from levels recorded in the 2018 surveys (Figure 7-40).

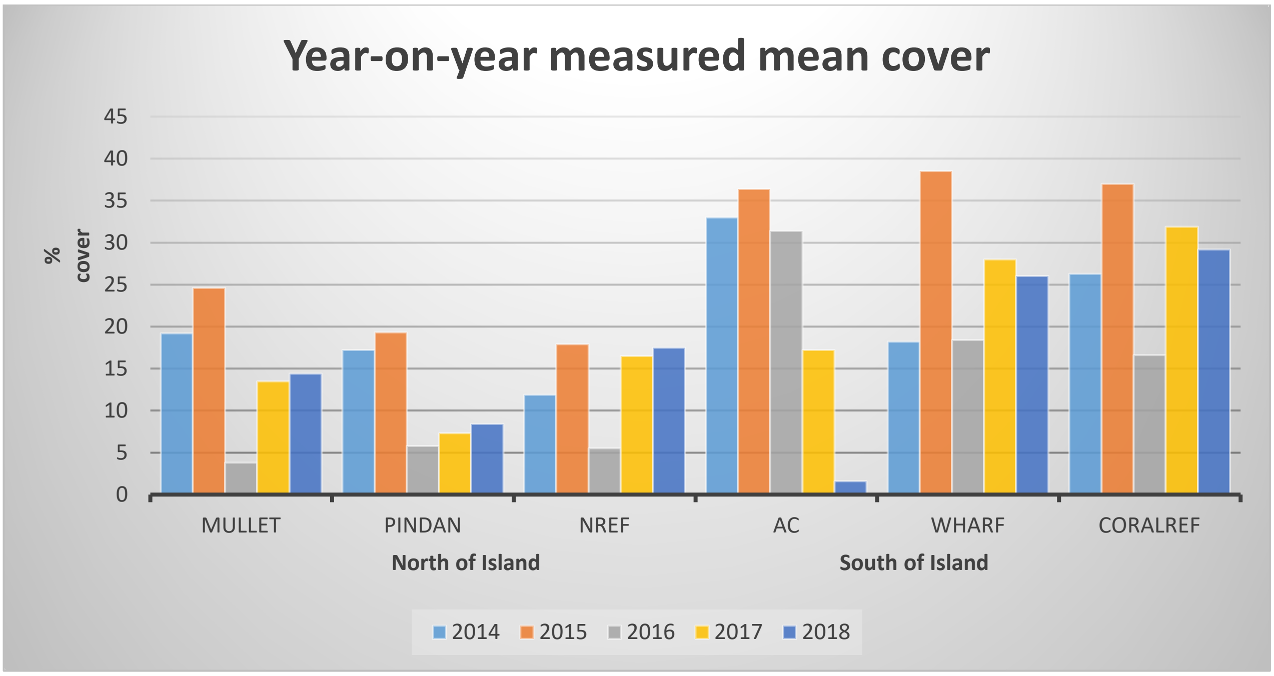


Figure 7-38 Time series of annual results 2014 to 2018 for each monitoring site (three LHS sites are North side of Island; three RHS sites are in the Canal)

The 2018 Arbitration Cove studies of MScience (2018a, b, c) concluded that coral loss at ACE-1 and ACE-2 appeared to have been caused by burial beneath seawall rocks, and detectable coral cover in quadrats ACE-3 to ACE-5 was driven by the loss of the predominant coral type, staghorn *Acropora*. The areas of highest coral loss were those of the western monitoring sites, near the seawall. The recent increase in coral cover at Arbitration Cove between 2018 and 2019 was due to reported increases at ACE-3 & ACE-5.

It is KIO's interpretation is that there has been an effect beyond the realms of natural variability at the Arbitration Cove monitoring sites, associated with the indirect effects of the seawall construction. This monitoring site is within a zone of 'Moderate Ecological Protection', which is an area where sub-lethal ecological effects on marine environmental quality are observed. It is likely that live coral cover at this site will increase over time (reducing turbidity and sedimentation), and benthic species re-establish (on seawall rock and other fill materials) – the increase in cover reported in 2019 may be an early sign of recovery. This expected regeneration will continue to be monitored in accordance with the MMP, and the directions of DWER in relation to MS 715.

In addition to coral monitoring under the MMP, in 2019 MGX engaged Jacobs to prepare a Coral Rehabilitation Plan (Jacobs, 2019) to guide implementation of a coral rehabilitation program in relation to the Arbitration Cove corals. The Jacobs (2019) plan details substrate trials and a full scale rehabilitation project (based on the outcome of the substrate trials), and prescribes completion criteria for the coral rehabilitation.

Four substrate types will be trialled from 2020 onwards: quartzite rock, re-used broken concrete (having been analysed for contaminants by leaching), concrete mattress structures (e.g. Armorflex concrete mats), and another natural terrigenous substrate (e.g. Elgee siltstone). It is anticipated that trials will commence from 2020. Acknowledging that closure activities (e.g. reshaping the seawall facia for long term stability, use of the barge ramp to facilitate maritime access, and / or construction of the decommissioning trench) may cause further disturbance at Arbitration Cove, coral rehabilitation may also be undertaken at alternate locations (Jap Bay, Arbitration Cove (West) , and the re-flooded Main Pit. A strategy of natural recovery and rehabilitation will be pursued initially by recruitment and growth. If monitoring indicates that this strategy is likely to be unsuccessful, active rehabilitation will be considered with the permission of DWER and DBCA.

7.12.5 Considerations for Mine Closure Planning

- Previous attempts to locate and test for possible contamination sources have failed to locate the source of the elevated nitrate / nitrite concentrations at the Wharf. Similar concentrations were noted prior to the seawall failure and are unlikely to be related to that event.
- Marine monitoring in 2018 and 2019 detected adverse effects on the benthic habitat at the Pindan and Arbitration Cove monitoring sites. Impacts at Arbitration Cove were likely associated with seawall reconstruction in 2018.
- In accordance with the MMP, ongoing surveys of the marine environment will be conducted to detect potential changes in marine water quality, sedimentation and benthic habitats. Monitoring will continue post mine closure (Section 11). The MMP will be revised at request of DWER from time to time.
- A coral rehabilitation trial is scheduled to commence in 2020, which will inform a full scale coral rehabilitation project (Jacobs 2019).

7.13 HERITAGE

7.13.1 Summary

The *Aboriginal Heritage Act 1972* protects Aboriginal sites in Western Australia whether or not they are known to the Department of Indigenous Affairs / Aboriginal Cultural Material Committee.

In addition to a desktop survey of the Aboriginal site register which lists six registered sites, a detailed archaeological and ethnographical survey was conducted in November 2004 (Archae-aus, 2005). Ten Areas were surveyed on the Island. The survey located one previously recorded site and one previously unrecorded aboriginal archaeological site (Site Number K04-01 Goats Head Bluff) outside of the registered sites. No isolated artefacts were recorded during this survey (Archae-aus, 2005).

During a meeting held with the Dambimangari Native Title Determinant group by Kimberley Land Council, the traditional owners stated they wish for this site (Goats Head Bluff) to be protected from any potential impact caused by mining activities. As part of the coexistence deed developed with the Dambimangari people and KIO, access to areas of cultural significance are prohibited through exclusion zones and information regarding exact site locations is kept confidential

7.13.2 CONSIDERATIONS FOR MINE CLOSURE PLANNING

Heritage sites of cultural significance are currently protected through environmental awareness inductions for KIO staff to ensure the maintenance of exclusion zones, and protection from any mining related activities. Subsequently, the culturally significant sites will be maintained at closure and will be the subject of ongoing consultation with DAC.

7.14 CONTAMINATED SITES

7.14.1 SITE CONTAMINATION STATUS

The whole of Koolan Island was classified as 'Potentially Contaminated – Investigation Required' (PC-IR) under the *Contaminated Sites Act 2003* on 25th June 2012 due to a number of reported fuel spills, former landfills and support infrastructure, primarily originating prior to MGX operations.

Two sites on Koolan Island are specifically noted on different notices as follows:

- The Former township due to hydrocarbon staining historically observed in underground storage tanks (UST); and
- The Airstrip due to a waste oil-water mixture historically used for dust suppression.

The notices mainly address historical contamination but do note two areas of contemporary contamination:

- A 2012 Fuel Spill located at the new barge; and
- The Mechanical Workshop that was deemed subsequently remediated by DWER.

Contamination status notwithstanding, DWER considers that Koolan Island is suitable for continued use as a mine site.

7.14.2 SUMMARY

MGX has a Contamination Management Plan (CMP) as required by MS 715. The CMP approved in 2016 (MGX, 2016a) was updated in 2019 and is currently being reviewed by DWER. Contamination at Koolan Island will continue to be managed in accordance with the MGX (2016a) CMP until the 2019 CMP is approved by DWER.

In the context of closure and relinquishment, contamination at Koolan Island falls into two categories:

- Legacy contamination: Contamination caused by third parties prior to the Project commencing. Legacy contamination may occur:
  - Within the disturbance footprint approved by MS 715; or
  - Outside the disturbance footprint approved by MS 715.
- Contemporary contamination: Contamination that occurred during the Project.

Areas of potential concern (**AOPC**) are shown in Figure 7-41.

7.14.2.1 Legacy Contamination

The following potential contamination sources relate to former mining operations:

- Domestic landfill disposal;
- Industrial landfill disposal;
- Workshop activities;
- Fuel and waste oil distribution and storage;

- Buried machinery; and
- Former township support systems and infrastructure.

Hydrocarbons and asbestos comprise the majority of legacy contamination at Koolan Island. Previously identified legacy hydrocarbon contamination within the MS 715 disturbance footprint includes:

- Two salvage industrial pits: Located just south of the former support area, and anecdotally are understood to include discarded motor vehicles and general inert industrial waste;
- Former mechanical workshop: Abandoned UST;
- Former wharf: An estimated 10 t of fuel leaked from the wharf side petroleum above ground storage tanks in 1988. The contaminated material was believed to be excavated between January and June of 2007. High tidal movements typical of the area are believed to have significantly flushed the area between the time of the spill and current KIO operations;
- Quarry petroleum hydrocarbon storage: formerly located at the western end of Main Pit;
- Barramundi Industrial Landfill: Minor contamination in near surface wastes; and
- Airstrip: Associated with historic spraying of the airstrip with an oil / water mix to condition the surface.

Legacy material containing asbestos has been found at the following areas within the MS 715 disturbance footprint:

- Former main fuel storage;
- Former Power House;
- Former Stores;
- Former administration buildings;
- Barramundi Industrial tip; and
- Eastern Industrial tip.

Potential legacy hydrocarbon impacts outside of the MS 715 disturbance footprint exist at the historical township, former boat club, Eastern domestic landfill, and 'Roche' area. Legacy material containing asbestos has also been found at the historical township.

7.14.2.2 Contemporary Potential Contamination Sources

AOPCs and infrastructure that could constitute potential contemporary sources of contamination are:

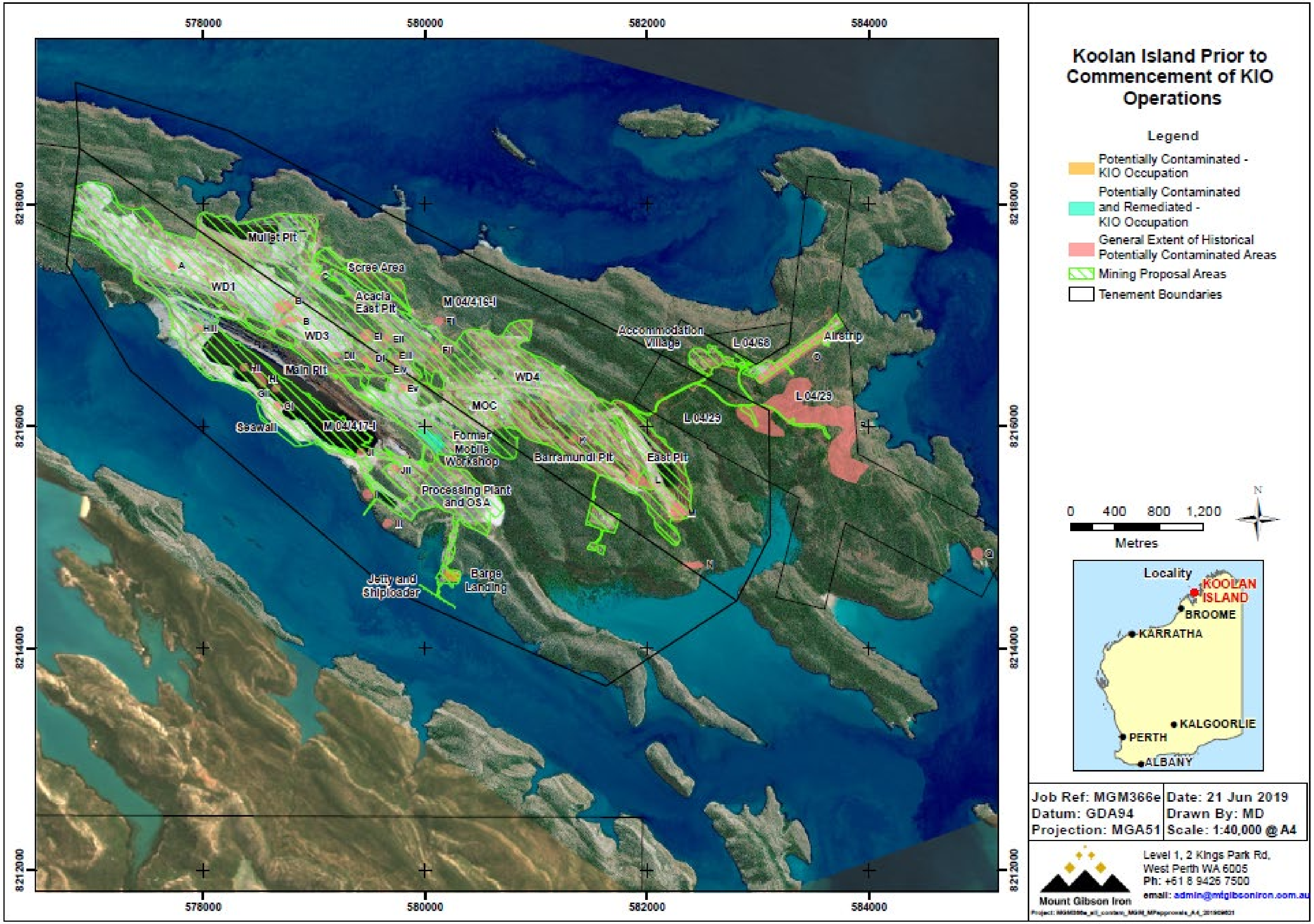
- Accommodation village (wastewater treatment facility and backup generators);
- Airstrip;
- Bioremediation facilities;
- Mine Site Offices (septic tanks, mobile equipment workshop, fuel storage, power generation facilities);
- Dewatering facilities (diesel powered floating pontoon pumps);
- Fuel storage;
- Warehouse and Logistics facility (packaged hydrocarbon and chemical stores);
- Jetty, Ship Loader and Barge Landing;
- Laydown areas;
- Explosive Magazine and Bulk Explosive Batching Facility (explosives, power generation equipment, storage tanks and containers);
- Buried services within the accommodation village, Main Operations Centre and processing areas;

- Power station at crushing plant, MOC and accommodation village (12 diesel generators in total, bulk fuel storage tank at each facility);
- OSA and processing plant (no chemical processing);
- Workshops (storage areas, oil separation facility); and
- Current Domestic and Industrial Landfills (near WD4).

7.14.2.3 Known Contemporary Contamination Events

In March 2011, a diesel spill at the barge landing resulted in the spillage of approximately 20,000 L of diesel. Much of this was largely contained to the barge landing itself. The incident was investigated and remediated for potential hydrocarbon contamination. Total recoverable hydrocarbons (TRH) was found at the barge landing due to the spill of diesel and approximately 5,000 m^3 of material was removed to the onsite bioremediation facility for treatment. Marine monitoring of the surrounding waters at the barge landing occurred for several months following the incident and hydrocarbon contaminated water was not recorded; strong shoreline currents and large tides were deemed to have reduced residual ris

Figure 7-39: Potentially Contaminated and Remediated Areas


Koolan Island Prior to Commencement of KIO Operations
Legend
Potentially Contaminated - KIO Occupation
Potentially Contaminated and Remediated - KIO Occupation
General Extent of Historical Potentially Contaminated Areas
Mining Proposal Areas
Tenement Boundaries
0 400 800 1,200
Metres
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Mullet Pit
Scree Area
Acacia East Pit
M 04/416-I
WD1
WD3
Main Pit
WD4
MOC
Seawall
M 04/417-I
Former Mobile Workshop
Barramundi Pit
East Pit
Processing Plant and OSA
Jetty and Shiploader
Barge Landing
Accommodation Village
L 04/58
Airstrip
L 04/26
L 04/25
578000
580000
582000
584000
8218000
8216000
8214000
8212000
Job Ref: MGM366e
Datum: GDA94
Projection: MGA51
Date: 21 Jun 2019
Drawn By: MD
Scale: 1:40,000 @ A4
Level 1, 2 Kings Park Rd, West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au
Mount Gibson Iron

TRH and ethylene glycols were found at the former mobile workshop, which has since been buried in-situ by advancement of a WRL. Remediation in accordance with the DER (2014) contaminated sites guidelines was undertaken and the site was deemed remediated by DWER, with no further investigations or remediation necessary.

Minor hydrocarbon staining was observed around the cyclone shelter (located at the accommodation village) due to a build-up of minor diesel spills over time that were out of view under grasses. Removal and bioremediation of impacted soils was undertaken, the area has been taped off, and permission to enter is required from Infrastructure Maintenance based on the Island.

7.14.3 Assessment of Current Conditions

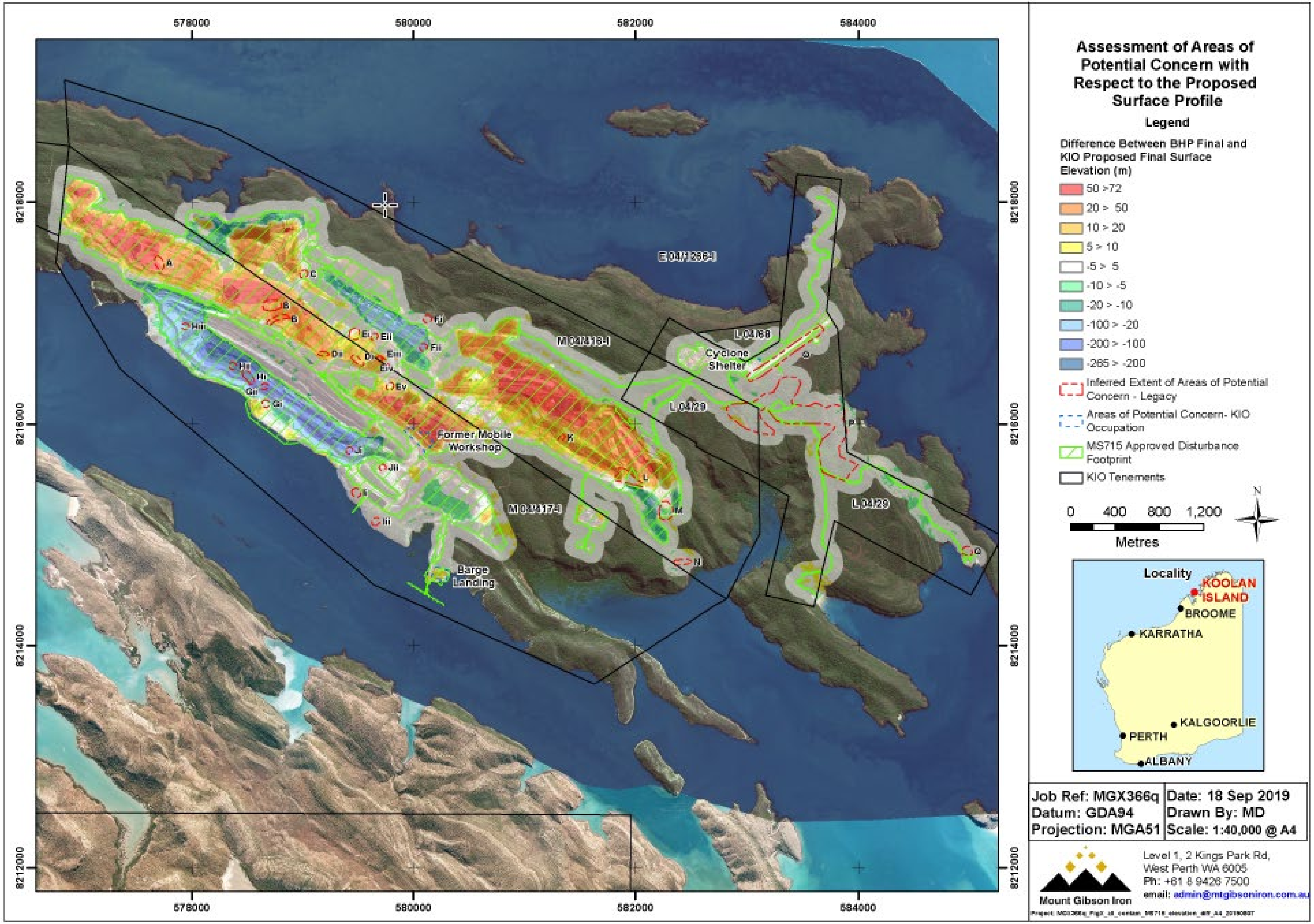
Many areas on site have been significantly modified since the Project commenced. Some AOPCs identified by site assessments at Project commencement may still exist, while others are not likely to present any residual risks to human or ecological health as a result of the site changes undertaken during operation of the mine and various management measures implemented.

Multiple AOPCs such as the former tyre dump, support buildings and landfills are now located under various WRLs, indicating these areas are now completely buried. The BHP wharf spill area is now located under KIO's seawall, which is ≈ 33 m in height. Other areas have been subject to significant excavation due to mining activities. Specifically, the quarry hydrocarbon storage area material was sent for bioremediation and no longer remains at the location. Figure 7-42 shows differences between surface elevations at the end of BHP operations and the proposed surface elevations at closure of KIO operations, illustrating areas where AOPCs have been excavated or buried.

7.14.4 Considerations for Mine Closure Planning

- Koolan Island is registered as a potentially contaminated site by DWER resulting from activities during occupation prior to MGX (legacy contamination). Contamination risk to human health and the environment is considered to be low by DWER due to groundwater being up to 170 m below ground level, and several AOPCs being covered by significant quantities of waste rock (up to 70 m thick).
- During operations, MGX has managed legacy contamination risk through internal ground disturbance procedures and the approved Contamination Management Plan.
- At closure, MGX will assess contemporary potential contamination sources (section 7.14.2.2) and the sites of known contemporary contamination events (section 7.14.2.3) in accordance with the DER (2014) site contamination guidelines.
- Investigation and remediation of the KIO barge landing diesel spill (section 7.14.2.3) were not conducted entirely in accordance with the *Contaminated Sites Act 2003* and DER (2014) guidelines, as the validation stage did not include laboratory analysis of soil or groundwater validation samples (validation was performed by visual observations and PID readings only). DWER advised that the facility is suitable for continued use as a mine site and that it presents a low level of risk to human health and the environment under current uses.
- Three soil samples were taken during removal of soils at the cyclone shelter, with minor exceedances of TRH fractions.
- Project environmental monitoring activities have not indicated the presence of contamination, including:
  - Marine quality monitoring in accordance with the Marine Management Plan;
  - Groundwater quality monitoring in accordance with the Water Management Plan and Licence L8148; and
  - Workforce health and safety monitoring.

Figure 7-40 BHP Final Surface Elevation and Proposed KIO Closure Surface Elevation Differentials


Assessment of Areas of Potential Concern with Respect to the Proposed Surface Profile
Legend
Difference Between BHP Final and KIO Proposed Final Surface Elevation (m)
50 >72
20 > 50
10 > 20
5 > 10
-5 > 5
-10 > -5
-20 > -10
-100 > -20
-200 > -100
-265 > -200
Inferred Extent of Areas of Potential Concern - Legacy
Areas of Potential Concern- KIO Occupation
MS715 Approved Disturbance Footprint
KIO Tenements
0 400 800 1,200
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref: MGX366q
Datum: GDA94
Projection: MGA51
Date: 18 Sep 2019
Drawn By: MD
Scale: 1:40,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd, West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au
578000
580000
582000
584000
8218000
8216000
8214000
8212000
E 04/1286-I
M 04/418-I
M 04/417-I
L 04/68
L 04/29
Cyclone Shelter
Former Mobile Workshop
Barge Landing

- Direct contact risks are considered to be low as AOPCs are either significantly buried (with low potential to future instability / erosion) or have been mined out, and affected soils have been taken to the bioremediation facility.
- Petroleum hydrocarbon contamination is unlikely to present a risk to groundwater due to the reduced leaching potential of diesel hydrocarbon fractions and the significant depth of groundwater.
- Under the *Contaminated Sites Act 2003*, remediation is only required where a source, pathway, and receptor are present. Due to the nature of petroleum hydrocarbon impacts on Koolan Island, the lack of an ongoing contamination source, depletion of historic sources, and no demonstrated pathway to receptors on the Island, it is unlikely that legacy contamination poses an unacceptable risk to human health or the environment. Areas where shallow groundwater is present, such as KIO's barge landing, should be assessed to confirm the absence of residues.
- Asbestos is a non-volatile substance that only represents a risk when disturbed due to the creation of free fibres which can be inhaled by people. Areas that have been avoided during mining efforts do not represent a risk due to asbestos into the future as they remain capped. Some former landfills have been covered by WRLs and do not represent a risk due to the significant depth to any asbestos contamination. Department of Health (2009) guidelines for asbestos contamination stipulate the management of asbestos in situ can be achieved where "if impacted soil is or will be covered by more than 3 m of clean fill, then that area will not normally be deemed asbestos contaminated" or "cover may be 0.1 m of organic mulch" for nature reserves due to the low likelihood of disturbance. Asbestos contaminated areas within the MGX footprint have been minimally disturbed and the levels of encapsulation described by Department of Health (2009) are likely to be achieved at closure.
- Potentially contaminated areas (contemporary and legacy matters) are to be managed in accordance with the Contamination Management Plan (MGX, 2019).
- Any legal liability for investigating and / or managing legacy potentially contaminated areas resulting from site occupation prior to Aztec and MGX will be resolved prior to relinquishment of mining tenements.

7.15 ANALYSIS OF CLOSURE DATA

Following the review and analysis of the closure data, a list of opportunities to further this knowledge is provided in Table 7-18. Further investigations have been identified and will be undertaken in order to accurately assess the key matters associated with closure of KIO operations and allow greater certainty in re-establishment of safe, stable and non-polluting post-mine landforms.

Table 7-18: Identified closure-related opportunities to further knowledge on closure data.

Area	Knowledge Opportunity	Investigation/Action to be undertaken	Timeframe
Flora	Information on seed viability and appropriate seed mix for use in rehabilitation.	Shadehouse trials demonstrated this approach is viable for testing seed viability. On-going trait analysis monitoring along with progressive rehabilitation and trials will provide information on ecosystem structure and diversity for further refinement of the species mix chosen for further testing for rehabilitation.	Ongoing (section 7.8)
Rehabilitation success	Generate further knowledge on the effect of materials composition to the establishment and growth of vegetation to better inform rehabilitation designs.	Rehabilitation and trials currently underway as described. Monitoring will further inform final landform design (such as use of flats, slopes and berms), rehabilitation methodology and completion criteria.	Ongoing (section 7.7.4)
Contaminated sites status	Determine how the current status of '*Potentially Contaminated – Investigation Required*' across the Island under the *Contaminated Sites Act 2003* will be treated at mine closure and lease relinquishment.	Additional assessment is required to determine the legal and financial liabilities of managing historical legacy areas. Outcomes of this assessment would be used to liaise with both DWER and DMIRS on the relinquishment of mining tenements.	2020
Acid and metalliferous drainage	Maximum potential acidity, acid neutralising capacity and net acid producing potential are currently unknown	Acid base accounting tests within the context of mined waste having very low (< 0.1 %) total S content.	2021
Marine rehabilitation	Hydrodynamic modelling of vertical mixing / layering in Main Pit	Specialist modellers will further refine existing models to: 1) Determine final dimensions and location of tidal trenches to maximise flushing exchanges and control scour and velocity 2) Manage the post closure risks of stratification or partial mixing of closed pit water body	2021

8 IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

Environmental and regulatory risks and opportunities associated with rehabilitation and closure have been assessed. The complete risk assessment is included as APPENDIX E. Key outcomes of the risk assessment are summarised in sections 8.2 to 8.13.

The process and methodology used to identify principal closure issues and risks follows the Leading Practice Sustainable Development Program for the Mining Industry as related to mine closure and rehabilitation (Department of Industry, Innovation and Science, 2016a & 2016b), considering the closure data and analysis detailed in Chapter 7.

Risk was assessed according to the tables and matrices provided in Appendix J of the DMP (2016) MP guidelines. The highest residual risk rating for identified hazards was "Moderate". A total of 19 discrete hazards attracted a moderate residual risk rating:

- Abandonment bund collapses into pit;
- DC impacts marine environment;
- DC not constructed according to the design;
- Erosion of growth media prior to establishment of revegetation;
- Excessive sediment loss and deposition into the marine environment;
- Insufficient supply of suitable growth media;
- Landforms erode, slump and / or collapse;
- Leaching of potential contaminants into Soil or Groundwater;
- Main Pit 'Lake' Water Quality Unsuitable for Environmental Values;
- Operational complexity to reconstruct the surface soil profile;
- Outer surface of WRLs not constructed according to the design;
- Pit Wall Instability due to uncontrolled runoff into Main Pit;
- Ponding of Water against abandonment bunds;
- Soil Conditions are Inadequate for Re-establishment and Growth of Vegetation;
- Tidal fluctuation of Main Pit water levels;
- Uncontrolled Surface Water Flows;
- Visual amenity of the WRLs is not congruent with the surrounding land surface;
- Wall collapses into open pit; and
- Weed invasion.

Risk mitigation strategies and treatments for Project wide closure issues, and closure domain-specific issues, are discussed in section 8.2, and sections 8.3 to 8.13, respectively.

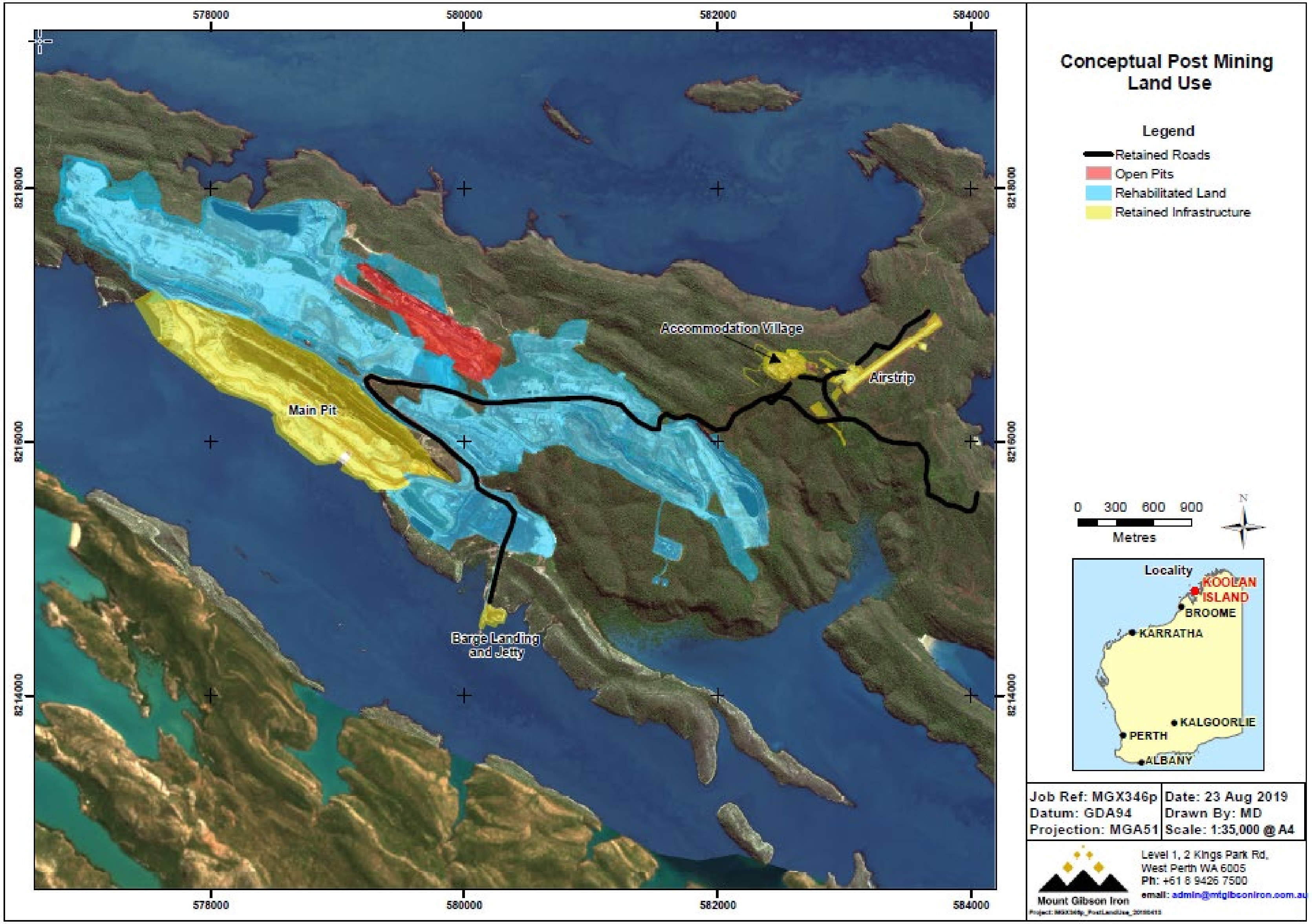
8.1 CLOSURE DOMAINS

The following three closure domain types have been identified for the Project:

- Open pits;
- WRLs; and
- Infrastructure (including a number of structural and civil engineered elements).

Final closure domain options are shown in Figure 8-1 and Figure 8-2. Current operational areas are shown in Figure 8-3

Figure 8-1: Closure Option 1


578000
580000
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584000
8218000
8216000
8214000
Accommodation Village
Airstrip
Main Pit
Barge Landing and Jetty
Conceptual Post Mining Land Use
Legend
Retained Roads
Open Pits
Rehabilitated Land
Retained Infrastructure
0 300 600 900
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref: MGX346p
Datum: GDA94
Projection: MGA51
Date: 23 Aug 2019
Drawn By: MD
Scale: 1:35,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au

Figure 8-2: Closure Option 2

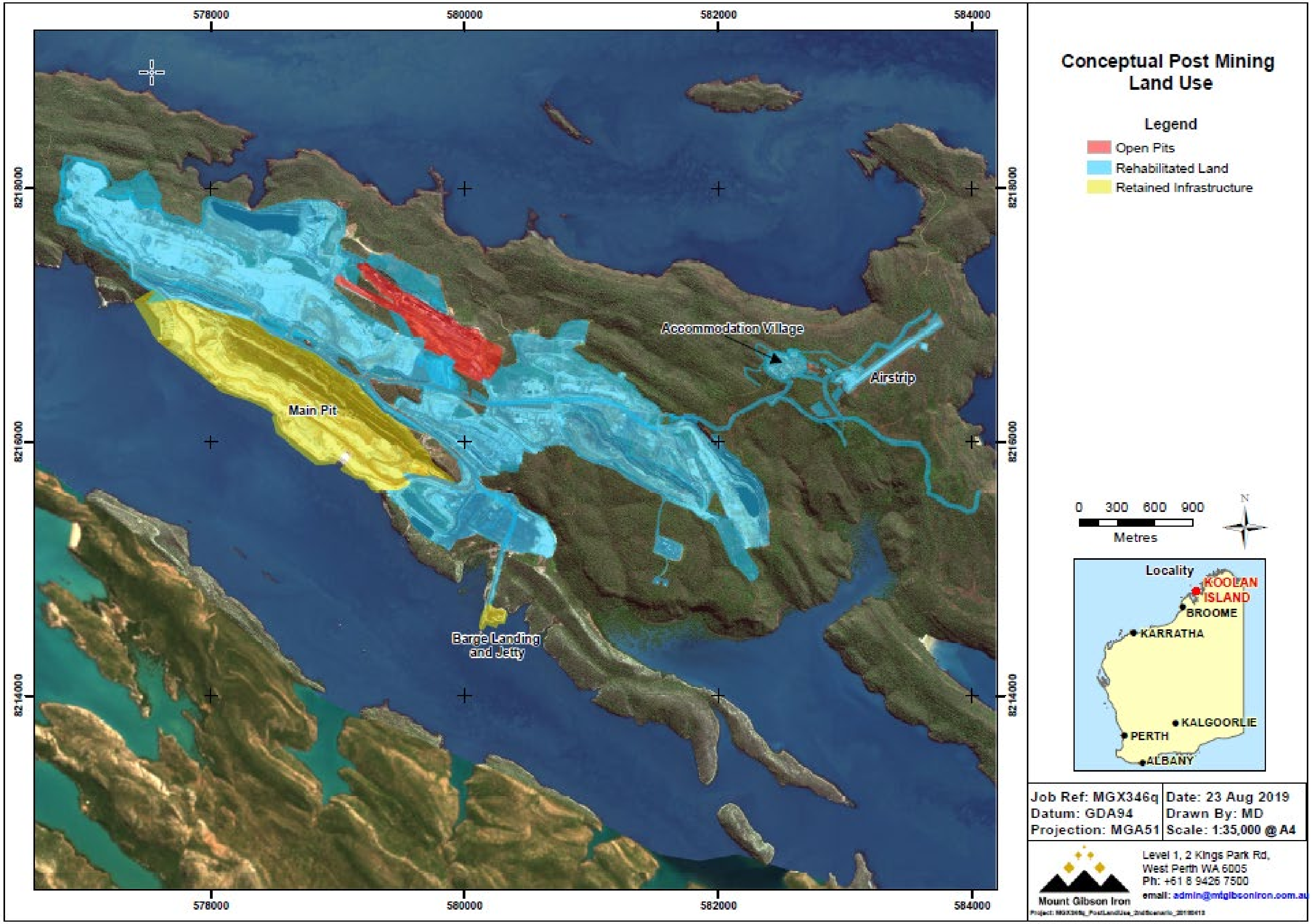
Conceptual Post Mining Land Use
Legend
Open Pits
Rehabilitated Land
Retained Infrastructure
Main Pit
Accommodation Village
Airstrip
Barge Landing and Jetty
578000
580000
582000
584000
8218000
8216000
8214000
0 300 600 900
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref: MGX346q
Datum: GDA94
Projection: MGA51
Date: 23 Aug 2019
Drawn By: MD
Scale: 1:35,000 @ A4
Mount Gibson Iron
Level 1, 2 Kings Park Rd,
West Perth WA 6005
Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au

Figure 8-3: Operational Areas (as at 2019)

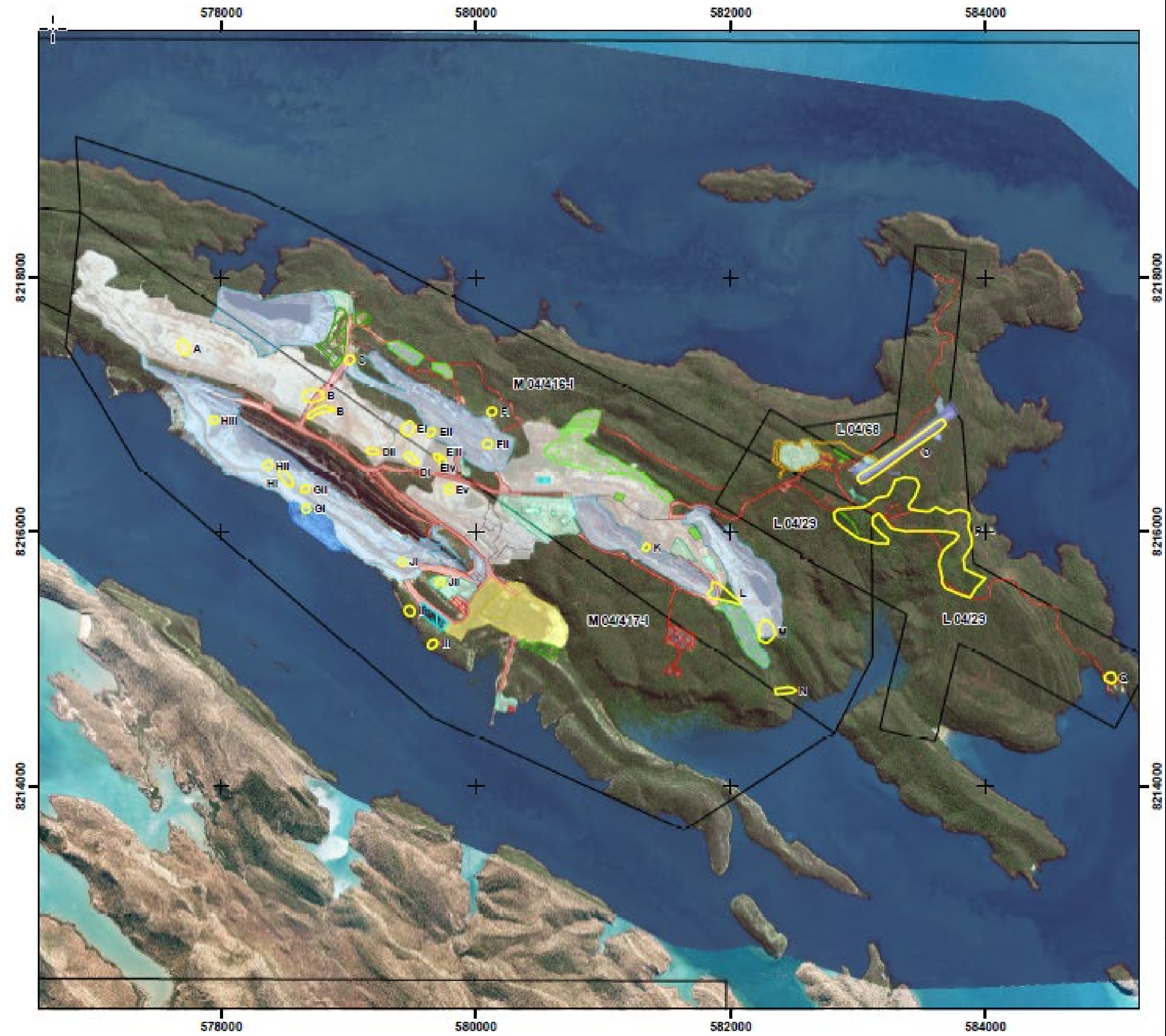

Figure 3: Current Mine Site Configuration and Infrastructure (as at Sept 2018)

Job Ref: MGM366h	Date: 16 Aug 2019
Datum: GDA94	Drawn By: MD
Projection: MGA51	Scale: 1:40,000 @ A4

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8.1.1 Open Pits

The following open pit voids will remain at closure:

- Main Pit; and
- Acacia East Pit.

Key characteristics of the open pits are listed in Table 8-1.

Table 8-1: Key Open Pit Characteristics

Mine Pit	Depth (at life of mine)	End of mine surface area (ha)
Main Pit	186 mbsl	82.5
Acacia East Pit	14 absl	34.1

Note: mbsl = metres below sea level, absl = metres above sea level

8.1.2 Waste Rock Landforms

The following WRLs developed from backfilled pits will remain at closure:

- Mullet Pit;
- Barramundi Pit; and
- East Pit.

At the time of this MCP, MGX was seeking approval to backfill Barramundi Pit and amend the forecast final surface profiles of East and Mullet Pits. Note, each of these pits has been accepted by Geological Survey of Western Australia. The 'Scree' area, from which surficial deposits were extracted, has also been included in the Backfilled Pits domain as the closure strategy for this mine (i.e. rehabilitation and revegetation) is the same as that proposed for backfilled pits. Key characteristics of the backfilled pits are listed in Table 8-2.

Table 8-2: Key Backfilled Pit Characteristics

Mine Pit	Max. Surface Elevation (at life of mine)	End of mine surface area (ha)
Mullet Pit	106 absl	42.8
Barramundi Pit	160 absl	23.6
East Pit	160 absl	37.5
Scree	N / A	10

Note: absl = metres above sea level

Waste rock generated from KIO mining of Main Pit is placed within the following WRLs:

- Waste Rock Landform 1 (WD 1);
- Waste Rock Landform 2 (WD 2);
- Waste Rock Landform 3 (WD 3);

- Waste Rock Landform 4 (WD 4 & East Pit Backfill);
- Barramundi Pit Backfill; and
- Mullet Pit Backfill.

Key WRL characteristics are listed in Table 8-3 and their locations are shown on Figure 8-3.

Table 8-3: Details of the Existing Landforms on Koolan Island.

WRL ID	Area (ha)	Maximum elevation (m RL)
WD 1	89	1,170
WD 2	24	1,165
WD 3	35	1,165
WD 4	56	1,160
Barramundi Pit Backfill	24	1,160
Mullet Pit Backfill	36	1090

8.1.3 INFRASTRUCTURE

8.1.3.1 Accommodation village

An accommodation village has been installed to house employees and contractors working at the mine site. The village (or camp) covers an area of approximately 9.5 ha, and consists of the following facilities:

- Single person en-suite rooms;
- Laundry modules;
- Kitchen and dry mess;
- Village administration office;
- First aid facility;
- Wet mess;
- Recreation room;
- Vehicle parking areas;
- Wastewater treatment facility;
- Maintenance laydown area;
- Cyclone shelter;
- Backup generators; and
- Firebreaks.

8.1.3.2 Airstrip

An airstrip has been used on the northeast end of Koolan Island. It was originally established by BHP for its mining activity on the Island up until 1993 and has been refurbished by KIO. The facility covers an area of 8.6 ha and consists of:

- An 870 m paved airstrip;
- Parking area for light vehicles;
- Waiting room; and
- Hardstand for parked aircraft.

On 15 August 2019 DMIRS approved a MP for the construction and operation of a new Airfield at Koolan Island over approximately 60 ha of the WRLs WD1 and WD3. The new airfield will be constructed to the Civil Aviation Safety Authority specifications to become a certified Airfield, and will include:

- Runway lighting and communications;
- Aprons for taxiways for safe movement of aircraft;
- 45 m wide runway and 30 m wide taxiway;
- Passenger terminal;
- Aircraft hangers and maintenance hangers;
- Aircraft washdown bay; and
- Refuelling area including bulk fuel storage.

The new Airfield will reduce the number of aircraft required to safely transport personnel to site, therefore reducing the number and frequency of take offs and landings that currently occur at Koolan Island. It will also reduce travel time to and from Koolan Island, as flights will link Perth with the Island directly. Note, once the new airfield construction commences, waste will no longer be placed on to WD1 or WD3.

8.1.3.3 Bioremediation Facilities

Bioremediation facilities have been established for the management of hydrocarbon-contaminated soil and biodegradable absorbent materials. At these facilities, the material to be treated is spread and periodically aerated by turning and sprayed with water to encourage aerobic biodegradation of contaminants. Each facility has been constructed and maintained in accordance with licence conditions (DER Licence L8148/2006/4).

8.1.3.4 Mine Site Offices

Mine site offices have been established in a central location known as the mine operational centre (**MOC**) located to the north east of the Main Pit and south east of Acacia East Pit. The MOC covers a total land area of approximately 14.4 ha, and consists of the following:

- Office work space;
- Ablutions (Septic tanks with leach drains);
- Crib rooms;
- Other general office facilities;
- Parking areas;
- Mobile Equipment Workshop;
- Stores and warehouse;
- Fuel storage; and
- Power generation facilities.

8.1.3.5 Dewatering facilities

Dewatering equipment removes water from certain Pits when under mining. This equipment typically consists of:

- Floating pontoons with a diesel powered pump;
- Booster cyclone pumps with two 77,000 L staging tank located on the South side of the Main Pit;

- 2 x 450 mm diameter polyethylene pipelines, each approximately 850 m in length;
- A settlement pond for the treatment of turbid water, when necessary;
- Floating pontoons on the discharge pipe; and
- Post sediment pond sampling point with Mag flow meters.

The pumping equipment and pipe inlet rests on a floating pontoon. The pipeline runs from the Main Pit, over the land surface into a settlement pond, then down slope to the sea. Water is discharged approximately 70 m offshore at a location approximately half-way between the Seawall and the ship-loading jetty. KIO also holds approval to discharge directly to the ocean from the Main Pit and Mullet Pit under DER licence L8148/2006/4.

8.1.3.6 Fuel Storage

Four fuel facilities exist on site and are located at the barge landing, power station, MOC and the Village. All four areas are managed under the site Dangerous Goods Licence. The facility at the power station is used for the storage of hydrocarbons, and as fuelling stations for mine site vehicles. The site at the barge landing is used for transferring fuel to the storage tank at the power station. The facility at the MOC is used to fuel light vehicles and the facility at the Village is used to fuel the power station. The sites cover a total approximate land area of 1 ha and consist of the following:

- Double skinned self-contained tanks within concrete bunding;
- Fuel transfer facility;
- Fuel pumps; and
- Fuelling pad.

8.1.3.7 Warehouse and Logistics Facility

The supply warehouse is located at the MOC and stores bulk supplies for mine site operations, including packaged hydrocarbon and chemical stores. The warehouse facility consists of indoor and outdoor storage and staging areas.

8.1.3.8 Jetty, Ship Loader and Barge Landing

Facilities have been constructed to transport processed ore from the OSA pad and to load the material onto Bulk Ore Carriers. The facility also serves as a loading and offloading facility serviced by supply barges from the mainland, referred to as the Barge Landing. The facility is managed under Commonwealth law which requires customs and quarantine arrangements to be observed. Part of the facility is located within the Crusher area, and is used to load the material onto a conveyor.

The loading facilities are located on the coastline approximately 1.5 km southeast from the Main Pit, and consist of:

- A 130 m concrete access jetty, built out from an area of reclaimed land;
- Barge Landing built out of an area of reclaimed land;
- Ship Loader service platform;
- Mooring dolphins; and
- Connecting walkway.

The main work areas are connected by approximately 950 m of conveyors.

8.1.3.9 Laydown areas

Laydown areas have been established around the mine site for temporary storage of equipment during normal mining and contractor operations. Each of the laydown areas consist of an open, compacted area of waste rock used for temporary outdoor storage. There are no permanent structures or utility connections in these areas. The laydown areas associated with different activities around the site include,

- Acacia hardstand (2.3 ha);
- Tip road laydown (0.8 ha);
- Old Central Warehouse Facility laydown (1.8 ha); and
- Other laydowns / hardstands (7.1 ha).

8.1.3.10 Explosive Magazine and Bulk Explosives Batching Facility

Bulk materials used to make up explosives in a batching plant are stored within sea containers situated on three compacted rock pads, in an isolated location away from the rest of the mine infrastructure. Ignition systems including boosters and detonators (High Explosives) are stored in a purpose built Magazine and separated from the batching plant. Batching and storage are managed in accordance with explosives and dangerous goods regulations under the site license. These sites cover a total approximate land area of 4.1 ha and consist of the following:

- Compacted rock or gravel pads;
- Concrete mixing pads;
- Power generation equipment; and
- Storage tanks and containers.

8.1.3.11 Buried Services

A total of approximately 10 km of buried services (i.e. power lines) have been installed at the mine site to service equipment within the main work areas. The majority of the buried services are installed within the Accommodation Village, MOC and processing areas.

8.1.3.12 Power station

A diesel power station has been established near the crushing plant to supply electricity to the ore processing plant, ship loading facility and associated infrastructures. Fuel is supplied to the power station from the neighbouring bulk fuel storage facility via a dedicated day tank. Electricity is transmitted from the generation facility to the work area by a network of high voltage and low voltage buried service cables.

The 2.5 Megavolt ampere (MVA) ROM power station covers approximately 0.1 ha and consists of the following,

- Five (5) 500 Kilovolt-Ampere (kVA) diesel generators
- Distribution transformers
- Concrete pads including transformer containment facilities
- Switchroom/control building
- Site office and maintenance/service containers

A diesel power station has been established adjacent to the MOC and associated maintenance infrastructures. Fuel is supplied to the power station from a bulk fuel storage tank and via a dedicated day tank, both located within the power station containment bund. Electricity is transmitted from the generation facility to the MOC and associated infrastructures by a network of low voltage buried service cables.

The 1.5 MVA MOC power station covers an area of approximately 0.06 ha and consists of the following:

- Three (3) 500 kVA diesel generators;
- concrete pads and containment facilities; and
- Switchroom / control building.

A diesel power station has been established at the accommodation village. Fuel is supplied to the power station from a dedicated bulk fuel storage tank located within the power station containment bund. Electricity is transmitted from the generation facility to the village and associated facilities by a network of low voltage buried service cables.

The 2.0 MVA Village power station covers an area of approximately 0.04ha and consists of the following;

- Four (4) 500 kVA diesel generators;
- Concrete pads and containment facilities; and
- Switchroom/control building.

8.1.3.13 Roads

A network of approximately 16 km of haul roads and >20 km of light vehicle tracks exist for access to the different areas of the site and for haulage of ore and waste. Haul roads are intended primarily for large mine vehicles, and are approximately 25-30 m in width, covering a total land area of approximately 25.3 ha.

Existing light vehicle tracks are approximately 8-12 m in width and provide access for light four-wheel-drive vehicles.

8.1.3.14 Ore Stockpile Area and processing plant

The OSA and processing plant are located to the east of the Main Pit. The OSA is used for storing unprocessed and processed ore. Product stockpiles are 8-10 m in height, and contain 100,000-250,000 t of product each. The stockpile yard is designed with a capacity of approximately 250,000 m^3 of product, though this may be increased if required. The crushing plant consists of a two stage dry crushing and screening plant and stacker. No chemical processing of the ore is undertaken with the product and therefore it is considered a Direct Shipping Ore product.

The OSA and crushing plant comprise a combined area of approximately 32 ha. This includes a laydown area along with the OSA pad.

8.1.3.15 Workshops

A workshop area has been established for the repair and maintenance of mine equipment at the MOC.

The workshop area consists of the following:

- Main workshop;
- Storage areas; and

- Oil separation facility.

Hydrocarbons and chemicals for maintenance are stored at the workshops. The workshop catchment areas are separated from general storm water interaction and native surface water catchment areas. Waste water from the workshop area is treated onsite by an oil separator prior to reuse for dust suppression or licensed and monitored discharge.

8.1.3.16 Landfill

A landfill has been established amongst WD4, near the eastern end of the mining operation, approximately 100 m south of the East Pit. This is currently licensed as a Class II landfill (DWER Licence: L8148/2006/4). Inert and putrescible wastes are buried in this facility. The trenches are excavated and backfilled upon filling with waste in order to minimise wind-blown rubbish, odours and the risk of fire.

The landfill is separated into two areas; the western landfill is used for industrial waste, while the eastern landfill is used for domestic waste disposal.

The base of WD3 has also been used in the past as a landfill area for inert industrial waste such as scrap metal. All landfills have been constructed and operated in accordance with approvals obtained by KIO from both the DMP and DER.

8.1.3.17 Seawall

To facilitate mining in Main Pit in accordance with MS715 and to maintain dry working conditions, an engineered seawall was constructed across the mouth of Arbitration Cove, keyed through existing landforms, with the structure reaching final completion in 2012. A total land area of approximately 8.2 ha was reclaimed.

In November 2014, a section of the Main Pit Seawall collapsed, resulting in the seawater inundation of Main Pit. In 2017, the MGX Board approved reconstruction of the seawall and restart of mining. The proposal for the redevelopment was submitted to the regulatory authorities as a MP (Reg ID 60751) and s45C amendment to gain Attachment 7 of MS715. The rebuild project commenced on 1 June 2017, comprised of three phases:

- Earthworks to close the Seawall breached section with rock material;
- Construction of an impermeable seepage barrier in the built rock matrix to seal the Seawall from seawater ingress; and
- Capital dewatering of resident sea water in the Main Pit and progressive ground support works to stabilise pit walls.

Work commenced after DMIRS approval of MP Reg ID 60751. Phase 1 of the project was completed in September 2017. Approximately 409,000 m^3 (882,000 t) of waste rock was excavated from existing waste dumps and placed in the breached section of the Seawall. Drainage holes were also engineered to extract water from the mass. Geotechnical and groundwater monitoring stations were installed into drilled bores and fixed prisms placed to assist in the detection of water and movement.

Phase 2 of the project commenced in September 2017 with the mobilisation of a civil contractor to construct the Seawall vertical seepage barrier. The rebuilt Seawall was completed in June 2018 with placement of the final vertical panels and installation of monitoring stations.

The Koolan Island Seawall incorporates a seepage barrier comprised of an inert grout and bentonite – cement content prepared using a mobile batching facility. The seepage barrier is comprised of 190 panels each with an effective width of 1.5 m, length of 2.3 m and depth from 2 m up to 45 m. Permeation grouting was also undertaken through injection drilling. The barrier effectively makes the constructed Seawall mass impermeable to seepage from the marine environment. Seawater is predicted to flow through fissures and cracks in native bedrock. The network of geotechnical sensors installed on the Seawall allows for the continuous monitoring of the ground stability on the Seawall and detection any seawater intrusion.

8.2 PROJECT WIDE CLOSURE ISSUES

8.2.1 POTENTIAL ACID AND METALLIFEROUS DRAINAGE

The potential for AMD to occur within waste rock units across each of the five deposits has been assessed using the geological database and a cut-off value of 0.3% Total S to define material which is Potentially Acid Forming (PAF). The assessment has shown that the occurrence of material with elevated Sulphide content is very low, with no evidence of specific locations or geological units containing high Total S contents and the overall volume insufficient to affect closure outcomes (section 7.4). Geochemical testing of waste rock will continue during life of mine.

8.2.2 UNDERPERFORMING REVEGETATION NOT MEETING COMPLETION CRITERIA

The growth materials (media and seed mix) which will be used in land rehabilitation, along with key species required to develop and maintain ecosystem function and diversity, have been characterised prior to revegetation so that the growth requirements of the species selected can be optimised, and therefore rehabilitation will develop each closure domains landscape function and resilience. Applying this 'design-based approach' to rehabilitation (Section 6) ensures that completion criteria is established and can be realistically achieved.

Considerable research has been conducted to quantify volumes balance, material properties and growth requirements of selected species (Section 7) to provide a quantitative basis for designing final landforms and developing effective rehabilitation procedures. Closure data detailed in Section 7.7 and 7.8 indicates that a variety of growth media are capable of supporting revegetation of land on both flat and sloped surfaces. Also, based on work conducted to date, a suitable floral species mix for the restoration of land has also been developed (section 7.8.2). Further monitoring of trials (section 7.7.4) and progressive rehabilitation will extend current knowledge and work towards successful revegetation of disturbed land.

The analysis of closure data identified opportunities to build upon current knowledge (sections 7.8.4 and 7.8.6). It is considered that ongoing monitoring of progressive rehabilitation and trials will be adequate to build upon current knowledge, provide further evidence for broad scale adoption of land rehabilitation techniques and further detail specific and achievable closure completion criteria.

In the event that revegetation monitoring indicates a significant risk of not meeting completion criteria targets, KIO will initiate a technical investigation to determine the reason/s for potentially unsuccessful revegetation. KIO would then implement appropriate mitigation measures depending on the outcomes of the investigation (e.g. surface water management, erosion control, mulching, growth matrix additives, revised seed mix, revised seeding procedures, etc.).

8.2.3 Weed Infestation

The key weed species associated with mine closure for successful rehabilitation outcomes is Stinking Passionflower (*Passiflora foetida*), which is generally constrained by soil moisture. Distribution appears to be very strongly correlated with the presence of artificial barriers to natural water flows. A key management measure is therefore minimising land forming and other activities that impede surface flows, causing the formation of ponds, soaks, and other artificially damp areas. Other key management measures include treatment of weed infested topsoil stockpiles prior to spreading and active vehicle hygiene measures.

The biological agent currently being trialled by CSIRO is likely to be used during closure if assessed as suitable for Koolan Island conditions.

8.2.4 Potentially Contaminated Sites Management

Legacy areas associated with potentially contaminated sites are discussed in section 7.14. The contaminated sites status has been incorporated into the mine closure planning framework as recommended by DWER. It is considered that target investigations where needed and if derived from KIO activity will resolve this matter and the underlying aspect of mining tenement relinquishment will be resolved in consideration of the *Contaminated Sites Act 2003* and the *Mining Act 1978*.

8.3 DOMAIN SPECIFIC CLOSURE ISSUES

Closure issues specific for each domain can be grouped into the following categories:

- Stability and structural integrity;
- Potential environmental impacts resulting from closure works;
- Rehabilitation;
- Visual amenity; and
- Operational implementation.

8.4 OPEN PITS

It is expected that at the cessation of mining, the Main and Acacia East Pits will remain open as voids, whilst the Mullet, Barramundi, and East Pits will be backfilled with waste rock. Main Pit will be inundated with diurnally tidally flushed seawater.

8.4.1 Stability and Structural Integrity

Mine pits have been, and will continue to be, designed in accordance with the Department of Minerals and Energy (**DME**) (1999) *Guidelines on Geotechnical Considerations in Open Pit Mines*, with sufficient Factor of Safety and Probability of Failure margins.

Slumping and Collapse of Pit Walls

Mining of Acacia East pit has ceased. Risk associated with pit wall slumping and collapse is avoided by limiting access to the pit by use of a rock bund.

Geotechnical investigations establishing rock mass properties and the 'safe' pit design for continued mining have been completed for Main Pit to an elevation of -80 m AHD, in accordance with Part 13 of the *Mines Safety and Inspection Regulations 1995*.

With the necessary geotechnical studies undertaken, a high level of safety built into the designs, and geotechnical control systems (i.e. anchoring, mesh and shotcrete of the Main Pit walls) the risk of large scale mine wall slumping and collapse during operations is low. Small-scale fretting, and erosion during the wet season are managed operationally. Geotechnical inspections of the pit walls are conducted regularly, with formal reports developed weekly and all evidence of pit wall movement and potential and actual failure recorded.

Main Pit will be seawater inundated at closure. As the ground water level rises following this inundation, the geotechnical stability of the saturated pit walls, and the overlying capillary fringe may be affected. The effects of rising groundwater, and fluctuating sea water levels (once groundwater conditions have 'stabilised') on the stability of the pit walls will be assessed by geotechnical analysis prior to closure design finalisation to ensure any long term effects have been taken into consideration.

After Main Pit is inundated post-closure, foot wall stability may be compromised in the long term by tidal action. Ultimately the geotechnical control systems will fail, likely resulting in slumping and / or collapse of sections of the foot wall. In acknowledgement of long term safety risk associated with foot wall instability to potential pit 'lake' users, KIO proposes to constrain access to the 'lake' to control vessels beneath sections at risk of rock fall. A potential and suggested management measure previously discussed with DMIRS is for a 'No Go Zone' marked by buoys and / or dolphins at the time of closure (post-flooding) (Figure 8-4).

Collapse of the Abandonment Bund into the Pit Void

Abandonment bunds will be placed within areas currently disturbed or approved for surface disturbance with sufficient setback from pit crests to allow for potential long term slumping of sections of crest rock. They will be located at least 10 m outside the area designated as the potentially unstable pit edge zone, according to the Department of Industry and Resources (**DIR**) (1997) Guidelines for *Safety Bund Walls Around Abandoned Open Pit Mines*. Following a geotechnical assessment, they may be re-aligned closer to the pit crests, in accordance with the DIR (1997) Guidelines. Abandonment bund will be constructed using competent (fresh) rock to a height of 2 m and a base 6 m wide in accordance with the DIR (1997) guidelines.

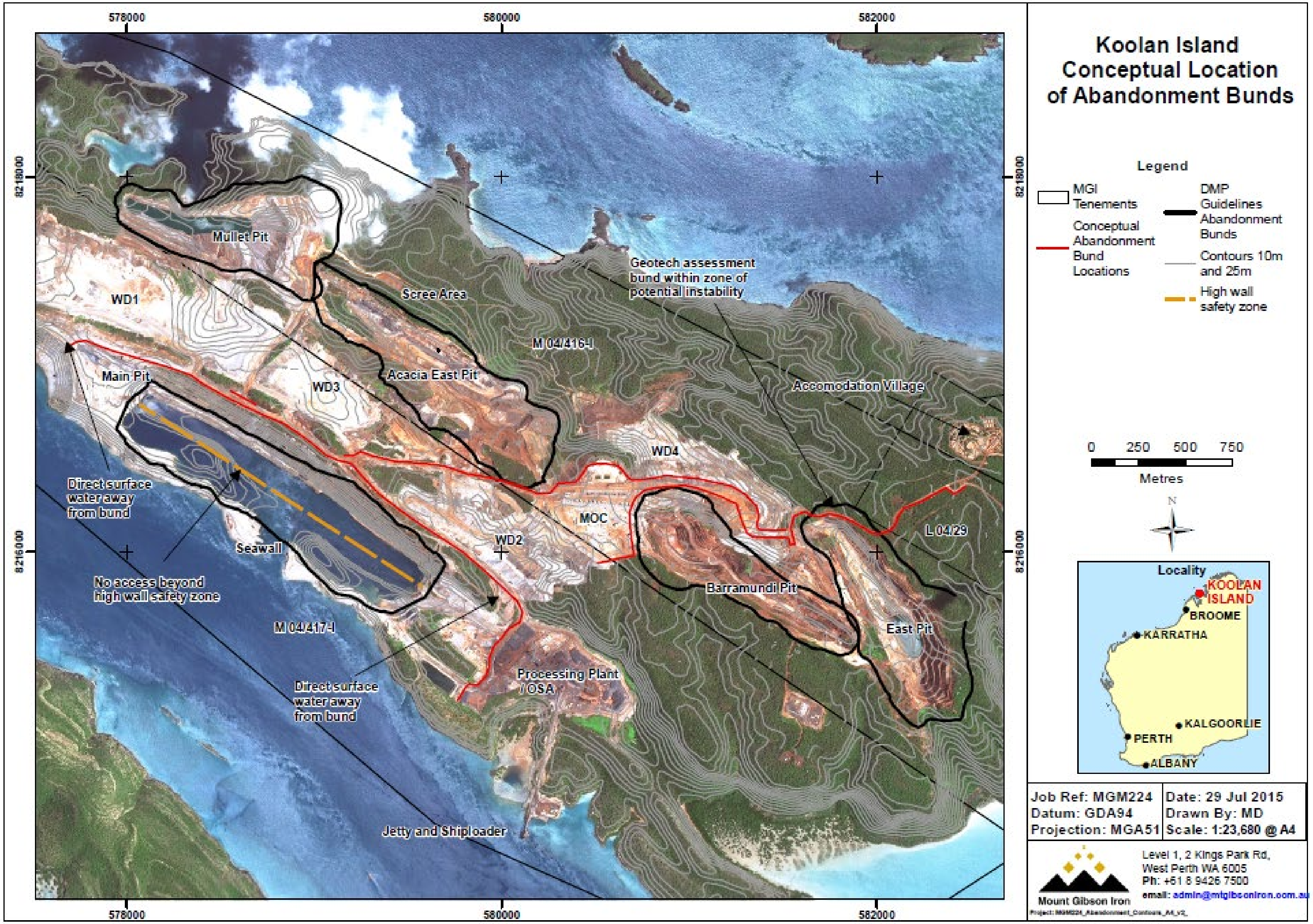
Figure 8-4 illustrates the location abandonment bunds would be placed by strictly adhering to the DIR (1997) Guidelines, and also illustrates KIO's abandonment bund strategy, utilising existing topography, waste dumps, existing bunding and the addition of new bunding to prevent inadvertent vehicle access. The bunds have been positioned at high points to mitigate the risk of scouring and instability due to rainfall. Given these management measures, the risk that the bunds will collapse into the pit void following large-scale wall failure is low. KIO is consulting with the DMIRS Resources Safety Division to determine a suitable abandonment bund strategy. Additional disturbance would be required under MS 715 for this abandonment bund strategy. Should Barramundi, East and Mullet pits be backfilled (section 8.5), the strategy would be revised accordingly as some bunds would no longer be required.

Uncontrolled Storm Runoff into Pits Resulting in Pit Wall Instability

For operational safety, all surface water which may enter mine pits is considered along with the potential need to divert surface water away from mine pits. As per section 7.5, a surface water hydrology investigation has indicated that a channel may need to be constructed for catchment 1 draining to Main Pit. The study did not indicate any potential issues, however, for Main Pit wall stability. Nonetheless, the potential for further erosion of existing rills on the Main Pit footwall exists, and their development will need to be checked regularly as part of the post-closure monitoring programme.

Storm runoff to Acacia East pit is limited due to its location towards the upper extent of catchment 7. Surface water flows within the pit are primarily limited to rainfall incident on the pit footprint and these are contained, destined for evaporation.

Figure 8-4: Conceptual Location of Abandonment Bunds


Koolan Island
Conceptual Location
of Abandonment Bunds
Legend
MGI Tenements
Conceptual Abandonment Bund Locations
DMP Guidelines Abandonment Bunds
Contours 10m and 25m
High wall safety zone
0 250 500 750
Metres
N
Locality
KOOLAN ISLAND
BROOME
KARRATHA
KALGOORLIE
PERTH
ALBANY
Job Ref: MGM224
Datum: GDA94
Projection: MGA51
Date: 29 Jul 2015
Drawn By: MD
Scale: 1:23,680 @ A4
Mount Gibson Iron
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Ph: +61 8 9426 7500
email: admin@mtgibsoniron.com.au
578000
580000
582000
8218000
8216000
Mullet Pit
WD1
Scree Area
Geotech assessment bund within zone of potential instability
M 04/416-I
Main Pit
WD3
Acacia East Pit
Accomodation Village
WD4
Direct surface water away from bund
MOC
L 04/29
Seawall
WD2
No access beyond high wall safety zone
Barramundi Pit
M 04/417-I
East Pit
Processing Plant / OSA
Direct surface water away from bund
Jetty and Shiploader

Scouring of Abandonment Bunds by Ponding of Water against the Bunds

The surface hydrology study (Section 7.5) indicates that a constructed channel may be required for catchment 1. Figure 7-2 and Figure 8-4 indicates the outlet for catchment 1 to the Main Pit may intersect the conceptual location of the abandonment bund. It should be noted that drainage at the eastern end of Main Pit is subsurface flow under constructed landforms. There is another location where contact between surface runoff and the abandonment bund may occur at the Western end of Main Pit, and this leaves the potential for scouring and ponding due to surface run off on both locations from the roads adjacent to the bund. As detailed above, the bund will be constructed of fresh competent quartzite and the interstices will allow water to drain freely. Localised drainage and the adjacent road will be constructed to control scouring and ponding against the bund and provide integrity is maintained to control inadvertent public access.

Surface flows are not expected to pond against Acacia East Pit abandonment bunds.

Surface flow analysis and mapping may be undertaken following establishment of the abandonment bund locations to determine if surface water is expected to pond. In areas where ponding is identified, the land surface will be reshaped to divert water away from the bund.

8.4.2 Potential Environmental Impacts

Sea-water Intrusion to Groundwater

As detailed in section 7.6, the southern syncline is the most at risk of seawater intrusion due to re-flooding of Main Pit. The northward movement of seawater will be minimal, as there is limited permeability across and between the stratigraphic units. There is some potential along the direction of the bedding (west to east); however, this is also considered a low risk owing to the tightness of the geological structure. Furthermore, the same risk was apparent due to former mining operations prior to KIO and seawater intrusion has not been identified through groundwater monitoring of production bores within the Southern Syncline, nor during the Main Pit inundation between 2014 and 2019.

The groundwater aquifer in the southern syncline is hydraulically disconnected from the central and northern ‘fresh’ aquifer systems by the low permeability schist. Subsequently, salt water filling Main Pit is highly unlikely to significantly impact the central and northern aquifers.

8.4.3 Visual Amenity

After the Main Pit void is inundated following mining, the northern pit face (foot wall) will be visible from passing boats and other ocean users. No rehabilitation of this pit face will occur and it will be left as a series of steep benches with exposed rock. Although this is the case, the exposed visible surface represents only a small portion of the total visible surface area of the Island.

As previously detailed (Section 5.2), the proposed post end land use is for the pit to be filled with sea water from a formed channel/s resulting in a saltwater lake. From the air the northern exposed pit slope of the Main Pit will be visible, but the void will appear as a large bay with a lake, improving its visual amenity and environmental value.

Exploration and mining activities have been occurring on the island since 1907 and in the past Koolan Island has been considered somewhat of a state icon (Smith, 1978). Closing the pit as described could be considered by some to be commensurate with the history of the Island and representative of its legacy given former operations.

Acacia East Pit will only be visible from the air, or the immediate vicinity (i.e. standing atop the abandonment bund).

8.5 WASTE ROCK LANDFORMS

Waste rock material has been placed in several designated WRLs around the island. The dumps comprise a mixture of various materials excavated from multiple pits (over several decades) and placed (tipped) in a manner consistent with conventional mining methods. WRLs contain variable percentages of quartzite, from 20% to 90%, with an average of around 60%. The vast majority of the placement occurred before 2014.

Based on a comparison between current topographic surveys, and historic (1955) site topography, the thickness of waste material (above original natural ground level) varies significantly but is up to ≈ 100 m in some areas, with the majority of WD1 and WD2 being < 50 m in vertical thickness. These WRLs were historically constructed within sub-valleys, and thus the thickest waste areas are generally located within the central area of the landforms. The currently exposed maximum slope heights (around the edge of the dumps) are typically < 50 m in vertical height.

As described throughout Chapter 7, a large body of work and studies have been completed which are aimed at determining final landform design and rehabilitation methodologies. This has included investigations into:

- Waste characterisation (SWC, 2014b, 2014c);
- Landform stability (SWC, 2014d, 2014e);
- Soil and vegetation associations (SWC, 2015b, 2014d); and
- Surface hydrology (SWC, 2014a, 2014c).

Chapter 7 also details a range of trials and progressive rehabilitation which have been carried out at Koolan Island over the operational history of the site. The work completed thus far has informed final landform design and rehabilitation methodologies to allow fulfilment of WRL closure objectives (section 5.3). The capacity for rehabilitated WRLs to meet these objectives is largely determined by the materials available and the local climate.

The studies undertaken have determined that post mine landforms can be constructed so as to remain safe, stable and non-polluting. Flora have been selected to promote revegetation where possible. However, sustainability of the different areas of the landforms must consider and be subject to the goals of safety, stability and reduction of environmental effects to surrounding receptors. This clarification in rehabilitation goals for the WRL's is due to a number of factors and acquired knowledge of site conditions discussed in Section 4 which include:

- The absence of AMD;
- The absence of any evidence indicating the transport of sediment from WRLs into the marine environment;
- Adequate knowledge of erosive materials and methodologies to counteract any potential loss of sediment;
- Adequate waste materials to also serve as plant growth media;
- Successful plant growth and revegetation trends; and
- Adequate competent waste rock which has been modelled as stable under a variety of scenarios.

Ongoing monitoring of rehabilitation trials and rehabilitated areas since the previous MCP (sections 7.7 and 7.8) indicates that KIO's preferred WRL rehabilitation design is likely to meet the WRL closure objectives. This design features ≤ 20° batter slopes (except where this would cause batter slopes to encroach on undisturbed vegetation or breach the approved disturbance footprint) and ≤ 5° backsloping berms. The top level of WRLs will be backsloped from perimeter bunds to encourage water storage by vertical infiltration of rainfall. Where appropriate and practical, drainage lines will be constructed utilising competent quartzite rock. Rehabilitated designs details for WRLs WD1 – 4 are summarised in Table 8-4.

Table 8-4: Conceptual rehabilitated waste rock landform design specifications

Final Batters	≤ 20° (unless final design is amended by approved MP)
Berm width	≈ 5 – 10 m
Berms	Back sloping at ≈ 5° Topsoil spread at 100 – 200mm, deep ripped on contour, seed mix spread
Top of WRL	Concave at ≈5° with perimeter bunds
Other treatments	Constructed drainage lines using competent rock (e.g. quartzite) as necessary

A large portion of the existing WRLs are located far from naturally vegetated areas, however natural vegetation is notably present in the north-west section of WD1 and beyond the south-east edge of WD2. Coffey (2019) have previously assessed that the WD1 and WD2 outer slope angles typically vary from 30 degrees to around 36 degrees ('angle of repose'). Figure 8-5, whilst specific to the central waste dump area, is indicative of the typical waste dumps at site. It should be noted that the majority of slopes have been constructed with one or two benches, and thus the overall slopes angles (from ultimate toe to crest) are generally < 25 ° in most areas, with some sections being < 20 °.

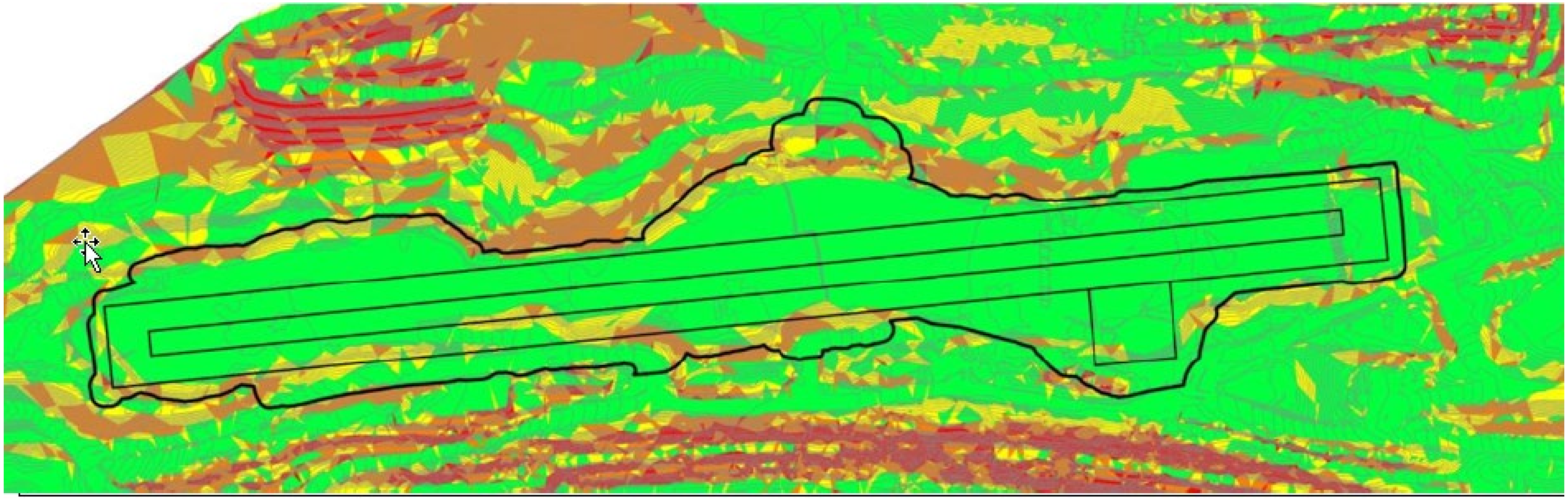

Figure 8-5: Slope Analysis of the Central Waste Dump Area (WD1 showing proposed airfield approved by Reg ID 79171)

Coffey (2019) particle size distribution testing (summarised in Figure 8-6) indicated that material is fairly consistent across each of the WRLs, with grading curves indicating that the material on average contains approximately:

- 15% sand;
- 35% gravel;
- 40% cobbles; and
- 10% boulders.

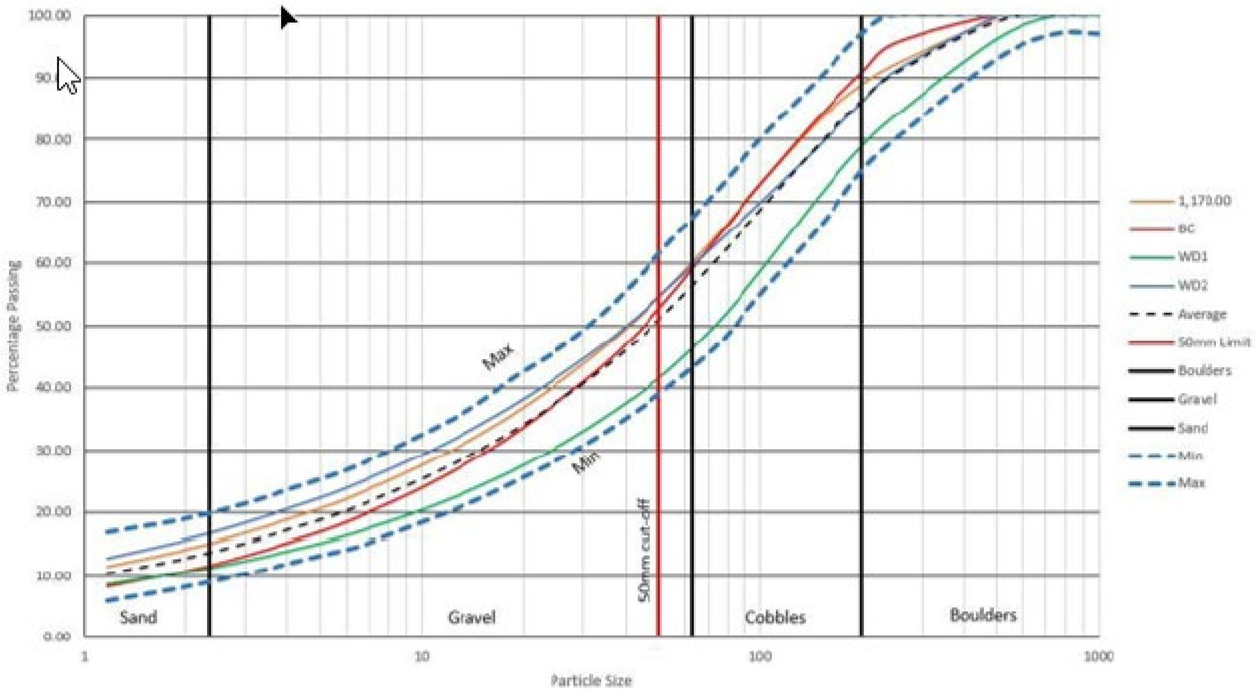

Figure 8-6: Koolan Island Waste Rock Landform Particle Size Distribution

Grading envelopes for a range of sizes of materials in WRLs WD1 – WD4 is summarised as follows:

- 2.36mm - 9% to 20% (sand)
- 63mm - 43% to 68% (gravel)
- 200mm - 70% to 97% (cobbles)

8.5.1 Stability and Structural Integrity

<u>Slumping and Collapse of Batter Walls</u>

Geotechnical modelling was carried out to determine the stability of the batter slopes under various rainfall and water content scenarios (SWC, 2014e). The results showed the design of the batter surface area and structural integrity of the landform to be stable under a variety of scenarios. Monitoring since publication of the previous MCP supports the modelling outcomes, with negligible slumping observed.

The results of previous point load testing and unconfined compressive strength testing work (Coffey 2019) indicates quartzite is generally high to very high strength rock, and is therefore expected to be very durable. The results also show that the analysis methods provided suitable means for assessing the physical characteristics of rock in waste dumps, and thus should be further considered for detailed closure studies.

Previous erosion testing and modelling has shown that the majority of materials which display favourable characteristics for revegetation (e.g. siltstone and stockpiled topsoil) perform poorly on constructed landform slopes. Conversely, those materials which have shown good erosion resistance (e.g. quartzite and schist) have less favourable rehabilitation characteristics as a plant growth medium. Consideration of ground medium and erosion resistance is therefore expected to be a key issue.

MGI has previously assessed the extent of potential rehabilitated land, assuming a maximum 20 degree angle projection from the existing waste dump crests, as denoted by the magenta hatched area shown in Figure 8-7. This construction approach would, in many areas, require that the waste dumps (i) extend a significant downstream distance in to areas of natural vegetation and (ii) require significant earthworks to be undertaken. This work is necessarily required for safe stable and non-polluting closed landforms.

Coffey has recommended to KIO it considers maintaining the toe of the existing waste dumps at / near their current (pre-closure) position and, as a potential option for sections, to flatten the slopes ‘inwards’ by adjusting the WRL crests. This method would serve to:

- Reduce environmental disturbance, by reducing the extents of clearing and general disturbance works in downstream vegetated areas;
- Reduce the overall height and crest width of the waste dumps; and
- Reduce the earthworks volume associated with the closure earthworks.

Alternatively, further analysis may resolve that, because of the strong and durable nature of quartzite rich materials, steeper angles up to 30 degrees may be adopted upon design.

To facilitate a modified “mined back” landform, the upper section of the waste dump would need to be cut and then the outer waste dump areas would be reshaped down. Earthworks would be balanced, so that minimal new waste rock is required to be imported to the areas. This is likely difficult and potentially unstable ground conditions for new work. Should it be possible, the additional footprint area for pushing out to 20 degrees would no longer need to be used, as earthworks could be carried out over the existing disturbance footprint. A new ultimate crest would be formed, which would need to include surface water management.

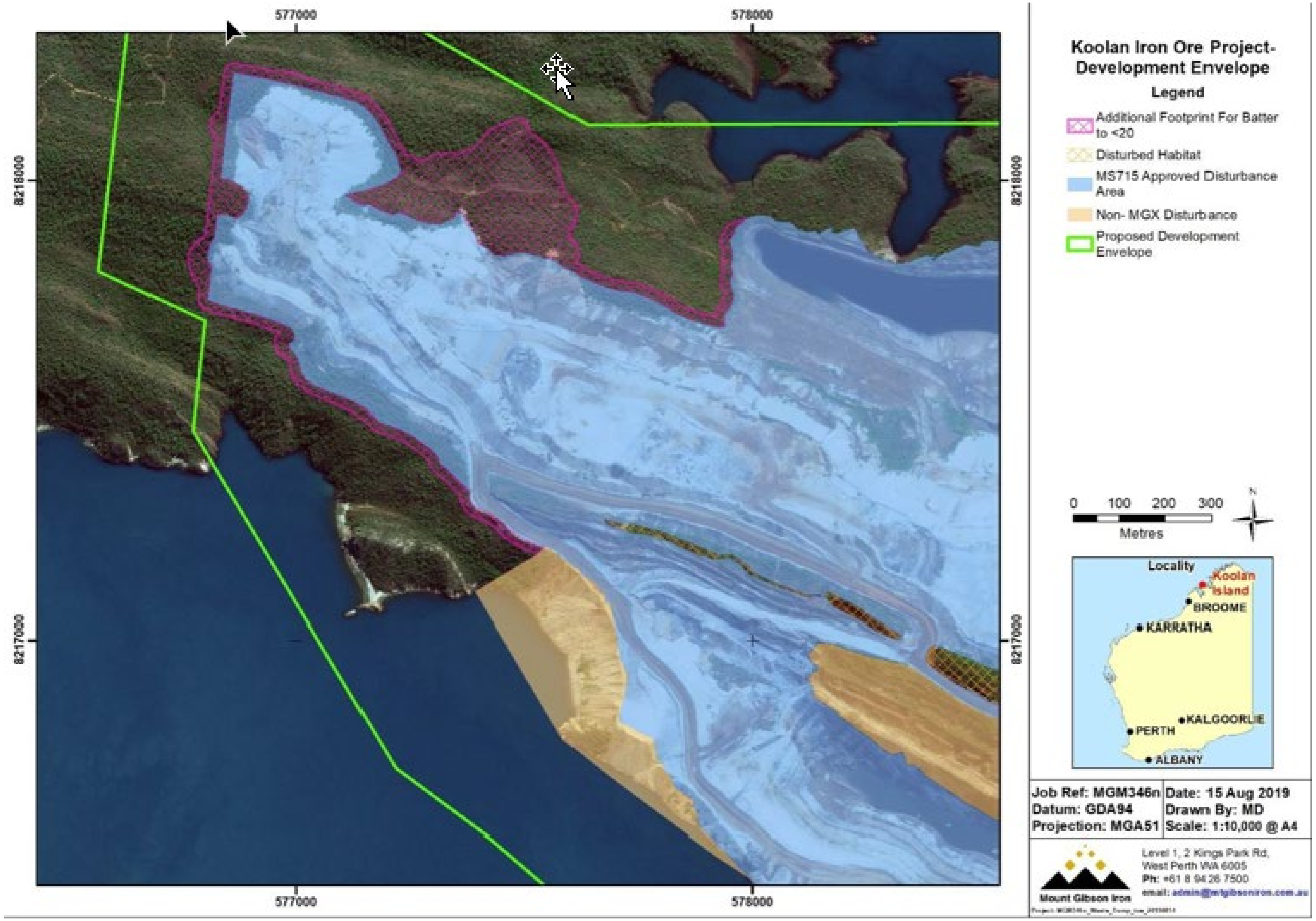

Figure 8-7: Additional Footprint for Flattening Existing WD1 Batters to < 20° (footprint subject to further approval)

Future Works for Waste Rock Landform Batter Slopes

To resolve the feasibility of doing nothing, mine back or push down options, the following technical works are recommended:

1. Map available records, including construction history, slope batters, mineralogy, chemical and physical properties of outer faces of existing landforms.

2. Field investigation works, to collect samples and carry out laboratory testing to confirm the geotechnical and geochemical parameters, as well as the lithology and rock type distribution. The laboratory testing should be developed based on the observed materials, but to include:

   a. Physical geotechnical characteristic testing, e.g. PSD, plasticity, friction, cohesion related tests.

   b. Dispersion tests to assess the susceptibility of the materials to erosion (slaking and dispersion)

   c. Electrical Conductivity (EC) to assess potential salinity yields on dispersion.

   d. Geochemical analysis, salinity and clay mineralogy testing

3. Consideration should be given to photogrammetric PSD analysis methods, to complement physical particle size testing, given that previous studies have shown good correlation between the two methods.

4. Review of all testing results to assess the material characteristics and erosion resistance of the various slope sections, to form the basis for the design of the final landform outer profile.

5. Prior to civil modelling of waste dumps, survey to a minimum accuracy of 100mm, to improve the accuracy of the design.

6. The surface water hydrology should be assessed and carefully considered, to reduce the potential for scour/erosion damage as a result of heavy rainfall events. The final drainage strategy should be incorporated into the ultimate landform design.

Uncontrolled Surface Water Flow leading to Excessive Erosion and Gullying

Extensive testing of erosion characteristics of the different waste rock material on site was conducted in response to gaps in knowledge identified in previous versions of this MCP. The results (summarised in section 7.7) were applied to different surface designs and modelled using 100 year synthetic climate data. The rainfall erosion data showed that long liner slopes, without competent quartzite rock placed as a cover, would result in high rates of erosion. To manage this impact, battered slopes in current rehabilitation areas have been deep ripped on contour to reduce surface flow velocity and avoid erosion. Backsloping berms and concave upper WRL surfaces with perimeter bunds will control potential mass erosion.

It is also anticipated that erosion rates will reduce with the establishment of vegetation, as indicated by surface treatment trials (section 7.7.4) and progressively rehabilitated areas.

8.5.2 Potential Environmental Impacts

Uncontrolled and Excessive Surface Water Runoff and Sediment Loss into the Surrounding Environment

As discussed in section 7.12, KIO undertakes a marine monitoring program in accordance with the approved marine management plan and surface hydrology studies have indicated the majority of catchments have outlets to the ocean. Ongoing monitoring of trials, progressive rehabilitation and marine monitoring will inform the potential risks associated with this aspect. To date, the monitoring program has not indicated adverse effects to the marine environment associated with WRLs and as materials composition of the landform will not change, this result is expected to continue. Where monitoring indicates the potential for adverse effects, remedial measures will be implemented.

8.5.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

Outer Surface of Rehabilitated Waste Rock Landforms not constructed According to the Design

A monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that the final landform surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

8.5.4 Visual Amenity

Visual Amenity of Waste Rock Landforms Incongruent with the Surrounding Land

The location and outer surface design of the rehabilitated WRLs (WD1 - 4) have been designed to integrate with the surrounding landscape. As the revegetation species to be seeded in these areas will be specifically matched to the capabilities of the soil profile, it is anticipated that sustainable rehabilitation will be produced which will not lessen the visual amenity of the Island. This is supported by the progress of surface treatment trials (section 7.7.4) and rehabilitated areas (section 7.8).

8.5.5 Other Items

Surface Hydrology

WRL surface hydrology has been considered and the key issue is the intersection of surface flows with the WD4 spur (Section 7.5.7). As described in section 7.5.7 the long term structural integrity issues associated with this landform have been addressed by the construction of a drainage channel. Ongoing monitoring of the geotechnical stability of the WD4 spur will determine its long term stability.

Final Landforms 'As Built' Footprints

The area known as the WD1 (west end) in its current form presents a risk of crossing approved disturbance and tenement boundaries if battered to 20°. Contouring of the top of this localised area has been undertaken to create a concave surface and direct surface water away from the outer batters, mitigating the potential for erosion and avoiding surface runoff to the outer batters. Final battering and rehabilitation of slopes at WD1 can be achieved within tenement and approved disturbance boundaries through appropriate use of dozers and/or other plant and equipment to reshape the constructed landform (i.e. cutting and filling), or retaining in situ based on further geotechnical assessment of long term stability.

8.6 BACKFILLED PITS

KIO has amended its approach to the retention of open pit voids at closure, and now proposes to backfill as many and as much of the voids as possible with available waste rock.

8.6.1 STABILITY AND STRUCTURAL INTEGRITY

Mullet Pit is currently partly backfilled with mine waste on its eastern and southern sides. It is expected this mine pit will be backfilled with waste rock to form a land surface which approximates the original land surface (Figure 8-8). The current design (approved by MP 34572) allows for complete backfilling of Mullet Pit (Figure 8-9). However, since the approval of that Mining Proposal, through dialogue with DMIRS, an alternate design has been identified which contains a post closure runoff retention sump. A new MP will need to be submitted well prior to closure to seek approval a revised design (Figure 8-10) incorporating a retention sump (section 7.5.4) – at 335,000 m^3 it exceeds the rainfall runoff 1:100 ARI 72hr event (an extra 20%) which will retain sediment mobilised in catchment runoff into the surrounding marine environment, Mullet Bay (section 8.6.2). It is worth re-iterating that infiltration of rainfall is a significant factor as the materials are conducive to vertical movement through coarse durable surface and sub-surface rocks.

Barramundi and East pits will also be backfilled such that they integrate with the existing WRL WD4, with batter slopes mimicking local natural forms where elevated above the former pit voids. Notably, East Pit is currently approved by Mining Proposal (Reg ID 34572) and Barramundi Pit has been accepted for pit sterilisation by DMIRS. Figure 8-11 shows the current approved landform design at closure for WD4 and East Pit backfill. The actual waste volume to be generated since this landform was approved has been less than that modelled for this design, and the current block model indicates there is unlikely to be sufficient waste material generated between now and closure (Table 8-5) to complete the landform to this design and also to backfill Barramundi Pit. A revised WD4, Barra Pit and East Pit landform closure concept has therefore been developed and its design will be the basis, along with the varied design of Mullet Pit, for a revised backfill schedule for the mining planned up until 2023.

Table 8-5: Scheduled volumes for forecast waste material as at 2019

WD	FY1	FY2	FY3	FY4	FY5	LOM MLCM
WD 4 & East Pit				3.22	3.44	6.57
WD 5 - Barra		5.42	4.69			10.11
WD 6 - Mullet	0.67	3.59	4.43	2.53	0.31	11.53
Total WDs	**0.67**	**9.01**	**9.12**	**5.75**	**3.76**	**28.31**

The revised WD4, Barra Pit and East Pit landform closure concept would allow for complete backfilling of Barra Pit while partially backfilling East Pit. The landform at closure would integrate with WD4 and the surrounding natural slopes, with the environmental benefit of a partial shallower void at East Pit for seasonal retention of surface water reporting from the landform complex. This revised treatment of the WD4, Barra Pit and East Pit landform will be the subject of a MP to be submitted to DMIRS prior to closure. It will be included in a new MP also for the revised Mullet Pit backfill design, as both Project elements relate to the management of waste rock until closure.

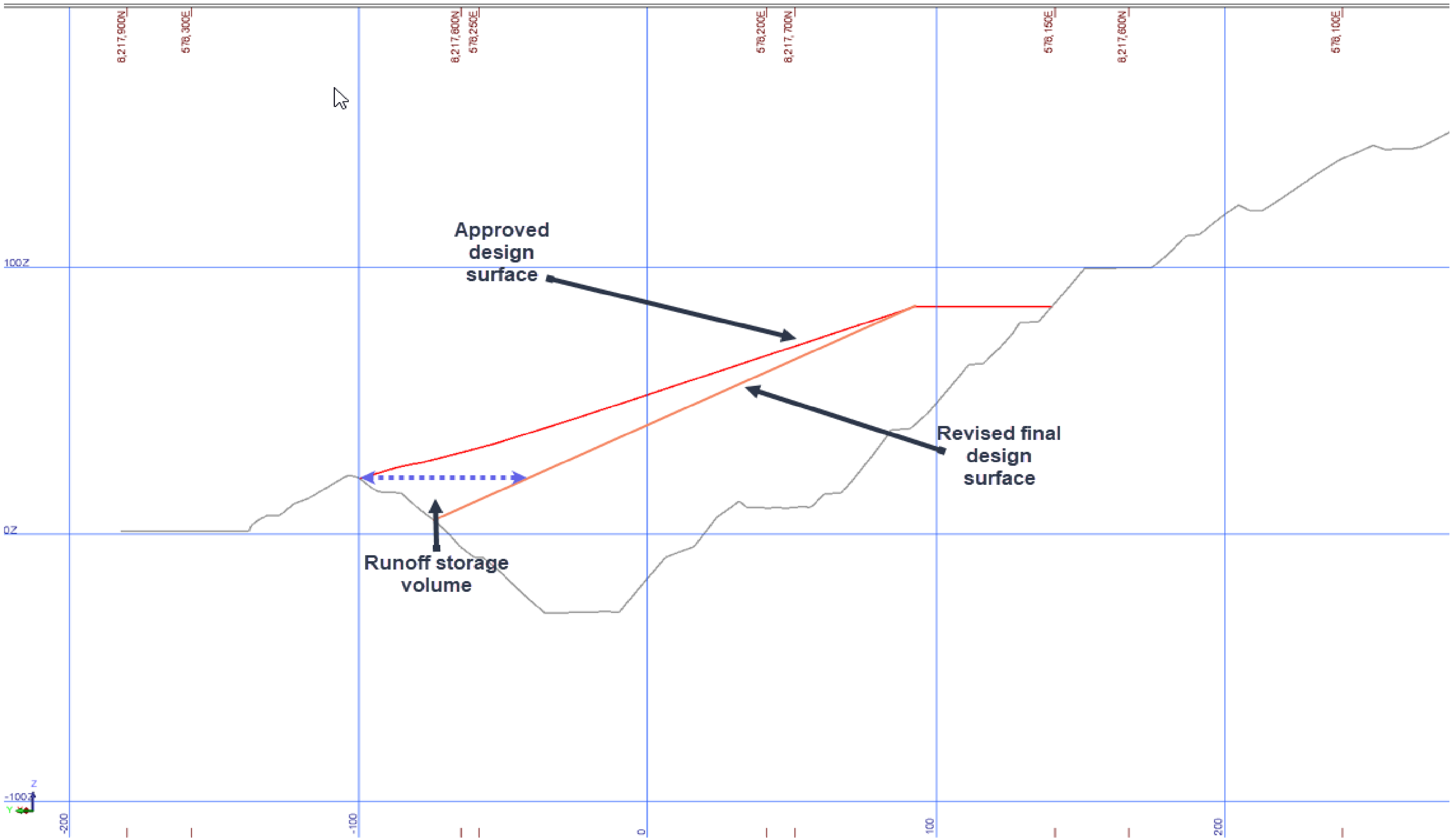

Figure 8-8: Approved (MP 34572) and Revised (MP Amendment to be Submitted) Mullet Pit backfill Design Surface Concepts

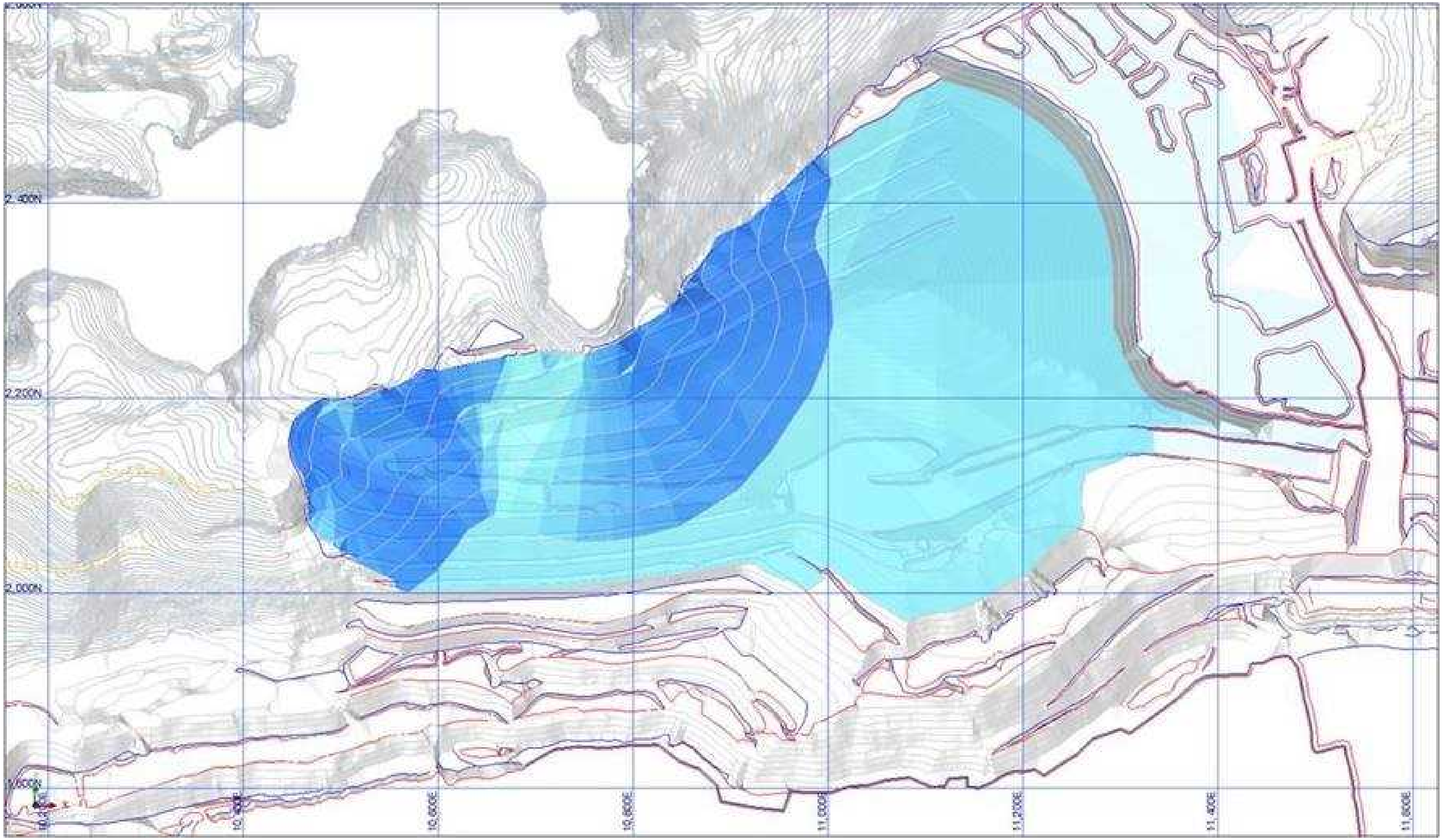

Figure 8-9: Approved Backfilled Mullet Pit Landform Design (subject to revision upon future DMIRS approval)

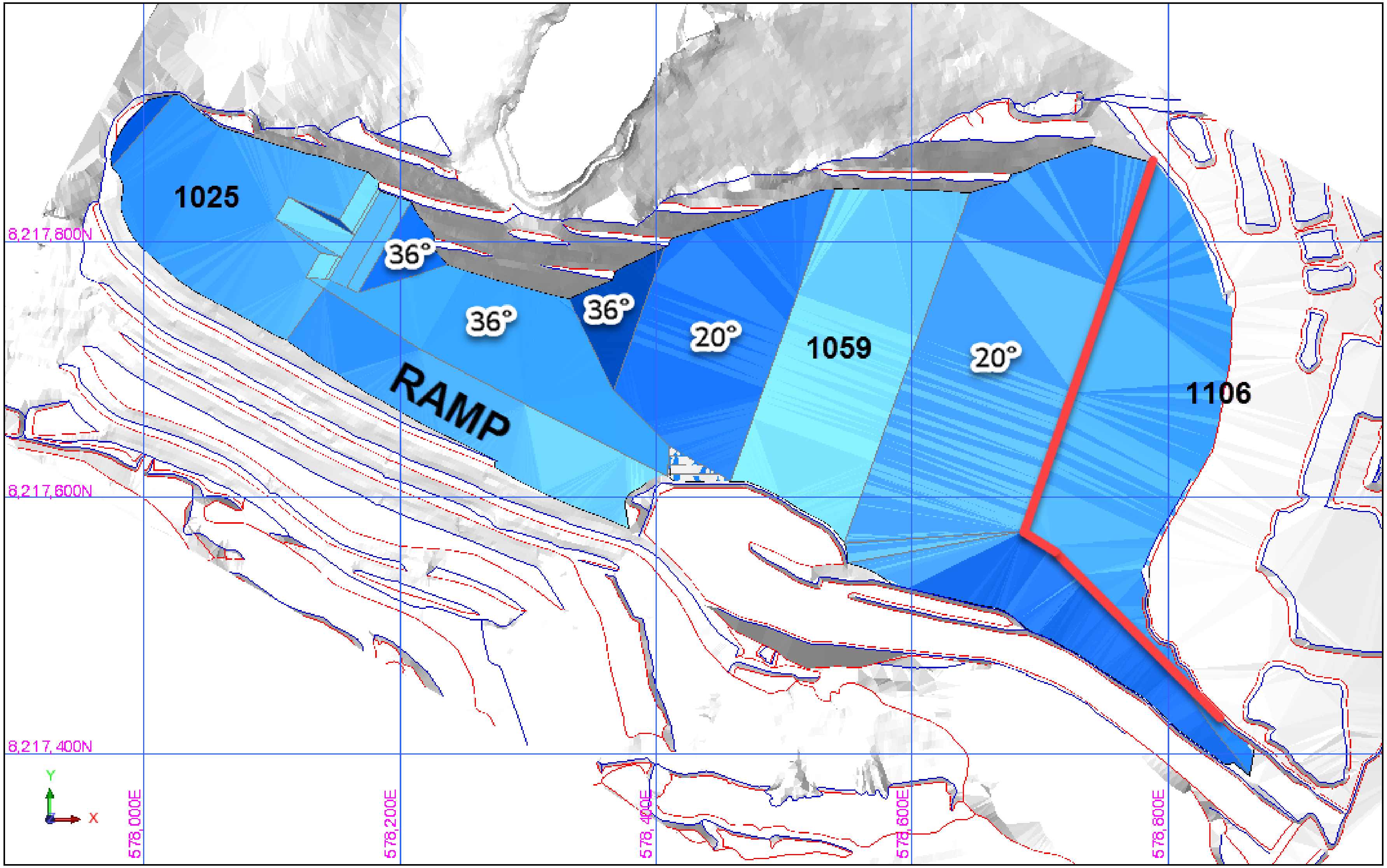

Figure 8-10: Revised (MP Amendment to be Submitted) Mullet Pit Backfill Landform Concept Design

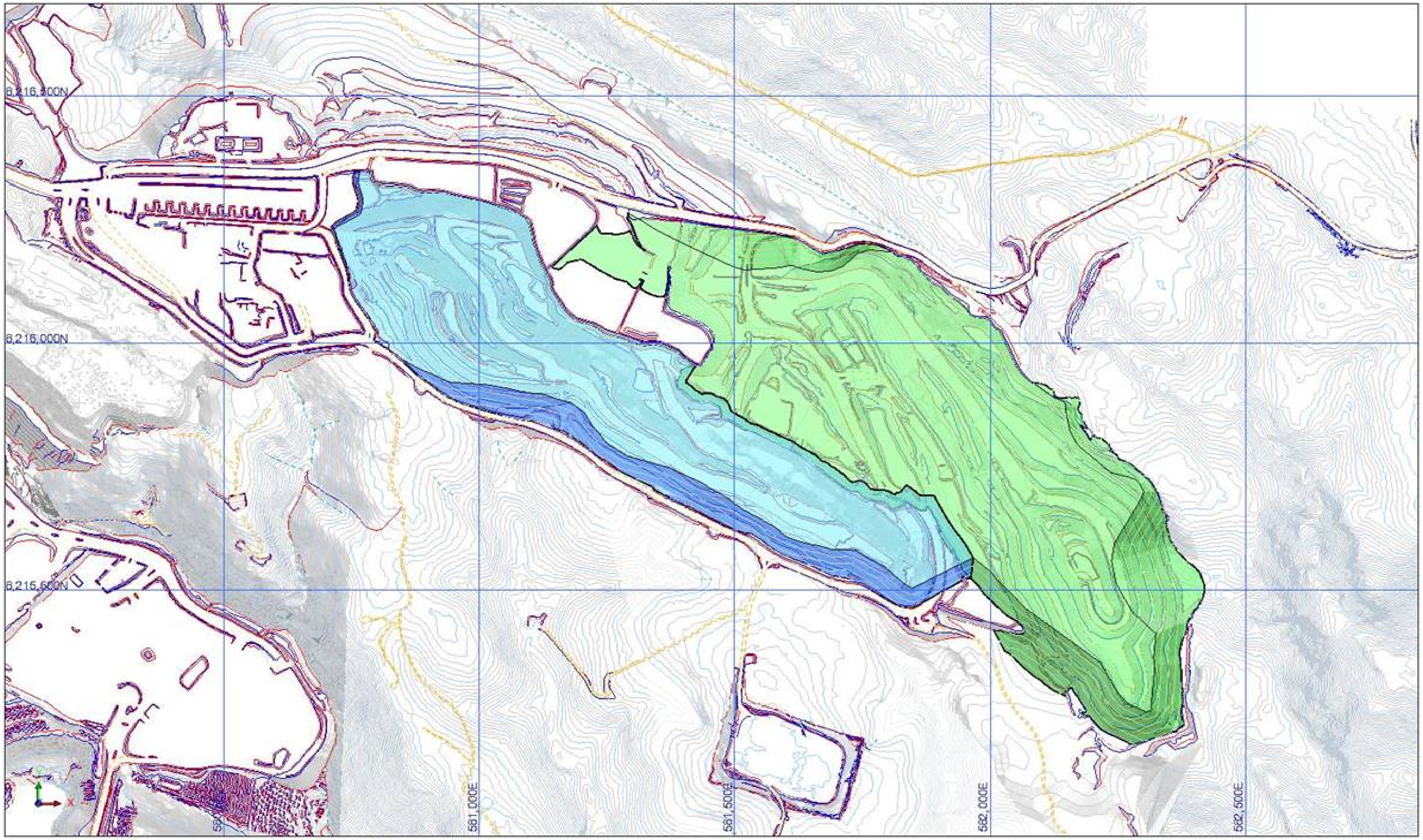

Figure 8-11: Current Approved WD4 and East Pit Backfill Landform Design (green). Blue is a design option for proposed Barramundi Pit backfill

Landform Slope Integrity

The backfilling procedure will follow design principles of outer and internal batters at ≤ 20°. Barramundi and East Pit backfill batters will be separated by (≈ 5 - 10 m) berms, as per the adjacent existing WRLs. The backfilled Mullet Pit landform face will aim to be in line with the natural fall of the pit crest to maintain an overall slope which approximates and is slightly lower than the original land surface. The backfilled Barramundi and East Pit landform faces will follow local slopes or existing WRL forms, as appropriate, to integrate closely with the surrounding land surfaces. Batter heights and berm widths are likely to vary across the surface of the backfilled pits for a more natural appearance.

Backfilled pit batters will be constructed of material containing competent coarse waste rock (e.g. quartzite) which would retard erosion rates and influence vertical infiltration of rainfall rather than surface runoff. Berms would be covered in an upper layer of growth medium sourced from mined siltstone, which displays suitable characteristics for plant growth (Section 7.7).

For potential effects including those below are considered as for Constructed Waste Rock landforms (Section 8.5):

- Excessive Erosion of Rehabilitated Land Surfaces
- Slumping and Collapse of Constructed Waste Rock Landform Slopes
- Tunnelling and Sinkhole Development on Berms

Batter slopes will contain a large complement of competent quartzite in the material at the surface; the materials demonstrate resistance to erosion and they promote water infiltration (7.7). The height and width of the batters and berms will vary so that the landform ‘keys’ in with the surrounding natural / WRL surfaces. The low overall external angle of the backfilled pit landforms will result in conservative berm heights and wide berm widths, enhancing overall stability.

Geotechnical modelling of batters (SWC, 2014e) provided results to show the design of batter surfaces to be stable provided that the batter slopes are constructed from material with competent quartzite waste rock. Furthermore, existing WRLs with faces constructed to these specifications from the proposed surface material mix are demonstrably stable. Management of this issue will therefore depend on correct use of waste rock material when completing outer surfaces of the backfilled pit WRLs. Other detailing of managing the risk of poor performance are the same as in Section 8.5.

As discussed above, modelling of 100 year synthetic climate data has shown that no overtopping of crests would occur, with the design having the additional safety measure of not overtopping due to the resistant surface of the batters and the remnant void volume. The upper surfaces of the WRL will be backsloped inwards to retain modelled rainfall events and vertical infiltration of incident rainfall. The berms will be designed and operated in accordance with section 8.5.

Surface Water Flows Entering Backfilled Pits

Within each of the Mullet Pit and Barramundi-WD4-East Pit landforms, drainage from incident rainfall will be contained within the constructed landform itself. Note, a forecast undersupply of waste rock means a terminal sump can be retained in East Pit, and one will be designed within Mullet Pit.

Collapse of Abandonment Bunds into Pit Voids

Consideration has been given to the potential placement of abandonment bunds. Abandonment bunds will be located at least 10 m outside the area designated as the potentially unstable pit edge zone, according to the DIR (1997) guidelines for *Safety Bund Walls around Abandoned Open Pit Mines*. Figure 8-4 illustrates the most conservative arrangement at which abandonment bunds would be placed by strictly adhering to the guidelines, and also the proposed conceptual location of abandonment bunds which utilise existing topography, WRLs, existing bunding and the addition of new bunding to control inadvertent public access.

KIO will consult with the DMIRS Resources Safety Division to determine a suitable abandonment bund strategy. Once the final backfill pit design is approved the design work will be done to determine an advanced design for bund placement. East Pit may need to be bunded, while Mullet and Barramundi Pits will be filled to design so not likely to require any bund.

Abandonment bunds will be constructed using competent (fresh) rock to a height of 2 m and a base of 6 m wide in accordance with the DIR (1997) guidelines.

Surface flow analysis and mapping may be undertaken to determine if surface water is expected to pond against bunds. In areas ponding , the land surface will divert water away from the bund. This will be undertaken prior to abandonment bunds being constructed.

8.6.2 Potential Environmental Impacts

Excessive sediment loss and deposition into the surrounding marine environment

The revised Mullet Pit, WD4, Barra Pit and East Pit landform concept, to be assessed by a forthcoming MP, provides the environmental benefit of incorporating surface water retention sumps (the remaining Mullet Pit and East Pit volumes), significantly reducing the risk of sediment transport by surface water flows into the surrounding terrestrial and marine environments.

As discussed above, surface flow analysis will be undertaken on both the design and 'as-built' land surfaces to show that it remains in a stable and non-erosive condition. Any areas identified as problematic will be addressed and reshaped to produce a stable landform.

8.6.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2 and Section 8.5.

8.6.4 Visual Amenity

Visual amenity of the WRLs is not congruent with the surrounding land surface

The location and outer surface design of the rehabilitated landforms have been designed to integrate with the surrounding landscape. As the revegetation species to be seeded in these areas will be specifically matched to the capabilities of the surface treatment, it is expected that sustainable rehabilitation will be produced which will not lessen the visual amenity of the Island. The berm areas of the preferred WRL design have the potential to support a woodland ecosystem that will provide a partial screen of the rocky batter slopes (from ground level) and improve the visual amenity values of the rehabilitated areas for visitors to the Island.

8.6.5 Operational Implementation

Specific construction plans will be prepared for the backfilled mine pits based on the nature and properties of the waste rock material to be backfilled. These plans will balance the surface stability and growth requirements of the revegetation with the capability of the machinery to be used in the construction of the profiles to ensure that the designs are able to be implemented in the field. Discussions with earthmoving operators will be undertaken prior to construction and shaping of berms on the outer surface of the waste dump so that all personnel are aware of the need for adhering to the designs.

8.7 INFRASTRUCTURE

These infrastructure items have been noted as being beneficial for use by another entity post mine closure:

- Access roads; Village;
- Airstrip/s;
- Jetty and Barge Landing;
- Cultural heritage and training centre; and
- Cyclone moorings (buoys).

Soil Contamination

A contaminated sites assessment will be undertaken at these areas in accordance with the DER (2014) contaminated site assessment guidelines to identify potential contamination prior to tenement relinquishment. Contaminated soils will either be treated in-situ or remediated at on site bioremediation facilities. Removed soil will be replaced with clean fill as necessary.

8.8 INFRASTRUCTURE – BIOREMEDIATION FACILITIES

8.8.1 Stability and Structural Integrity

Scouring and erosion of rehabilitated areas

A surface water flow analysis will be undertaken for rehabilitated and reshaped land surfaces so that they are ‘keyed-in’ with the surrounding land surface and topography to inhibit scouring and erosion. Any remaining compacted surfaces will be deep ripped to approximately 800 mm to improve water infiltration.

Ponding of rainfall on the compacted clay liner underlying the bioremediation facility

The compacted clay liner underlying each bioremediation facility will be left in place, and the facility will be filled in and the land surface reshaped according to the surface water flow analysis. It is possible that water may be held-up in the surface soil profile above the buried clay liner. Because the upper surface of the liner will be flat and a stable material will be used to fill in the facility, subsurface lateral flows and erosion are not expected to be an issue. Also, the clay liner will be punctured in several locations to allow for percolation of water infiltration.

8.8.2 Potential Environmental Impacts

Soil Contamination

A contaminated sites assessment will be undertaken at each bioremediation facility following decommissioning. This assessment will focus on sampling of the natural ground beneath the bioremediation facility to determine if any contamination has breached the clay liner. Where possible, contaminated soils will be treated in-situ. Soils will be assessed as per the DER (2014) contaminated sites guidelines. Removed soil will be replaced with clean fill as necessary.

Groundwater Contamination

As described in section 7.6, the ground water level is very deep and contamination risk is considered very low owing to the tight and low-permeable nature of the hydrogeology. Groundwater contamination is therefore not expected to be a risk. However, in the case that a soil assessment indicates leaching of contaminated materials into underlying soils, the potential for this to impact groundwater will be taken into consideration.

8.8.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

Rehabilitated Land Surface not constructed according to the Design

A suitable monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

8.9 INFRASTRUCTURE – ORE STOCKPILE AREA AND PROCESSING PLANT

8.9.1 Stability and Structural Integrity

Slumping and collapse of the batter walls

The OSA is constructed primarily from competent waste rock to support heavy mine vehicles. Because this fresh rock is stable, non-erosive, and specifically engineered so that it will not slump or collapse under the weight of heavy machinery, the OSA is not expected to slump or collapse post-closure.

Uncontrolled Surface Water Flow Leading to Excessive Erosion and Gullying

The OSA is inherently permeable and generally allows rainfall to rapidly infiltrate through the pad as it is constructed from fresh competent waste rock. Constant trafficking on the upper surface of the OSA may break down the competent rock into finer particles that will compact under the weight and movements of machinery. With the passage of time this compacted surface may pond water under some circumstances, and surface water flows may develop on the surface. Although ponding may occur, the competent nature of the rock will limit the extent and severity of erosion and gullying.

Tunnelling and Sinkhole Development

Tunnelling and sinkhole development on the surface of the OSA is unlikely to occur due to the engineered competent nature of the structure.

Ponding on the Concrete Pad underlying the Processing Plant

The concrete pad underlying the processing plant will be left in place or fragmented, depending on machinery capabilities (section 8.1.3), and covered with stable soil to sufficient depth for revegetation with the rehabilitation species mix (section 7.8.2). In the case the concrete pad is not fragmented, because the upper surface of the concrete pad will be flat and a stable soil material will be used to cover the pad, subsurface lateral flows and erosion will not be an issue.

8.9.2 Potential Environmental Impacts

<u>Uncontrolled and Excessive Surface Water Runoff and Sediment Loss into Surrounding Environment</u>

The potential for excessive surface water runoff and sediment loss from the OSA is considered small due to the predominately competent, permeable nature of the waste rock used to construct the pads. The development of a thin compacted surface layer may result in some surface water and sediment runoff and this will be controlled by deep ripping across the upper surface, placing perimeter bunding around the edge and shaping the upper surface into a concave shape similar to the upper surfaces of WRLs (section 8.5) so that surface water infiltrates vertically, thereby controlling surface water and sediment runoff.

<u>Soil and Groundwater Contamination</u>

Processing plant area soils will be assessed in accordance with the DER (2014) contaminated site assessment guidelines following decommissioning. Contaminated soils will either be treated in-situ or bioremediated at on site bioremediation facilities. Removed soil will be replaced with clean fill as necessary. A groundwater contamination investigation would be considered if soil impacts at depth were reported.

8.9.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

<u>Rehabilitated Land Surface not constructed according to the Design</u>

A suitable monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

<u>Soil Conditions are Inadequate for Re-establishment and Growth of Vegetation</u>

Decommissioning of the OSA pads and processing plant will involve removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. All natural disturbance surfaces will be deep ripped to approximately 800 mm to alleviate compaction and improve water infiltration and root penetration of revegetation species.

The concrete pad underlying the processing plant will be left in place or fragmented, depending on machinery capabilities (section 8.1.3), and covered with an appropriate growth medium to allow for re-establishment of vegetation whilst minimising the impact of large scale demolition works (blasting etc.) which would be necessary to remove the concrete pad.

The rehabilitated OSA pads and processing plant area will be seeded with the species mix outlined in section 7.8.2, with evidence to date suggesting these species are suitable for the restoration of disturbed land.

8.10 INFRASTRUCTURE – LOGISTICAL SUPPORT AREAS

Logistical support areas include:

- Mine Operations Centre;
- Fuel storage;
- Laydown areas;
- Explosives magazine; and
- Workshops.

8.10.1 Stability and Structural Integrity

Scouring and Erosion of Rehabilitated Areas

Decommissioning of the logistical support areas will involve removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. Compacted surfaces will be deep ripped to approximately 800 mm to improve water infiltration and reduce erosion. A surface water flow analysis will be undertaken for all rehabilitated and reshaped land surfaces to ensure that they are 'keyed-in' with the surrounding land surface and topography to inhibit scouring and erosion.

Ponding of Rainfall on Buried Concrete Pads

The concrete pads will be left in place or fragmented, depending on machinery capabilities, and covered with stable soil to sufficient depth for revegetation with the rehabilitation species mix (Section 7.8.2). In the case a concrete pad is not fragmented, because the upper surface of the concrete pad will be flat and a stable soil material will be used to cover the pad, subsurface lateral flows and erosion will not be an issue.

8.10.2 Potential Environmental Impacts

Soil and Groundwater Contamination

Each logistical support area will be assessed in accordance with the DER (2014) contaminated site assessment guidelines following decommissioning. Contaminated soils will either be treated in-situ or remediated at on site bioremediation facilities. Removed soil will be replaced with clean fill as necessary. A groundwater contamination investigation would be considered if soil impacts at depth were reported.

8.10.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

Rehabilitated Land Surface not constructed according to the Design

A suitable monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that the final landform surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

Soil Conditions are Inadequate for Re-establishment and Growth of Vegetation

Decommissioning of logistical support areas will involve removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. Disturbance surfaces will be deep ripped to approximately 800 mm to alleviate compaction and improve water infiltration and root penetration of revegetation species.

Concrete pads will be left in place or fragmented, depending on machinery capabilities (section 10), and covered with an appropriate growth medium to allow for the re-establishment of vegetation whilst minimising the impact of large scale demolition works (blasting etc.) which would be necessary to remove the pads.

The rehabilitated areas will be seeded with the species mix outlined in section 7.8.2, with evidence to date suggesting these species are suitable for the restoration of disturbed land.

8.11 INFRASTRUCTURE – GENERAL

General infrastructure includes:

- Power plant;
- Power lines;
- Roads; and
- Dewatering facilities.

These areas have similar closure issues and consequently they have been grouped together.

8.11.1 Stability and Structural Integrity

Scouring and Erosion of Rehabilitated Areas

Decommissioning of the general infrastructure will involve removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. All compacted surfaces will be deep ripped to approximately 800 mm to improve water infiltration and reduce erosion. A surface water flow analysis will be undertaken for all rehabilitated and reshaped land surfaces to ensure that they are ‘keyed-in’ with the surrounding land surface and topography to inhibit scouring and erosion.

8.11.2 Potential Environmental Impacts

Soil and Groundwater Contamination

The power plant and dewatering sites will be assessed in accordance with the DER (2014) contaminated site assessment guidelines following decommissioning. Contaminated soils will either be treated in-situ or remediated at on site bioremediation facilities. Removed soil will be replaced with clean fill as necessary. A groundwater contamination investigation would be considered if soil impacts at depth were reported.

8.11.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

Rehabilitated Land Surface not constructed according to the Design

A suitable monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that the final landform surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

Soil Conditions are Inadequate for Re-establishment and Growth of Vegetation

Decommissioning of the general infrastructure will involve removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. All natural disturbance surfaces will be deep ripped to approximately 800 mm to alleviate compaction and improve water infiltration and root penetration of revegetation species.

Concrete pads will be left in place or fragmented, depending on machinery capabilities, and will be covered with an appropriate growth medium to allow for the re-establishment of vegetation whilst minimising the impact of large scale demolition works (blasting etc.) which would be necessary to remove concrete pads.

The rehabilitated areas will be seeded with the species mix outlined in section 7.8.2, with evidence to date suggesting these species are suitable for the restoration of disturbed land.

8.12 LANDFILL

8.12.1 Stability and Structural Integrity

Scouring and Erosion of Rehabilitated Areas

Decommissioning of the landfill will consist of removing above ground infrastructure and constructing a compacted soil cap over the landfill profiled to direct surface flows away from the landfill cell. The cap will be comprised of a minimum 1 m of compacted clean clay fill, overlain by 1 m of locally sourced topsoil. The topsoil will be manually seeded with local provenance seed mix.

Surface water flow over the cap will be analysed to ensure it is constructed as designed to direct surface water flows away from the landfill cells.

Slumping and sinkhole development

Slumping and sinkhole development can occur on the upper surface in situations where the landfill inadequately drains or consolidates before the deposition of new (fresh) material. Deeper unconsolidated material may slump under the weight of the overlying layers resulting in an unstable upper surface that is prone to sinkhole development. All layers will be compacted prior to deposition of new material to reduce the risk of this occurring.

8.12.2 Potential Environmental Impacts

Uncontrolled and excessive surface water runoff and sediment loss into surrounding environment

As discussed in sections 7.5.2 and 7.12, surface hydrology studies indicate the majority of catchments have outlets to the ocean and KIO undertakes a marine monitoring program in accordance with the approved marine management plan. Ongoing monitoring of trials, progressive rehabilitation and marine monitoring will inform the potential risks associated with this aspect. To date, the monitoring program has not indicated adverse effects to the marine environment associated with the landfill and as materials composition of the landform will not change, this result is expected to continue. Where monitoring indicates the potential for adverse effects, remedial measures will be implemented (Section 10).

Leaching of Contaminants from the Landfill into Soil or Groundwater

The landfill has been constructed and managed as a Class II landfill in accordance with Licence (L8148/2006/4) requirements, and therefore contamination of the surrounding environment is not expected. Environmental monitoring, such as groundwater, is undertaken during operations and will continue post-mine closure (Section 10).

8.12.3 Rehabilitation

Underperforming revegetation is discussed in section 8.2.2. Other aspects are discussed below.

Rehabilitated Land Surface not constructed according to the Design

A suitable monitoring program will be implemented to ensure rehabilitated land surfaces are constructed in accordance with design specifications. In addition, inspection of completed landform surfaces will be conducted by site environment personnel to ensure that the final landform surfaces are constructed utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

Soil conditions are Inadequate for Re-establishment and Growth of Vegetation

At least 1 m of appropriate fill / soil material will be placed over the top of landfill caps to improve root penetration of revegetation species.

Rehabilitated landfills will be seeded with the species mix outlined in section 7.8.2, with evidence to date suggesting these species are suitable for the restoration of disturbed land.

8.13 MAIN PIT SEAWALL

In November 2014, a Main Pit Seawall section collapsed, resulting in inundation of the Main Pit by seawater. The seawall was rebuilt in 2017-2018. Upon closure, it is intended to construct a trench through a natural section of the coastline and convey tidal waters to re-inundate Main Pit in a manner which is safe and non-polluting. The seawall will otherwise remain in-situ.

8.13.1 Stability and Structural Integrity

Scouring and Erosion

Marine monitoring undertaken since the seawall was rebuilt in 2018 has indicated localised physical water quality effects (increased turbidity) and benthic habitat (reduced coral cover) potentially associated with reconstruction of the seawall; specifically, burial beneath seawall rocks and increased sediment loads (section 7.12). The slope of the upper seawall section (≈ 1:1.25 vertical:horizontal above mean sea level) is steeper than the seawall toe (≈ 1:2). The lower portion of the seawall is likely to already be relatively stable, while the upper section will predictably continue to erode naturally on falling tides until a stable profile is reached - the stable slope would likely be ≤ 1:3 (Siragusa, 2019). This design and operate approach uses time as the modifier for the structure to reach stable equilibrium.

The alternative if required before mine closure to allowing nature to determine the stable slope is to re-profile the upper section of the seawall to achieve a slope of 1:1.5 (typical slope used for breakwaters) and to armour the reprofiled slope with two layers of armour rock as schematically shown in Figure 8-. The size of the armour rock would be determined by the selected design wave criteria. MGX will consider this option in the event that natural coastal processing does not form a suitably stable profile within closure timeframes. An expansion of the MS 715 disturbance footprint would be required to accommodate the reprofiled seawall slope and rock armouring.

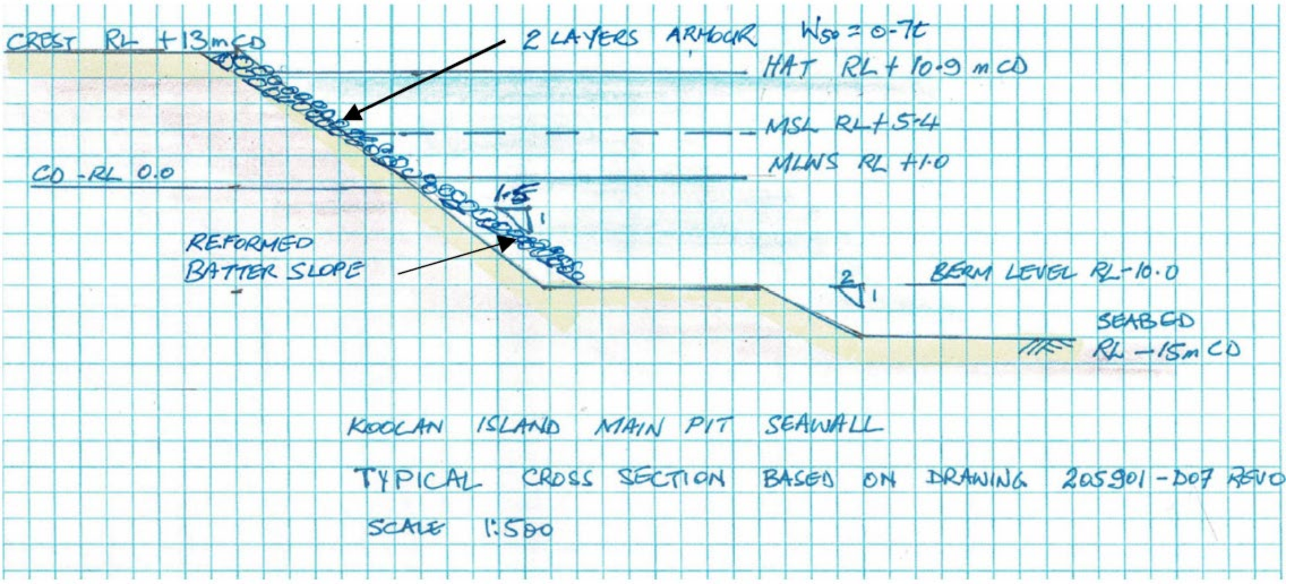

Figure 8-12: Schematic of Reprofiled Seawall Slope and Placement of Rock Armour

8.13.2 POTENTIAL ENVIRONMENTAL IMPACTS

<u>Uncontrolled and Excessive Rock and Sediment Loss into Surrounding Environment</u>

It is likely that seawall sediment will become entrained in surrounding seawater (and ultimately deposited to the sea bed) and seawall rock deposited on to the adjacent seabed in the short to medium term as the upper seawall erodes until a stable profile is reached.

In the medium to longer term, once a stable seawall profile has developed, rock deposited from the seawall will form a new sea bed surface and the rate of seawall erosion will reduce a levels similar to that of surrounding, natural substrates. As the rate of seawall erosion equilibrates with the local natural rate, so too will localised turbidity and sedimentation rates, which are functions of coastal processing. The return to natural conditions will allow benthic species to establish on the new sea floor. This condition will continue to be monitored in accordance with the MMP.

<u>Main Pit 'Lake' Water Quality Unsuitable for Environmental Values</u>

Main Pit will be re-inundated at closure by way of a trench (referred to as the DC) constructed though a natural (i.e. not engineered) section of coastline next to the seawall. Due to the limitations of flow through the DC, hydraulic connectivity between the Main Pit 'lake' and the ocean will be restricted relative to that of Arbitration Cove (prior to KIO mining of Main Pit and construction of the seawall). This could potentially result in physiochemical conditions within the lake such that the lake is unable to support a taxonomic suite representative of the local marine environment.

In 2015-16, DHI built a fully calibrated hydrodynamic model (MIKE21) which was used to simulate the transport of sediment away from the seawall during its reconstruction. Diurnal tidal movements were known with high accuracy. The same calibrated model has been used to simulate the intrusion of seawater into a reflooded Main Pit through a trench or cut made through the elevated coastal margin. The trench was modelled to be made through native rock and not through the engineered seawall for reasons explained elsewhere. Preliminarily, a number of dimensions were assigned to trench options in terms of widths and bed elevations, mindful of two countering factors: the larger the trench the more ocean exchange water but the greater the opportunity for vessel navigation in the post closure period; smaller the trench, the less excavations and engineering to be made.

Congruence of the pit lake (Arbitration Lake) and adjacent ocean waters physiochemical parameters is proportional to the efficiency and completeness of mixing of the two bodies of water. Various DC configurations were therefore hydrodynamically modelled (DHI, 2019) to determine patterns of flow and mixing with water from the adjacent ocean:

- -1.5 m AHD invert, 10 m wide base 1H:2V side slopes;
  - West of the engineered seawall, normal to the seawall;
  - East of the engineered seawall (at the ramp), normal to the seawall;
  - Two channels: East of the engineered seawall (at the ramp) and west of the engineered seawall, both normal to the seawall;
  - West of the engineered seawall, rotated 6° from normal to the seawall; and
  - Two channels: East of the engineered seawall (at the ramp), normal to the seawall, and west of the engineered seawall, rotated 6° from normal to the seawall.
  - Two channels: -1.5 m AHD invert, 10 m wide base 1H:2V side slopes, east of the engineered seawall (at the ramp), normal to the seawall, and +1 m AHD invert, 10 m wide base 1H:2V side slopes west of the engineered seawall, rotated 6° from normal to the seawall.

An interesting aspect of the 2D surface simulations was the tidal flushing effect at the east and west DCs. When just one DC was applied in isolation the eastern one worked far better, while the western one resulted in a relatively poorly mixed section of water at the eastern side of the pit even after 14 days. An explanation for that is that the eastern DC generates a jet of tidal water which crosses the pit and induces mixing in both directions when it collides with the foot wall, while the western one tends to generate a self-perpetuating counter-clockwise gyre resulting, in the latter case, in less efficient water exchange, both in terms of the distribution of the incoming clean water, and because more of the clean water is drawn out again on the following tide. The total volume of water conveyed through the canals over the simulations (east canal in isolation vs. west canal in isolation) are identical.

There was a significant difference in the tidal range in the pit for the one DC versus two DCs. For one canal the spring range is around 3.5 m (identical whether east or west location) while for both active it's about 5.0 m. Mean sea level in the pit lake is also a bit lower when both canals are active, and when one DC is active the mean sea level in the pit lake is always higher than mean sea level. Tidal levels over the modelling period in and outside Main Pit are shown in Figure 8-.

Modelled water mixing of the lake and ocean was most rapid with using two DCs with -1.5 mAHD inverts, with at least 99% of (a 20 m deep upper layer) lake water exchanged with the ocean after only 14 days (DHI, 2019). A single DC east of the engineered seawall (at the ramp) with the same design proved nearly as effective at mixing, with at least 95% of lake water exchanged with the ocean after 14 days (DHI, 2019). The single DC is KIO's preferred option as:

- Environmental impacts of construction (i.e. blasting and subsequent sediment and rock deposition to the marine environment) will be lower, and
- Spring tidal range for one cut (≈ 3.5 m) is significantly lower than for two cuts (≈ 5.0m) (DHI, 2019), reducing scouring and erosion of pit walls.

DHI (2019) considers that pit lake mixing using one decommissioning cut should be sufficient if the pit is to be left in an unmanaged “natural” state. Construction of a second cut would be more beneficial if future pit lake use includes aquaculture or other activities that would introduce a significant nutrient load (DHI, 2019).

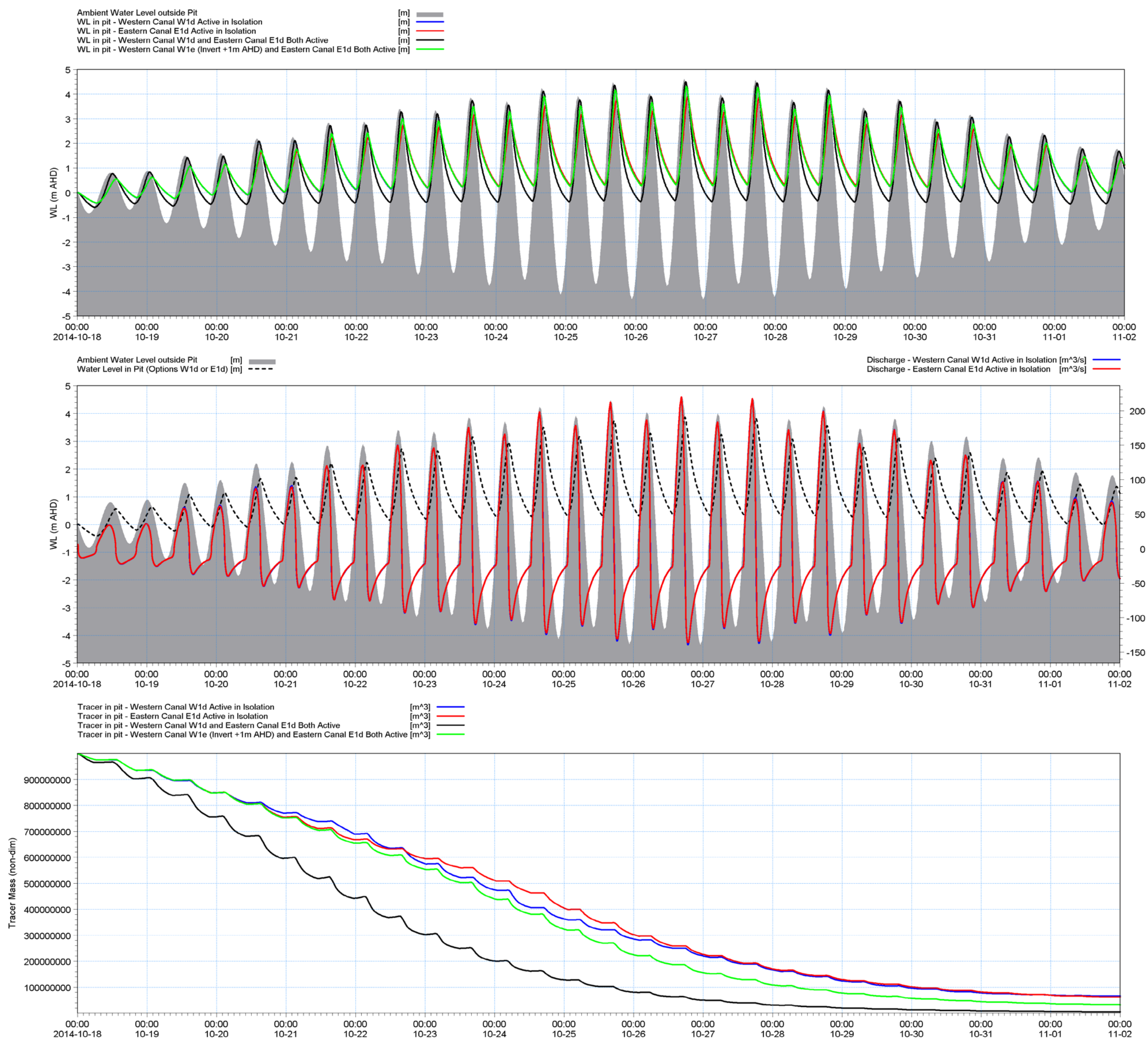

Figure 8-13: Tidal Levels in and outside of Re-flooded Main Pit

Current speeds over the shallows just offshore of seawall east DC are only approximated at this stage, and a finer model would be required to describe the transition out of the Pit lake into the sea via the DC. The existing model suggests that the peak localized currents exiting DC into the sea are high in a very localised area and highest upon an extreme runout spring tide. This would occur during late spring ebb when levels in The Canal have fallen well below the invert level of the DC bed but the levels in the Pit lake remain perched several meters higher. When this happens, the flow exits in a hurry, and flows onto an exposed slope on the seaward side of the seawall. Further small-scale modelling will be done to determine the size and extent of the current flux field (from typical and extreme runout tides), and this will inform where (down to ten of metres) the DC would be installed to avoid established benthic habitat near the seawall. Figure 8-14 provides a snapshot of a localised velocity field simulation around a single decommissioning cut (DHI, 2019).

It is estimated that within one to two months, the seawall east DC option would provide ocean quality water at the surface, noting:

- The surface layer of the pit lake is set to extend down to -20m AHD (the photic zone for light dependent benthos);
- Entrance and exit losses for DC have been included; and
- Roughness of the DC has been set high (n=0.075), based upon what appears to be a very rough boulder-strewn ultimate condition of the rock.

The next tranche of modelling work to be completed by June 2020 will progress the following items:

- Examine localized effects of scour potentially from ebbing tide velocities at through the coastline near hard corals and benthic substrates;
- Examine the joint effect of tide and wind mixing of surface water by exchanges (i.e. oxygen) into deeper pit lake water layer(s). This will consider the risk of seasonal vertical turnover of waters after hot summer time vertical stratification;
- Provide a design of the trapezoidal decommissioning cut to be stable in time and constrain vessel navigation; and
- Iterate the model should external stakeholders express interest in aquaculture within the closed pit lake.

8.13.1 Rehabilitation

Decommissioning Cut not constructed according to the Design

A suitable monitoring program will be implemented to ensure the decommissioning cut is constructed in accordance with design specifications. In addition, inspection of the completed cut will be conducted by site environment personnel to ensure that it is located and oriented correctly, utilising the correct material types, and actions taken where necessary to rectify any non-compliances.

Engineered Seawall and / or Decommissioning Cut Indirectly Affects Marine Habitat

KIO undertakes a marine monitoring program in accordance with the approved marine management plan (section 7.12). The existing Arbitration Cove, Diffuser and Wharf monitoring sites are well placed to capture any ongoing impacts potentially associated with seawall reconstruction and / or future construction of the decommissioning cut. Similarly, they are expected to indicate impact reduction and improving environmental quality when the engineered section of seawall reaches a stable profile (section 8.13.1). The marine management plan will be updated prior to closure to incorporate post-closure monitoring of the existing marine monitoring sites. Where monitoring indicates the potential for adverse effects, remedial measures will be implemented (Section 10).

Pit ‘Lake’ Environmental Quality Inadequate for Establishment of Marine Ecosystem

KIO undertakes a marine monitoring program in accordance with the approved marine management plan (section 7.12). The marine management plan will be updated prior to closure to incorporate post-closure monitoring of the Main Pit lake marine environment similar to that currently undertaken (i.e. Main Pit water quality, sediment quality and benthic habitat). Where monitoring indicates the potential for adverse effects, remedial measures will be implemented (Section 10)

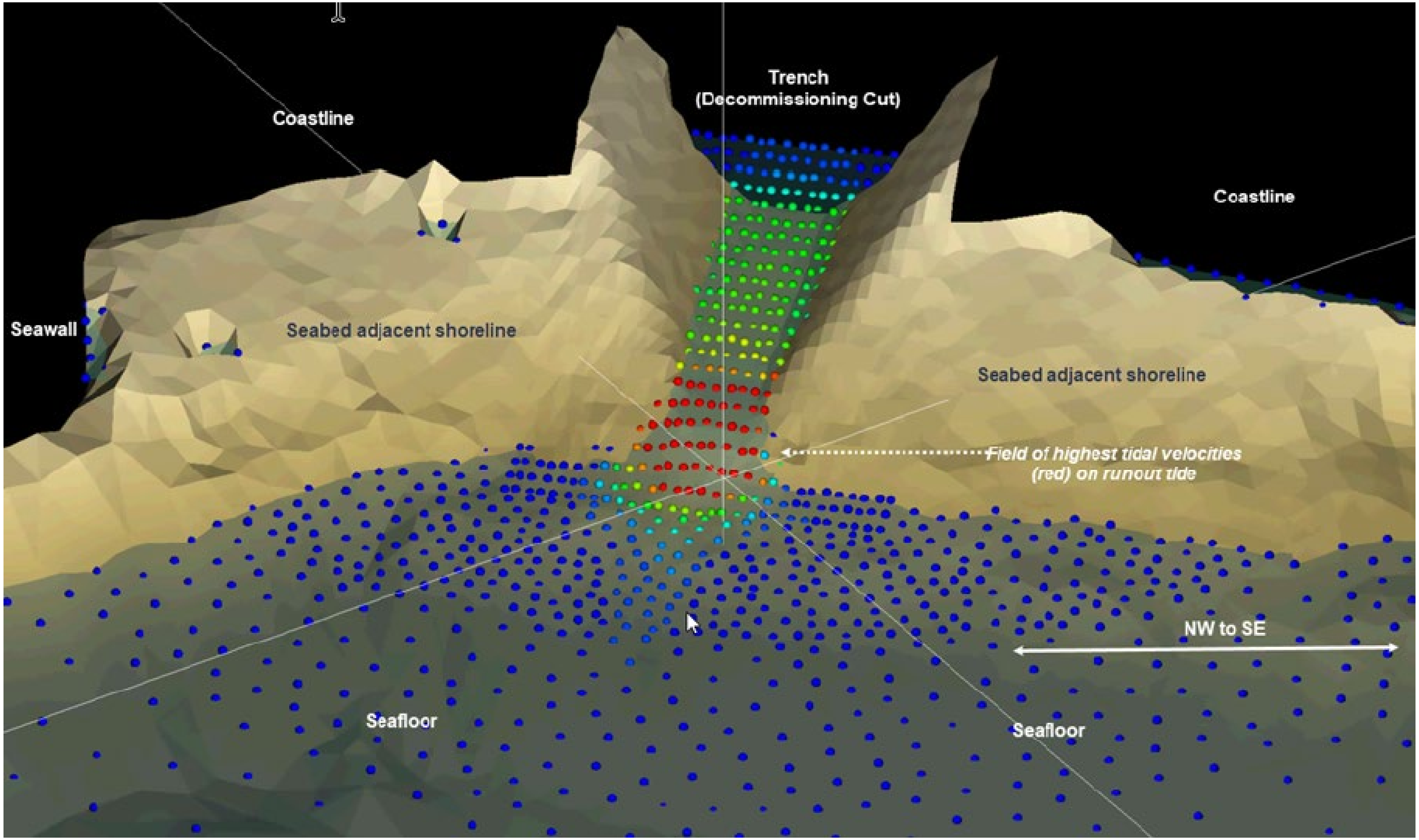

Figure 8-14: Snapshot of Time Series Localised Velocity Field Simulation around Modelled Decommissioning Cut (for tidal conveyances between sea and the flooded Main Pit)

9 CLOSURE IMPLEMENTATION

Closure implementation is detailed in Table 9-1. A table has been utilised for ease of interpretation by on ground personnel who are responsible for implementation of the tasks.

9.1 CARE AND MAINTENANCE

Operations at Koolan Island entered a formal period of C&M in early 2016, lasting until 2018 when the seawall was reconstructed and Main Pit dewatered. The activities required for a formal period of C&M were implemented in accordance with a C&M Environment Management Plan (MGX, 2016b). The C&M plan would be re-implemented if the mine again entered a formal period of C&M.

Table 9-1: Closure tasks, schedule of work for research, investigation, trials and materials required, identification and management of information gaps, key tasks for unexpected and temporary closure, decommissioning tasks

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Open Mine Pits					
Main Pit	• Main Pit will be flooded with seawater by way of a decommissioning cut through the seawall (refer to Infrastructure domain below). • Construct abandonment bund around mine void in accordance with design criteria outlined in DIR (1997) *Safety Bund Walls Around Abandoned Open Pit Mines* guideline and using competent and stable waste rock. Final bund strategy to be determined following consultation with DMIRS and geotechnical assessment. This is shown in Figure 8-4 with the key focus being to prevent inadvertent vehicle access. • All Pit ramps will be barricaded with competent and stable waste rock. Similar to abandonment bunds this will control inadvertent vehicle access. There is ample volume of waste rock on the Island for both abandonment bunds and barricading ramps, whether this is derived from existing WRLs or Mine Pits.	• Geotechnical assessment and modelling of proposed abandonment bund alignments will be undertaken prior to closure.	• Optimum abandonment bund alignments yet to be determined and approved by DMIRS.	• Unexpected closure would require that the closure tasks identified are implemented immediately. • Construct abandonment bunding – conceptual locations depicted in Figure 8-4 and barricade pit ramps.	• Disconnect and remove dewatering equipment, and associated pipelines • Construct decommissioning cut (refer Infrastructure section below) • No other specific decommissioning tasks necessary.
Acacia East Pit	• Acacia East is currently at its final depth. • Construct abandonment bund around mine void in accordance with design criteria outlined in DIR (1997) *Safety Bund Walls Around Abandoned Open Pit Mines* guideline and using competent and stable waste rock. Final bund strategy to be determined following consultation with DMIRS and geotechnical assessment. This is shown in Figure 8-4 with the key focus being to prevent inadvertent vehicle access. • All Pit ramps will be barricaded with competent and stable waste rock. Similar to abandonment bunds this will control inadvertent vehicle access. There is ample volume of waste rock on the Island for both abandonment bunds and barricading ramps, whether this is derived from existing WRLs or Mine Pits.	• Geotechnical assessment and modelling of proposed abandonment bund alignments will be undertaken prior to closure.	• Optimum abandonment bund alignments yet to be determined and approved by DMIRS.	• Implement closure tasks immediately. • Construct abandonment bunding – conceptual locations depicted in Figure 8-4 and barricade pit ramps.	• As per closure tasks. No other specific decommissioning tasks necessary.
Waste Rock Landforms					
Mullet Pit Backfill	• The backfilled pit will be rehabilitated in accordance with the design and specifications discussed in sections 8.5 and 8.5. • Backfilled waste will be surfaced with quartzite batter slopes. Flat areas (berms and any flat areas on top) will be surfaced with siltstone. Existing siltstone will be used as a growth medium where flat surfaces are already composed of the material. Where necessary (i.e. flat areas not composed of siltstone), siltstone will be placed on flat areas at a depth of at least 0.5 m. • Batter all slope surfaces in accordance with final landform design specifications (section 8.5). • Back slope berms as surface water control. • Deep rip slopes on contour to a depth of at least 800 mm. • The siltstone will be deep ripped and hand seeded with the strategic seed mix detailed in section 7.8.2.	• Sufficient information on surface hydrology, seed mixes, available materials and trials has been collected, and is detailed in Chapter 7.	• Sufficient studies have been undertaken to inform the final design and construction of the Mullet Pit backfill.	• Mullet Pit is currently partially backfilled. • In the event of unexpected closure an abandonment bund (Figure 8-4) and barricading of pit ramps to control inadvertent vehicle access. There is ample volume of waste rock on the Island available from WRLs or mine pits • With the current void left in the pit, it is not considered likely that overtopping of surface runoff into the natural environment will occur (section 7.5)	• As per closure tasks. • No other specific decommissioning tasks necessary.

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Barramundi Pit Backfill	• The backfilled pit will be rehabilitated in accordance with the design and specifications discussed in sections 8.5 and 8.5. • Backfilled waste will be surfaced with quartzite batter slopes. Flat areas (berms and any flat areas on top) will be surfaced with siltstone. Existing siltstone will be used as a growth medium where flat surfaces are already composed of the material. Where necessary (i.e. flat areas not composed of siltstone), siltstone will be placed on flat areas at a depth of at least 0.5 m. • Batter all slope surfaces in accordance with final landform design specifications (section 8.5). • Back slope berms as surface water control. • Deep rip slopes on contour ≥ 800 mm. • The siltstone will be deep ripped and hand seeded with the strategic seed mix detailed in section 7.8.2.	• Final design of Barramundi Pit backfill to be completed by 2020. • MP amendment required for approval of East Pit backfill to be completed by 2020. • Sufficient information on seed mixes, available materials and trials has been collected, and is detailed in Chapter 7.	• Barramundi Pit backfill surface hydrology and waste rock capacity to be assessed.	• In the event of unexpected closure an abandonment bund (Figure 8-4) and barricading of pit ramps to control inadvertent vehicle access. There is ample volume of waste rock on the Island available from WRLs or mine pits • With the current void left in the pit, it is not considered likely that overtopping of surface runoff into the natural environment will occur (section 7.5)	• As per closure tasks. • No other specific decommissioning tasks necessary.
East Pit Backfill	• The backfilled pit will be rehabilitated in accordance with the design and specifications discussed in sections 8.5 and 8.5. • Backfilled waste will be surfaced with quartzite batter slopes. Flat areas (berms and any flat areas on top) will be surfaced with siltstone. Existing siltstone will be used as a growth medium where flat surfaces are already composed of the material. Where necessary (i.e. flat areas not composed of siltstone), siltstone will be placed on flat areas at a depth of at least 0.5 m. • Batter all slope surfaces in accordance with final landform design specifications (section 8.5). • Back slope berms as surface water control. • Deep rip slopes on contour to a depth of at least 800 mm. • The siltstone will be deep ripped and hand seeded with the strategic seed mix detailed in section 7.8.2.	• Final design of East Pit backfill to be completed by 2020. • MP amendment required for approval of East Pit backfill to be completed by 2020. • Sufficient information on seed mixes, available materials and trials has been collected, and is detailed in Chapter 7.	• East Pit backfill surface hydrology and waste rock capacity to be assessed.	• In the event of unexpected closure an abandonment bund (Figure 8-4) and barricading of pit ramps to control inadvertent vehicle access. There is ample volume of waste rock on the Island available from WRLs or mine pits • With the current void left in the pit, it is not considered likely that overtopping of surface runoff into the natural environment will occur (section 7.5)	• As per closure tasks. • No other specific decommissioning tasks necessary.
Waste Rock Landforms (WD1, WD2, WD4, WD4)	• The as built WRLs will be a heterogeneous composition of quartzite batter slopes and siltstone flat areas. Existing siltstone will be used as a growth medium where flat surfaces are already composed of the material. Where necessary (i.e. flat areas not composed of siltstone), siltstone will be placed on flat areas at a depth of at least 0.5 m. • Batter all slope surfaces in accordance with final landform design specifications (section 8.5). • Back slope berms as surface water control • Back slope top of WRLs to encourage vertical infiltration of surface water flows • Deep rip slopes on contour ≥ 800 mm • Deep rip top of WRLs • Hand seed all areas with strategic seed mix detailed in section 7.8.2. • Accurately survey all WRLs to ensure construction is in accordance with design specifications	• Continued maintenance of topsoil stockpiles for later use in rehabilitation. • Continued monitoring of trials and progressive rehabilitation as detailed in Chapter 7. • Active rehabilitation of WD4 is complete, with monitoring of revegetation progress continuing. • Assuming a depth of 100 mm for the spreading of topsoil and subsoil, the slopes of WRL 1 – 3 require a total of 120,000 m3. As described in Chapter 7 the total topsoil / subsoil available is approximately 180,000 m3. This material will be used strategically and mainly on the slopes of the WRLs. Siltstone derived from the mining of Main Pit will be utilised on the flat / top areas of WRLs, of which there is ample volume (see Chapter 7).	• LFA monitoring and surface trials, as described in Chapter 7, provide evidence of the efficacy of various rehabilitation methods, and have informed MGX's proposed WRL rehabilitation strategy. Continued monitoring of trials and progressive rehabilitation will further inform the requirements and methodology for the establishment and growth of vegetation.	• Key objective is for WRLs to remain safe, stable and non-polluting. In the event of unexpected closure targeted surveys will be undertaken to identify aspects requiring remedial measures necessary to meet these requirements	• No specific decommissioning tasks
Infrastructure					

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Wharf – Jetty and Shiploader	• All ship load out facilities other than the cyclone moorings, jetty and maintenance platform are to be decommissioned and removed from site as they items will be handed over to another entity. • Cyclone moorings are to be handed over to the Traditional owners and for the other infrastructure to be handed over to another entity, appropriate tenure will be acquired as described in section 5.2. • Conduct an appropriate assessment to identify any adverse effects to the marine environment and contamination. • Undertake any additional work, as agreed through consultation with the entity receiving the infrastructure (e.g. remediation of contaminated areas, rehabilitation with native plants).	• No topsoil or growth medium is required. • The closure tasks cannot occur prior to closure as the infrastructure is required for ongoing mining operations. • Consultation with the entity receiving the infrastructure at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Nil.	• Remove all chemicals and hydrocarbons from site. • Disconnect electricity supply.	• Remediate any contaminated material identified during the contamination assessment. • For infrastructure being decommissioned and removed from site, the following will apply: o Disconnect any above and below ground utilities. o Deconstruct all steel components and where economically feasible barge all steel components off site for recycling. o Any remaining materials will be buried on site either within mine voids or within licenced landfills as per DER Waste Classification Guidelines and Licence 8148. • Implement closure tasks including disposal or recycling of inert materials.
Barge Landing	• Handover to an entity (likely Department of Transport). • Ensure appropriate tenure is in place prior to handover and relinquishment of mining tenure as described in section 5.2. • Undertake contamination assessment of the barge landing as per DER guidelines to ensure the registration is updated to reflect that it is in a suitable condition for the post end land use. • Undertake any additional work, as per consultation with an entity to which the infrastructure will be handed over to (e.g. remediation of contaminated areas, rehabilitation with native plants).	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Nil.	• Proceed with closure tasks immediately. • Engage with entity to finalise details on handover of infrastructure and securing appropriate tenure.	• As per closure tasks. No other specific decommissioning tasks necessary.
Accommodation Village	For the part of the village not to be handed over to an entity, the following will apply: • Conduct an environmental assessment for potentially contaminated areas • The village is currently vegetated in areas absent of infrastructure. Due to this, rehabilitation works will not be necessary as following the removal of infrastructure the density of vegetation will increase naturally • This will be monitored post closure and where necessary areas will be ripped and hand seeded with native species (Chapter 7) currently occurring within and surrounding the village For the part of the village to be handed over to an entity: • Ensure appropriate tenure is in place prior to handover and relinquishment of mining tenure as described in section 5.2. • Undertake any additional work, as per requirements of consultation (e.g. remediation of contaminated areas, rehabilitation with native plants).	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Details of which, if any, parts of the village will be handed over to an entity are currently unknown. This will be determined prior to closure and through further consultation with an identified entity.	• Remove all chemicals and hydrocarbons from site. • Remove all material from the waste water treatment facility. • Disconnect electricity supply. • Proceed with closure tasks immediately. • Engage with entity to finalise details on handover of infrastructure and securing appropriate tenure.	• Remediate any contaminated material identified by the environmental assessment. • Remove, recycle or demolish any infrastructure not to be handed over to an entity.

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Airstrip and Cyclone Shelter	If the airstrip and cyclone shelter are to be handed over to an entity: • Ensure appropriate tenure is in place prior to handover and relinquishment of mining tenure as described in section 5.2. • Undertake any additional work, as per requirements of consultation (e.g. remediation of contaminated areas, rehabilitation with native plants). • Undertake any additional work, as per outcomes of consultation for the handover of infrastructure (e.g. remediation of contaminated areas). If the airstrip and cyclone shelter are to be rehabilitated: • Demolish runway pavement and cyclone shelter. Recycle demolition materials or dispose of to appropriately licensed landfill. • Conduct an environmental assessment for potentially contaminated areas. • Deep rip ≥ 800 mm and hand seed with strategic seed mix detailed in section 7.8.2.	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Nil.	• Proceed with closure tasks immediately. • Engage with entity receiving infrastructure to finalise details on handover of infrastructure and securing appropriate tenure as per section 5.2. • Process for acquiring appropriate tenure to run in parallel with all other tasks.	• Nil.
Cultural Centre	• Handover to TOs • Ensure appropriate tenure is in place prior to handover and relinquishment of mining tenure as described in Chapter 7. • Undertake any additional work, as per agreement with the TOs reached through consultation for the handover of infrastructure (e.g. remediation of contaminated areas)	• Within the bounds of the co-existence deed, the TOs will be engaged at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Nil.	• Proceed with closure tasks immediately. • Engage with TOs to finalise details on handover of infrastructure and securing appropriate tenure. • Process for acquiring appropriate tenure to run in parallel with all other tasks.	• Nil.
Dewatering and Production Bores	• Removal of infrastructure and rehabilitation must take place at the end of mining operations when the infrastructure is no longer required. • The dewatering infrastructure (pipelines) cover a long narrow corridor in which little vegetation is disturbed. • Rehabilitation of dewatering and production bore areas is not necessary as they cover very small areas and the re-emergence of vegetation will occur naturally. • (This is inclusive of production bores and dewatering infrastructure for the Main Pit).	• Nil.	• Currently unknown if any production bores will be handed over to an entity for domestic use. This will be determined at least two years prior to mine closure in consultation with an entity.	• Remove all chemicals, explosives and hydrocarbons from site. • Disconnect electricity supply. • Remove floating pontoons from the Pit Lake and sea (diffuser).	• Disconnect all above and below ground utilities. • Remove all mobile equipment and supplies from site. • Where economically feasible, any salvageable, resalable or recyclable clean waste and decommissioned equipment will be removed from site. • All remaining infrastructure will be demolished to ground level and removed. • All Production bores will be decommissioned as per the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee, 2012).

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Bioremediation Facilities	• Conduct an appropriate environmental assessment to determine the presence of contaminants in the soil below the clay liner. • If contaminants are found in the soil below the facility: o Remediate any contaminated materials. o Conduct groundwater tests. • No further materials will be required for rehabilitation • The materials composition of the bioremediation facilities will be capable of retaining water and therefore capable of supporting vegetation (see Section 7.7) • Following determining the absence of contamination, the facilities will be flattened using appropriate machinery and deep ripped ≥ 800 mm. The areas will then be hand seeded with the strategic mix detailed in Section 7.8.2. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns and reshape the land surface, as necessary.	• No research, investigations or trials are required.	• The detail required to determine if the facilities will be handed over to another entity is currently unknown. This will be determined at least two years prior to mine closure in consultation with an entity.	• No further works required other than those already identified.	• Remediate any contaminated material identified during the environmental assessment. • Remove all mobile equipment and supplies from site. • Stockpile the treated material from the bioremediation facility and remediate contaminated materials for disposal according to DWER (2018) waste classification definitions.
Fuel and Bulk Storage	• Conduct an appropriate environmental assessment to test the storage areas for contamination prior to rehabilitation. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns. Reshape the land surface, as necessary – this will include covering of the concrete pads left behind at the fuel storage facility. Following determining the absence of contamination, the facilities will be flattened using appropriate machinery and deep ripped ≥ 800 mm. The areas will then be hand seeded with the strategic mix detailed in Section 7.8.2.	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure. • Contamination assessment at closure. • Surface hydrology assessment of rehabilitated landform prior to seeding.	• The detail required to determine if the facilities will be handed over to another entity is currently unknown. This will be determined at least two years prior to mine closure in consultation with another entity.	• Remove all chemicals and hydrocarbons from site. • Disconnect electricity supply.	• Remediate any contaminated material identified during the environmental assessment. • Remove all chemicals and hydrocarbons from site. • Disconnect all above and below ground utilities. • Remove all mobile equipment and other supplies from site. • Where economically feasible any salvageable, resalable or recyclable clean waste and decommissioned equipment will be removed from site. • All remaining infrastructure will be demolished to ground level and removed. • Concrete pads will be left in place if on site machinery is not capable of breaking it and buried to a depth of at least 1 metre. If machinery can break it, than it will be buried in an open pit or licenced landfill as per DWER (2018) waste classification definitions.
Landfill	• Landfills are located in flat areas and ongoing mining operations will allow the landfills to be progressively covered with a mixture of siltstone and quartzite • Removal of above ground infrastructure to ground level • Construct cap comprised of ≤ 1 m compacted clean clay fill, overlain by ≤ 150 mm locally sourced topsoil profiled to direct surface flows away from the landfill. • Topsoil manually seeded with the strategic mix detailed in section 7.8.2.	• Landfills which are no longer in use will be rehabilitated progressively during operations when rehabilitation materials derived from the pits are available. • All other landfills will be decommissioned and rehabilitated at the end of mining operations when they are no longer required for ongoing operations. • Conduct soil contamination assessment. • Surface water flow over the cap will be analysed to ensure it is constructed as designed to direct surface water flows away from the landfill cells.	• The detail required to determine if the facilities will be handed over to another entity is currently unknown. This will be determined at least two years prior to mine closure in consultation with an entity.	• No further tasks other than those already identified.	• Remove all mobile equipment and supplies from site. • Remediate contaminated material identified by the environmental assessments as per DER (2014) guidelines. • Cover all waste with a minimum of 1 metre soil/rock material likely to be composed of quartzite and siltstone (this activity is ongoing throughout the life of the mine, and will be completed when the landfill is decommissioned).

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Laydown and Hardstand Areas	• Conduct an appropriate environmental assessment to test the soil for contamination prior to rehabilitation • Remediate contaminated material identified by the environmental assessment • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns and reshape the land surface, as necessary. • Rip all surfaces ≥ 800 mm with appropriate machinery. • Plant all disturbed areas with the strategic mix detailed in section 7.8.2.	• These areas are composed of a heterogeneous mixture of quartzite, siltstone, clay/silts and natural ground. For this reason and based on rehabilitation investigations and trials to date, the materials will support vegetative growth. If necessary, siltstone derived from the pits will also be utilised to place a suitable substrate for vegetative establishment and growth (≈ 1m deep). • Decommissioning of the laydown areas will take place at the end of the overall mine closure process. These areas will be decommissioned sooner, where possible, but they are expected to be required for ongoing mine operations and to support other decommissioning and rehabilitation activities.	• The detail required to determine if the facilities will be handed over to another entity are currently unknown. This will be determined at least two years prior to mine closure.	Other than those tasks already identified the following will be applied; • Remove all chemicals and hydrocarbons from site.	• Remove all mobile equipment and supplies from site.
Roads	For roads to be handed over to an entity: • Ensure appropriate tenure is in place prior to handover and relinquishment of mining tenure as described in section 5.2. • Undertake any additional work, as per outcomes of consultation undertaken prior to the handover of infrastructure (e.g. contamination assessment). For roads to be rehabilitated: • Compacted surfaces ripped ≥ 800 mm. • Compacted clay liner underlying bioremediation facilities will be left in place, the facilities filled in, and land surfaces reshaped according to the surface water flow analysis. • Rehabilitated pads and processing plant area seeded with the strategic mix detailed in section 7.8.2.	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Nil.	• Proceed with closure tasks immediately. • Engage with entity to finalise details on handing over infrastructure and securing appropriate tenure.	• Nil.
Explosives magazine and bulk explosives batching facility	• Conduct a contamination assessment prior to rehabilitation. • Remediate any contaminated material identified. • The area is made up of waste rock materials similar to those which have demonstrated successful revegetation as per the areas described in Chapter 7. For this reason it is not considered that the import of topsoil or surrogate growth medium will be necessary. • Rip compacted surfaces ≥ 800 mm, with appropriate machinery. • Plant all disturbed areas with the strategic mix detailed in section 7.8.2. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns. Reshape the land surface as necessary – this will include covering of any concrete pads left behind.	• No research, investigation or trials will be undertaken specifically for the decommissioning and rehabilitation of this area.	• Nil.	• Remove all hydrocarbons and chemicals from site. • Disconnect all above and below ground utilities.	• Decommissioning will take place at the end of the overall mine closure process as the facilities are needed for ongoing mining operations. • Safely remove all explosives or detonate on site by appropriately qualified persons • Remove all hydrocarbons and chemicals from site for either disposal at licenced facilities or use elsewhere. • Disconnect all above and below ground utilities. • Remove all mobile equipment and other supplies from site. • Where economically feasible any salvageable, resalable or recyclable clean waste and decommissioned equipment will be removed from site. • All remaining infrastructure will be demolished to ground level, removed and buried to ≈1 m depth in appropriate areas.

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Power Stations and Power Lines	• As power lines are located throughout other domains (specifically infrastructure areas), environmental assessments for contamination will be conducted in these areas. • Remediate any contaminated material identified during the environmental assessment. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns – reshape the land surface as necessary. • The areas in which the power stations are located is a heterogeneous composition of siltstone and/or clay silts. Rehabilitation trials to date have demonstrated the capacity for materials such as siltstone clay/silts to be capable of supporting vegetation. For this reason it is not considered that the import of topsoil or surrogate growth medium will be necessary. • Rip all compacted surfaces ≥ 800 mm with appropriate machinery. • Plant all disturbed areas with the strategic mix detailed in section 7.8.2. The village power station may be handed over to an entity along with the part of the village which that entity will retain	• Consultation with an entity at least 2 years prior to mine closure to determine the details required for the handover of infrastructure.	• Confirmation of any infrastructure to be retained and, therefore, power stations and power lines required to be retained. This will be determined at least two years prior to mine closure in consultation with the appropriate entity identified.	• Disconnect electricity supplies. • Remove all hydrocarbons and chemicals from site. • Switch off and lock out the power plant.	• Remediate any contaminated material identified by the contamination assessment. Tasks for power lines include: • Disconnect all power lines from infrastructure. • Remove all above ground power lines and send off site for recycling where economically feasible or dispose of in a licenced landfill in accordance with DWER (2018) waste classification definitions. Tasks for power stations inclusive of the MOC and ROM are: • Remove all chemicals and hydrocarbons from site. Disconnect all above and below ground utilities • Remove all mobile equipment and other supplies from site. • Where economically feasible any salvageable, resalable or recyclable clean waste and decommissioned equipment will be removed from site. • All remaining infrastructure will be demolished to ground level and removed and buried to a depth of at least 1 metre in a mine void or licenced landfill in accordance with DWER (2018) waste classification definitions.
MOC (Administration, Workshop, Warehouse)	• Conduct contamination assessment. • Remediate any contaminated material identified. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns and reshape the land surface as necessary. • Rehabilitation trials to date have demonstrated the capacity for materials such as siltstone and clay/silts to be capable of supporting vegetation. The surface which the MOC covers is a heterogeneous composition of siltstone and/or clay silts. • Rip compacted surfaces ≤ 800 mm with appropriate machinery. • Plant all disturbed areas with a strategic seed mix as per Chapter 7.	• No research, investigation or trials will be undertaken for the decommissioning and rehabilitation of this area	• Nil.	• Remove all hydrocarbons and chemicals from site. • Disconnect electricity supply.	• Decommissioning of the MOC will take place at the end of mining operations as the infrastructure is required to support ongoing operations. • Disconnect all above and below ground utilities. • Remove all mobile equipment and supplies from site. • Where economically feasible, any salvageable, recyclable or resalable clean waste and decommissioned equipment will be removed from site. • All remaining infrastructure will be demolished to ground level and either buried within an open mine pit or licenced landfill in accordance with DWER (2018) waste classification definitions. • Concrete pads will be left in place if on site machinery is not capable of breaking it and buried to ≥ 1 m depth. If machinery can break it, than it will be buried in an open pit or licenced landfill as per DWER (2018) waste classification definitions.

Domain / Area	Closure Tasks	Schedule of work for research, investigation, trials and materials required	Identification and Management of Information Gaps	Key tasks for unexpected closure	Decommissioning Tasks
Crusher, ROM and Product Stockpile Pads	• Conduct contamination assessment. • Remediate any contaminated material identified. • Rip all compacted surfaces ≥ 800 mm with appropriate machinery. • Cover all disturbed areas with topsoil (or surrogate material) to a minimum depth of 100 mm. • Plant all disturbed areas with a strategic seed mix as per section 4. • Batter off the eastern end of the product stockpile to ≤20 degrees. Spread subsoil material Deep rip on contour and hand spread the strategic mix detailed in section 7.8.2. • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns. Reshape the land surface as necessary - this will include covering any concrete pads and the re-shaping of any remaining stockpiles.	• Following the completion of WRL rehabilitation, there will be approximately 60,000 m^3 of subsoil available for use in this area. Processing plant, ROM and product stockpiles and the soil dump cover an area of approximately 32.5 ha. The rehabilitated profile of the eastern end will cover an area of approximately 1.1 ha and will be the priority location for spreading the available subsoil. The rehabilitation approach for the eastern end of the product stockpile is similar to that for the WRLs (Table 8-4). There is ample subsoil to spread at a depth of 100 mm across this sloped area. Remaining material will be used strategically and only where growth medium is required to supplement the existing soil profile which will contain siltstone capable of supporting vegetative growth. • Siltstone will be spread over flat concrete areas and with ample volumes of material available, a thicker soil profile capable of supporting vegetative growth may be established.	• Nil	• Remove all chemicals and hydrocarbons from site. • Disconnect electricity supply. • Block access to the crusher, ROM and product stockpile pads.	• Disconnect all above and below ground utilities. • Remove all mobile equipment and supplies from site. • Product stockpiles shipped off site during operations. • Demolish all infrastructure including processing plant and other buildings. • Concrete pads will be left in place if on site machinery is not capable of breaking it and buried to ≥ 1 m. If machinery can break it, then it will be buried in an open pit or licenced landfill as per DWER (2018) waste classification definitions. • Send materials off site for recycling where economically feasible and dispose of all other inert materials either in mine voids or licenced landfills in accordance with DWER (2018) waste classification definitions.
Settlement Pond and Turkeys Nests	• Assess areas and remaining water for potential contamination (sample for TRH and heavy metals) and treat contaminated water as necessary • Undertake decommissioning tasks • Undertake a surface flow analysis to ensure that the rehabilitated areas are 'keyed-in' with the surrounding areas and flow patterns. Reshape the land surface as necessary – this will include covering of any concrete pads and the re-shaping of any remaining stockpiles. • Rip siltstone growing medium and subsequently spread the strategic mix detailed in section 7.8.2.	• As described in Chapter 7, there is ample volume of siltstone available for use in rehabilitation. • No further research, investigation or trials are required.	• Nil.	• No further tasks other than those detailed.	• Drain ponds of water in accordance with Licence 8148. • Cut HDPE pond liners and fold into base of pond for burial. • Concrete and other inert waste may be tipped into settlement pond. This will be dozed and levelled. • Doze and push in pond embankments making them level. • Backfill ponds with siltstone, which is available in ample volumes and will be useful as a growth medium. • Shape surface making it flat and key into surrounding surface hydrology.

10 CLOSURE MONITORING AND MAINTENANCE

Following the rehabilitation phase there will be a period of post closure monitoring. Chapter 6 briefly outlined monitoring tools and compliance procedures related to completion criteria of the various domains of Koolan Island. This section provides further details of these monitoring systems, including the general approach and related concepts for monitoring and data collection. The overarching goals for monitoring systems at Koolan Island are to provide managers and stakeholders:

- Clear and robust data on progress towards rehabilitation goals;
- Integrated information that considers pathways for contaminant, water and energy flows in the wider receiving environment; and
- Definitive end-points for closure.

KIO is committed to implementing monitoring systems that meet these goals with the aim of timely closure of the rehabilitated post-mine environment.

Monitoring systems on Koolan Island are well embedded with the implementation of management plans required by MS 715. Monitoring required by these plans since the start of operations provides a strong background for assessment against specific closure criteria, and as the requirements will be also necessary post closure. Where monitoring requirements of these plans differ to those required during post closure, the plans will be updated and approval sought from the necessary agency (either EPA and / or Department of the Environment). The plans include:

- Significant Flora and Fauna species Management Plans;
- Northern Quoll Management Plan;
- Quarantine Management Plan;
- Marine Management Plan;
- Water Management Plan; and
- Contamination Management Plan.

For instance, in the post-closure phase, monitoring may need to be done less frequently and / or less extensively. For further detail, Koolan Island management plans can be found on the Mount Gibson Iron website at (http://www.mtgibsoniron.com.au/koolan-Island/)

10.1 GENERAL APPROACH TO MONITORING AND DATA COLLECTION

10.1.1 MONITORING SUMMARY

Table 10-1 illustrates the entire monitoring program to be implemented post-closure. The program encompasses requirements of this mine closure plan, completion criteria (Section 8) and management plans under MS 715. Closure provisioning has allowed five years for the monitoring program's duration. The frequency of monitoring and its duration may change dependent on operational monitoring during the life of the project and initial closure monitoring results.

The progression of monitoring data results relative to completion criteria targets will dictate the suitability of the site for relinquishment. Nominally, this may take in the order of five to ten years.

Table 10-1: Post closure monitoring program summary

Aspect	Domain / Area / Management Plan	Methodology / Frequency	Completion Criteria
Geotechnical structural stability	Open mine pits (Main, Acacia East, East and Barramundi)	• Post closure geotechnical assessment by a suitably qualified geotechnical engineer of high walls and Main Pit seawall • Ongoing biennial geotechnical assessment of high wall and sea wall or as required	• Pit slopes and voids are geotechnically stable • Pits are safe to public – inadvertent public access controlled
	WRLs and backfilled mine pits	• Post closure geotechnical assessment by a suitably qualified geotechnical engineer • Ongoing biennial geotechnical assessment or as required	• Gully frequency and cross-sectional area stable • Sediment movement not affecting final landforms design stability • No adverse effects on surface run-off, sediment inflows of natural streams and marine environments • Landforms maintain visual amenity of surrounding natural landscape, species mix comprised of native species
Rehabilitation performance (surface stability and revegetation)	WRLs, backfilled mine pits, onshore infrastructure domains and Scree	• Quadrats randomly placed in rehabilitated land, as specifically cited for the domain / area. This may reduce over time, dependent on rehabilitation success and trends • Within quadrats assess germination, species composition and diversity, coverage, vegetation function, evidence of fauna, weeds • Within and surrounding area of quadrats assess erosion such as gullies, tunnelling, washouts,	• Gully frequency and cross-sectional area stable • Sediment movement not affecting final landforms design stability • No adverse effects on surface run-off, sediment inflows of natural streams and marine environments • Growth-medium reconstructed using proven materials, revegetation mix tailored to biophysical conditions and demonstrably resilient

Aspect	Domain / Area / Management Plan	Methodology / Frequency	Completion Criteria
		overall loss of sediment to surrounding environment • Inclusive of a general visual inspection of the surrounding areas • Combination of field notes and photographic monitoring points • Conducted annually post wet season and within dry season	• Revegetation supporting functional and structural diversity and target individual species maintaining equivalent function as in analogue flora monitoring quadrats • Revegetated habitat capable of supporting fauna and invertebrates, weed coverage not adversely affecting rehabilitated land quality • Landscape Organisation Index within 25 % of analogue site • Stability Index within 25 % of analogue site • Number of plants per hectare and Canopy Volume within 25 % of analogue site • Rehabilitated areas to include at least two Target flora species
Surface / Marine systems	Marine Management Plan and all other domains (onshore, offshore, WRLs, Pits)	• Monitoring of marine water quality and benthic fauna and habitat as per Marine Management Plan • Installation of active rehabilitation areas for coral habitat in Main Pit and areas along southern shoreline	• No adverse effects on marine environment • Colonisation of newly formed Main Pit benthic habitat • Compliance with Marine Management Plan
Surface and Groundwater Quality	Water Management Plan / Open Pits	• Biennial monitoring open pit water bodies, monitoring and production bores for basic parameters (pH, EC, TDS), heavy metals and hydrocarbons as per Water Management Plan • If water quality parameters indicate the requirement, undertake biennial monitoring for	• No adverse effects on groundwater quality • Compliance with Water Management Plan

Aspect	Domain / Area / Management Plan	Methodology / Frequency	Completion Criteria
		subterranean fauna as per the Subterranean Fauna Management Plan	
Fauna (Quolls)	Northern Quoll Management Plan	• Biennial Island wide Northern Quoll Survey in accordance with Northern Quoll Management Plan	• Compliance with Northern Quoll Management Plan
Quarantine (exotic flora and fauna)	Quarantine Management Plan	• Biennial Island wide Northern Quoll Survey in accordance with Northern Quoll Management Plan (also allows for monitoring of exotic fauna) • Biennial Island wide weed survey in accordance with Quarantine Management Plan	• Compliance with Quarantine Management Plan

10.1.2 Reporting and remedial measures

As outlined in Section 8, reporting of performance against the post closure monitoring program will be through AER's submitted to DMIRS and other relevant agencies. Reporting will focus on the progress reached in meeting completion criteria.

Remedial measures must be tailored to the specific requirements of the matter which needs addressing and compared to performance against completion criteria. For example, surface erosion may be minimal only requiring rock armouring in a localised area. Or surface erosion may be excessive which could require large scale earthworks to redirect surface water away from the affected area.

Remedial measures will be implemented based on the specific circumstances which have resulted in the deviation from completion criteria and identified through the detection systems (Table 10-1). This will ensure that any remedial measures implemented will be suitable for the intended purpose. Where significant remedial measures are required and there are significant deviations from completion criteria, DMIRS will be notified as soon as practicable and informed of actions to remedy the non-conformance. If the measures required are only minor, the issue and the actions taken will be reported in the AER.

11 FINANCIAL PROVISIONING FOR CLOSURE

MGX has used industry standard rehabilitation costing models to calculate closure and rehabilitation provisions for KIO. The closure cost estimates are reviewed annually, at both a site and corporate level, and are updated based on revised costs from KIO operations and relevant rehabilitation activities. KIO's closure provisions cover decommissioning and rehabilitation costs scheduled to be incurred after mining has finished at the site. Rehabilitation and closure activities undertaken during the mining phase are funded from operating budgets. Preston Consulting undertook a review of the closure cost estimate for the purpose of provisioning in August 2019. The review was conducted in accordance with the International Financial Reporting Standards (**IFRS**) and the scope of this review consisted of the following;

- Review the existing MCP to identify key closure and rehabilitation requirements and commitments;
- Visit the Koolan Island site, view the key features for rehabilitation and closure, discuss closure and rehabilitation requirements and capability with relevant mine staff. Access any unit costs particular to the operation that are relevant to the closure cost estimate; and
- Prepare a set of assumptions to base the closure and rehabilitation costing upon.

This review was based on an extensive database of closure costs including actual (contractor) and estimated "contractor equivalent" costs from rehabilitation at other mine sites. In particular, costs from other Kimberley based mining operations have been referenced to benchmark unit rates where possible. The cost estimate has been developed from bottom up first principles (capital and operating costs) and calibrated against actual rehabilitation earthworks contractor rates from a rehabilitation cost database.

The review undertaken is described in greater detail below. Internally, annual reviews are conducted based on the methodology applied by Preston Consulting. When it is considered necessary (for example, significant changes in operations) external assessments or audits of the closure provision are sought.

11.1 METHODOLOGY AND KEY ASSUMPTIONS

The following was included in the review:

- All earthworks costs associated with rehabilitating all disturbed footprints including waste rock landforms, stockpiles, run of mine pads, open pits including abandonment bunding, all associated infrastructure footprints including ore processing plant sites, laboratories, reagent storage facilities, workshops, administration, stores, warehouse, camp, airstrips, lay downs, water containment facilities, drainage infrastructure, water supply facilities, pipelines, storage sheds etc.
- Costs were included for maintenance and repair earthworks during the passive closure period as the rehabilitated site stabilises. The conceptual footprint aligned with Option 2 (Figure 8-2).
- All decommissioning and demolition costs for dismantle and removal of all infrastructure from the site, breakup and burial of demolition rubble, rubbish and non-recyclable materials.
- All costs associated with contamination investigations, removal and reporting.
- All consultant costs associated with the active and passive closure periods (note that consultant costs required during operations have been excluded from the LOM estimate).
- All mobilisation and demobilisation of equipment and personnel required during all closure periods.
- All project management costs including engineering, procurement, management and supervision, QA/QC, owners' costs, travel (FIFO) and accommodation costs associated with each of the closure periods.
- All costs associated with any and all contracted services obligations such as power supply contract agreements, land access and tenure agreements, and any other contractual commitments including stakeholder agreements

and communications contracts, and supply contracts required during the various closure periods including fuel, general supplies, camp, and commute costs etc.

- All inventory and asset disposal costs.
- All environmental and mineral tenement licence monitoring and reporting obligations during the closure periods.
- All corporate costs including insurances, levies, equipment leasing payments, and overhead costs.
- All employee costs including salaries and wages and on-costs (workers compensation, payroll taxes, annual and long service leave obligations, severance and retrenchment obligations, superannuation obligations etc.).
- Any contingencies that may be applied to any and all of the costs.

The cost estimate is based on assumptions. The key assumptions relating to mining were:

- At 2019 the resource would be mined out by 2023 and the closure decommissioning, demolition and rehabilitation works execution phase will commence thereafter (noting that the estimate is based on the current disturbance footprint as per IFRS requirements).
- All topsoil stockpiles removed ahead of mining operations have been identified and stockpiled in an appropriate manner and are available for rehabilitation purposes.
- Where topsoil and growth media is to be used for rehabilitation purposes, revegetation seeding is assumed to be applied to at least 95% of the area or as specified.
- All low grade ore stockpiled during mining operations will be processed prior to final closure. The cost estimate allows for rehabilitation of the low grade stockpile footprint.
- All waste rock landforms are constructed as per design and any problematic materials have been fully integrated into the landforms as per DMP requirements and commitments.
- It is assumed that any required earthworks for closure can be completed within the scope of the current approvals, or if approvals are required, they will be accommodated within any LOM footprint approval amendments.

The key infrastructure cost assumptions included:

- All costs associated with decommissioning, demolition, and removal off-site of all ore processing and handling plant and equipment, and associated infrastructure and buildings including all infrastructure support related components (power, water, buildings etc.).
- Closure and rehabilitation of structures and building foundations, including concrete slab break-up and removal for burial within the Main Pit dewatering settlement pond and breaking down (using excavator mounted shears) and removal of scrap steel to an appropriate landfill site or off site depending on the prevailing scrap metal price at the time of the works.
- Clean up and removal of contaminated material for treatment within the bioremediation facility prior to its final rehabilitation. The key source of potential contamination is assumed to be hydrocarbons as all previous removal and remediation of asbestos has been completed.
- Closure and rehabilitation of all infrastructure footprints including storage areas, lay downs, landfills; borrow pits, go-lines, car parks etc.
- Removal of the accommodation village apart from a limited number of accommodation units and the dry mess and kitchen facilities required for use during the passive post closure monitoring period and assumed to be agreed to be left for the benefit of another entity at the end of closure.
- Retention on site of a vessel and facilities to enable marine post-closure monitoring.
- Decommissioning and removal of all potable water infrastructure including the water treatment plant and water storage tanks (one tank to remain for rain water storage for post closure monitoring period).
- The cultural centre will be retained for the continued use and benefit of and management by the TO’s.

- The concrete section of the jetty, the floating dock, the barge landing area and the adjacent laydown area is to be cleared of assets and infrastructure, cleaned and prepared for retention once all closure activities have been completed and all equipment is demobilised. The retained facilities are for use during the passive post closure monitoring period and prospectively for another entity once relinquishment is achieved.
- Barging for mobilisation and demobilisation of all equipment and infrastructure has been based on current contractor rates for marine travel to Derby.

Other key assumptions are:

- Revegetation costs are based on typical native species of the Western Kimberley's. It should be noted that some of the species listed may not be present on Koolan Island but are provided to enable the inclusion of seeding costs. It is estimated that a total of 3,863 kg's of native seed will be required for revegetation purposes across all disturbed areas of the project and is based on a 8 kg/ha dispersal rate.
- No salvage value is ascribed to infrastructure items for the purpose of provisioning.
- No sale value or ongoing management cost is ascribed to any retained accommodation units and support infrastructure, the cultural centre, the jetty and associated maintenance platform or adjacent laydown area after lease relinquishment.
- Marine barging costs, diesel fuel costs (ex-rebate), fly in fly out costs, and camp costs are as per current contracts.

11.2 METHODOLOGY – DETAILS ON COST ESTIMATE

The following section provides detail for all cost elements included in the review and draws on the disturbance footprint reported in the 2019 Mine Rehabilitation Fund (MRF) and other aspects such as progressive rehabilitation.

Table 11-1: MRF Disturbance Area Summary

Rehabilitation and Closure Domain	Disturbance Footprint (ha)
Landforms	272.5
Infrastructure	60.3
Mining Infrastructure	229.9
Water Containment Facilities	2.0
Roads	43.9
Exploration	0.3
Total	**609.0**

Note: Annual revisions take into consideration updated Mine Rehabilitation Fund disturbance data. This is the data applied by Preston Consulting so it has been described here

11.2.1 LANDFORMS

Reshaping methodology used prescribed for re-profiling and deep contour ripping the dumped angle of repose tip edge to 20° (1V:3H) and reducing each berm width from 43.1 m to 15 m. Each berm would be shaped away from the berm crest at 5° to ensure drainage is away from the 1 m high crest bunds and water containment cells are to be constructed on each berm and top of WRL. Note, this approach is not yet supported with the necessary approvals to allow the activity (i.e. push to ≤ 20°). The additional work to be done on outer slope design (section 8.5) will inform the provisions to be provided in 2021.

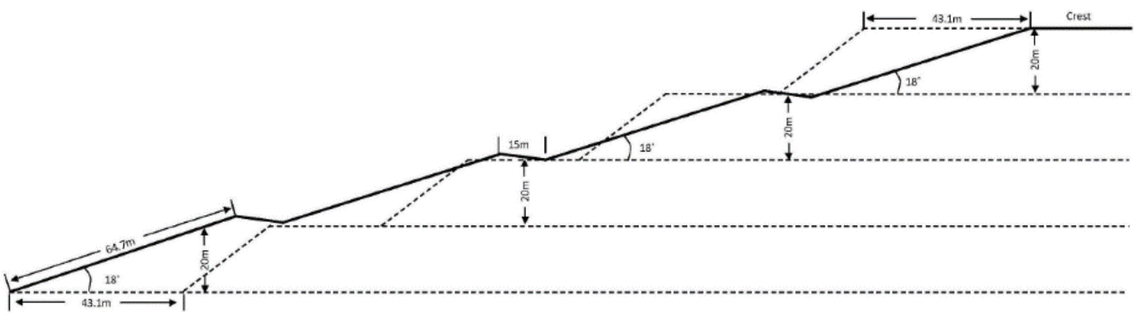

Figure 11-1: Landform Outer Slope Design Assumed for purpose of Closure Estimate

(Note: Final landform design represented by: -----------)

The review assumed that all stocks of ore will be removed and processed for shipping and the only requirements will be to rehabilitate the stockpile footprint to establish a stable surface. It was assumed that the soils beneath the stockpiles will not require covering with suitable growth media or topsoil but will be capable of re-establishing vegetation across the footprints once drainage works and deep ripping has been carried out.

The stockpile rehabilitation tasks include:

- Shape and level the disturbance footprint to re-establish natural drainage across the footprint;
- Deep contour ripping; and
- Revegetation of 95% of the footprint.

The cost review also assumed some additional costs to ensure the integrity and stability of the landforms are maintained during the post closure monitoring period. This allowed for weed management and erosion repairs.

11.2.2 Infrastructure Facilities

The key infrastructure facilities include; ore processing facilities, the ship load out facilities, the mining operations centre, workshop, and stores, and the accommodation village and airstrip. Other operations support infrastructure is in place and includes power, water supply, waste water treatment, fuel storage, land fill, and laydowns.

The review was based on the following:

- Demolition and removal (offsite) of all processing plant infrastructure and equipment, ship load out infrastructure (except the jetty and maintenance platform), and all other infrastructure and buildings including all infrastructure support related components (power, water, buildings etc.) apart from a limited number of buildings required during the passive closure period.
- Closure and rehabilitation of all structures and building foundations, including concrete slab break-up and removal for burial within the settlement pond and breaking down (using excavator mounted demolition shears) and removal of scrap steel off site.
- Marine demolition works using suitable cranes and excavator mounted demolition shears working from a barge (all required marine facilities to be removed to a minimum 300 mm below sea bed level).
- Clean up and removal of any contaminated material for treatment within the bioremediation facility (bio pad) prior to its final closure and rehabilitation.
- Closure and rehabilitation of all infrastructure disturbance footprints including storage areas, lay downs, landfills, borrow pits, etc.

- Estimated costs for the demolition of the facilities are based on the estimator's industry experience and the previous estimates provided by experienced demolition contractors.

11.2.3 Mining Infrastructure

The review looked at the requirements for each pit as it currently exists and for making the pits safe as per the requirements of the DMP. This included installing abandonment bunding around the pits where there is a risk of inadvertent access. The DMP guidance on abandonment bunding has been used to calculate the costs required to build the bunds.

In accordance with the currently proposed post end land use, the Preston Consulting estimate took into account the costs associated with cutting a channel into the seaward side of the Main Pit wide enough for small vessels to make their way into what would be the harbor of the Main Pit. However, with the effective removal of the seawall, this aspect has been removed from the methodology.

11.2.4 Water Containment Facilities

This includes the Main Pit dewatering settlement pond and a small turkey's nest pond. All works are assumed to be undertaken during the closure period and the ponds are dry and free of any sediment that would require special contamination treatment.

The review allowed for the following activities:

- Cutting the HDPE pond liners and folding into the base of each of the ponds for burial.
- Dozing and levelling the concrete and rubble from clean up and demolition works deposited into the settlement pond.
- Dozing and pushing in the pond embankments to back fill the ponds.
- Source, excavate, load, haul, and dump suitable oxide growth media cover material to complete backfilling of the ponds.
- Dozing and shaping the growth media cover material to establish natural drainage across the footprint, contour ripping and revegetation.

11.2.5 Groundwater Infrastructure

This included all dewatering and production bores and monitoring wells as well as removal of any water pipe lines and associated pumping infrastructure. The review included for the removal of exposed bore-hole casings and providing suitable plugs and caps and minor rehabilitation works at each of the bore sites as well as decommissioning and removal of pipelines and associated infrastructure off site.

The cost review estimate has allowed for the following activities:

- Removal of any transfer tank, pumps, generators and support infrastructure from the well heads.
- Decommissioning and removal of any above ground bore field pipe line infrastructure.
- An allowance for rehabilitation, topsoiling, and revegetation along the pipeline route as required.

11.2.6 Roads and Tracks

This covered the closure and rehabilitation of all haul roads, access roads, and tracks across the site. Many of these roads are expected to be required for post closure monitoring purposes. The cost review has assumed that the majority of the roads on the site will be required, but the footprint of the roads will be reduced to suit the smaller traffic expected after closure.

Earthworks included de-compaction, and re-contouring of the road surfaces to re-establish natural drainage across the roads, culvert removal (if any), topsoil haulage and placement were required, and removal of any redundant road safety furnishings.

The review allowed for the following activities:

- Removal of any culverts and road furnishings where they are no longer required.
- Dozing, re-contouring, and decompaction of the road running surfaces no longer required so as to reinstate surface water drainage across the road.
- Installing a rock and/or topsoil cover (assumed rilled adjacent to the road side) over the dozed and reshaped portion of the road surface to at least 100mm average thickness, ripped and revegetated as required.
- Reshape and prepare road surface including sheeting and compaction.
- Establish a suitable rip-rap rock lined drainage along the waste rock dump high side edge of road way.
- Rock armour to stabilise the cut and fill slope faces as required.
- Install any road furnishings as required.

11.2.7 Exploration Disturbance

Although exploration disturbance is rehabilitated as per the requirements of the Program of Works Exploration, for the review the requirement to undertake an audit of all exploration disturbance was included.

11.2.8 Post Closure Monitoring

Post closure monitoring is required to ensure that agreed completion criteria has been satisfied. The review assumed a period of 10 years would be necessary and it included the following activities;

- Annual vegetation and rehabilitation monitoring, usually through Ecology Function Analysis (EFA) and Land Function Analysis (LFA) monitoring techniques to assess the development of and success against stable landforms and revegetated land (monitoring process may differ to this specific methodology but this was considered adequate for the purpose of the provision estimate).
- Annual erosion and surface water drainage monitoring and impacts assessment.
- Biennial geotechnical monitoring of the waste rock dumps and the open pit high walls especially the Main Pit high wall.
- Biennial ground water monitoring that includes both ground water sampling, and lab analysis.
- Triennial surface water quality monitoring especially associated with the waste rock dumps.
- Biennial fauna and habitat monitoring.
- Triennial benthic marine monitoring.
- Biennial satellite imagery and photographic assessment of rehabilitated areas.

11.2.9 Management

During the closure period personnel will be required to manage, supervise and provide technical support. This was allowed for in the review along with other closure obligations during this period. Excluded from the review was corporate staff, stakeholder engagement, tenement holding, tenement rents and shire rates. The following was allowed for;

- Allowance (excluded from the provision) for regional environmental support over the closure and post closure periods (10 years).
- A project manager or site coordinator to assume the role of registered manager for the site (71 weeks).

- A senior engineer responsible for contractor management, supervision, design, engineering and alternate registered manager (71 weeks).
- A senior environmental officer responsible for all environmental aspects of the site including QA/QC, monitoring and supervision (71 weeks).
- An administration support responsible for all administration activities including liaison with corporate purchasing, HR, and accounts (71 weeks).
- A safety officer/medic responsible for all safety aspects of the site (71 weeks).
- An allowance for two electrical and two mechanical maintenance personnel to maintain all services during the active closure period (71 weeks).
- An allowance for a closure earthmoving contractor workforce of 35 including supervision, maintenance personnel and operators (71 weeks).
- An allowance for a demolition contractor workforce of 8 personnel including supervision, maintenance and operators spread over two demolition contract of works periods (24 weeks).
- Allowance for light vehicle maintenance costs for 3 vehicles including the site ambulance (71 weeks).
- An estimate for all camp and FIFO costs including power and water supply, catering for all project personnel and contractors, and weekly commute flights.

The review also included technical expertise and consultant support on aspects such as;

- Annual environmental reporting requirements.
- Preparation of the “as-built” and engineering sign-off of final rehabilitated landforms.
- Preparation of the relinquishment reporting requirements at the end of the post closure monitoring period.
- Review and analysis of the ground and surface water monitoring data and preparation of the monitoring reports undertaken biennially.
- Review and analysis of the fauna habitat monitoring data and preparation of the fauna monitoring reports undertaken biennially.
- Review and analysis of the benthic marine monitoring and preparation of the monitoring reports undertaken biennially.

11.2.10 Contingency

For the review a contingency of 15% was applied to allow for any unforeseen risks or events that may be encountered during the execution of closure activities. Based on the cost estimate methodology described above, MGX provides for the costs of closure in its accounts and reports them consistent with the requirements of IFRS. By reviewing the cost estimate annually, the addition of new areas of disturbance, changes in rehabilitation techniques and costs are incorporated into the closure cost estimate and provision rate. The provision account is preserved for mine closure costs with on-going mining, landforming and rehabilitation costs charged to operating accounts.

12 MANAGEMENT OF INFORMATION AND DATA

A closure, environment and community database is maintained by KIO to capture baseline data, mining records, logistical and site procedures within a centralised framework for the effective management of information and data relevant to closure. Figure 12-1 shows a schematic flow diagram that represents the process and methodology for flows between three tiers, including:

1. Information base, e.g. baseline, logistical data;
2. Closure planning and implementation by domain; and
3. Evaluation (3a) and compliance (3b).

The first tier is fed by existing data, records and procedures of which selected themes (represented by orange boxes) are relevant to the second tier domain specific closure planning and implementation. The third tier represents the small-scale research; monitoring and trials ran in parallel with large-scale closure works for each domain. The information is currently being used to evaluate progress towards closure goals and is an important stimulus for adaptive management and remediation works by building on the existing information base throughout LOM. Reporting and compliance will be ongoing to demonstrate progress towards closure and that final land-use is in line with the agreed stakeholder standards and completion criteria.

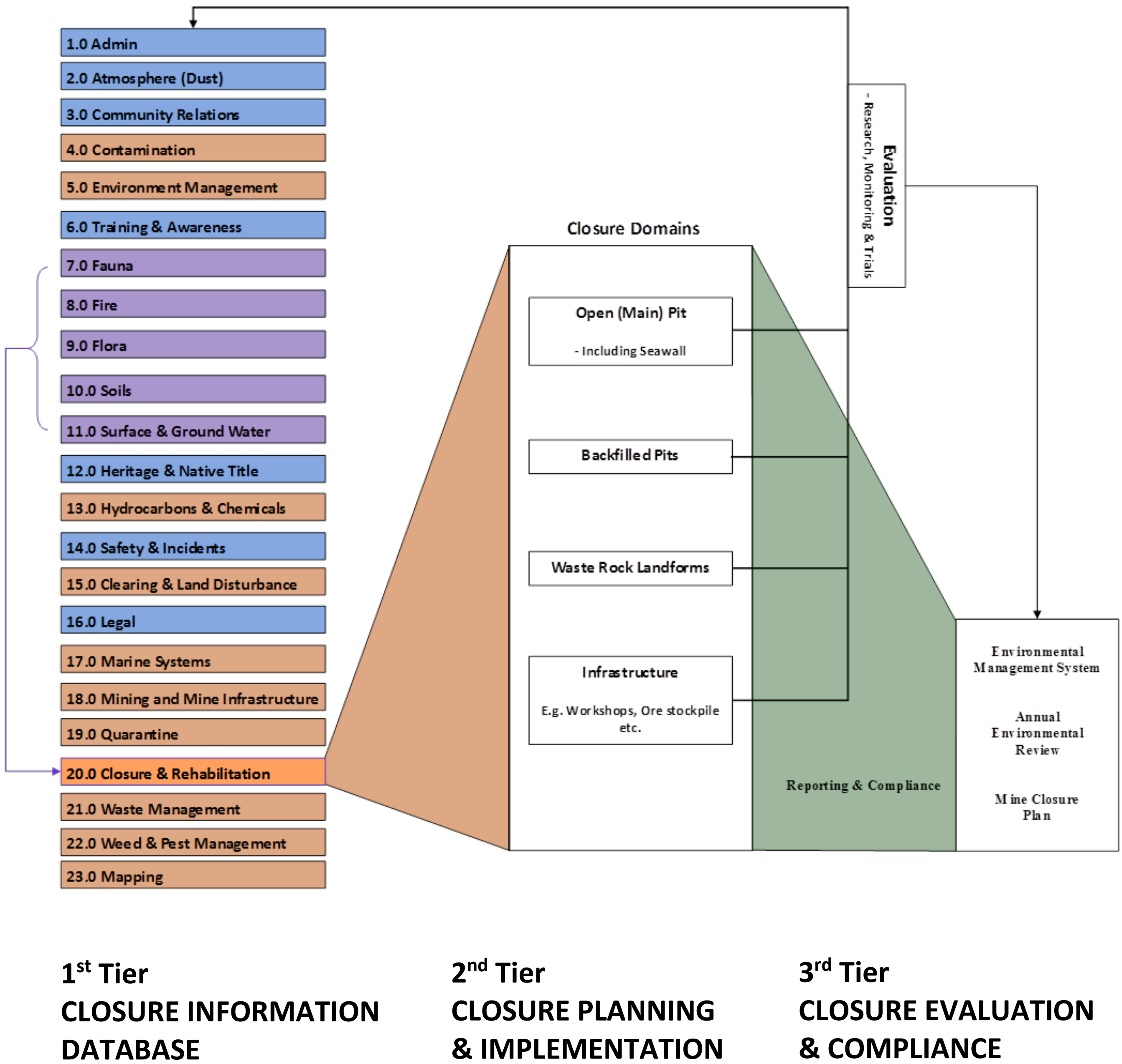

Figure 12-1: Schematic flow diagram showing management of information and data at KIO

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APPENDIX A: CLOSURE OBLIGATIONS REGISTER

LEGISLATIVE REQUIREMENTS

KIO has identified the general legislative obligations relevant to closure of the Project within Table 13-1.

Table 13-1: State Legalisation Closure Obligations

Legislation and reference	Requirement relevant to Closure
Mining Act 1978. Part IV (84AA)	A mine closure plan is required to be approved by the Department and reviewed every 3 years, or as specified by the Department.
Environmental Protection Act 1986	Specifies provisions for issuance of Closure Notices.
Mining Act 1978. Part III (1)(20)(3a)	Make safe all holes, pits, trenches and other disturbances on the surface of the land which are likely to endanger the safety of any person or animal.
Mining Act 1978. Part III (1)(20)(3b)	Take all necessary steps to prevent fire and damage to trees or other property.
Mining Regulations 1981. Part V, (6)(97)	Avoid activity that obstructs any public thoroughfare or undermines any road, railway, dam or building in such manner as to endanger the public safety.
Mining Regulations 1981. Part V, (6)(98)	The proponent shall not allow detritus, dirt, sludge, refuse, garbage, mine water or pollutant from the tenement to become an inconvenience to the holder of any other mining tenement or to the public, or in any way injure or obstruct any road or thoroughfare or any land used for agricultural purposes.
Environmental Protection Act 1986. Part V, (49)	Prevent conducting activities that may emit unreasonable emission or transmission of noise, odour or electromagnetic radiation which unreasonably interferes with the health, welfare, convenience, comfort or amenity of any person.
Environmental Protection Act 1986. Part V, (51)	The proponent shall not affect some or all of the native vegetation in an area, including the draining or flooding of land, the burning of vegetation, the grazing of stock, or any other act or activity, that causes: (e) the killing or destruction of; (f) the severing of trunks or stems of; or (g) any other substantial damage to, some or all of the native vegetation in an area without the relevant clearing permit conditions in place.
Environmental Protection Regulations 1987. Part III, (5L)	The proponent shall provide notification of details of any discharge of waste during closure activities.
Environmental Protection Regulations 1987. Part VI, (14)	Tyres are to be disposed in accordance with Regulation 14: Tyres may be disposed of by burial under a final soil cover of not less than 500 mm – (a) in batches separated from each other by at least 100 mm of soil and each consisting of not more than 40 cubic metres of tyres reduced to pieces;

Legislation and reference	Requirement relevant to Closure
	(b) in batches separated from each other by at least 100 mm of soil and each consisting of not more than 1 000 whole tyres.
Environmental Protection Regulations 1987. Part VIII, (20B)	The proponent shall continue the reporting of monitoring results during the closure period.
Contaminated Sites Act 2003. Part I, Section 11 *Contaminated Sites Regulations 2006*. Part II (6)	The proponent or individuals are to report known or suspected areas of contaminated sites.
Contaminated Sites Act 2003. Part I, (8)	All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.
Contaminated Sites Act 2003. Part III, (23)	Sites classified as Contaminated - Remediation Required as described under the *Contaminated Sites Act 2003* are to be remediated.
Mines Safety and Inspection Regulations 1985. Part III, (2)(3.11)	Notification of suspension of mining operations must be in writing and include: • the name and location of the mine; • the number of the lease, tenement or other interest; • the name and address of the principal employer at the mine; • what mining operations are to be affected, and whether they are to be commenced, recommenced, abandoned or suspended; and • the date on which the mining operations are to be commenced, recommenced, abandoned or suspended (as the case may be). • the reason for the suspension and the planned duration of the suspension; • whether the closure is total or whether access to underground and/or open pit workings is to be maintained; • if underground and/or open pit access is to be maintained, details of the arrangements that have been made for the provision of regular services and emergency services to ensure the safety of employees engaged in maintaining the mine; • the measures that have been taken to prevent unauthorised access or entry to the mine; • the precautions that have been taken to protect underground equipment and service installations; and • any plans required to be prepared under section 88 of the Act.
Mines Safety and Protection Regulations 1985. Part III, (2)(3.16)	The proponent shall secure the site against inadvertent public access.
Mines Safety and Protection Regulations 1985. Part III, (2)(3.16)	The proponent shall design against mine subsidence.

Legislation and reference	Requirement relevant to Closure
Mines Safety and Protection Regulations 1985. Part III, (2)(3.16)	All buildings and structures are to be removed or secured and the site left in safe condition.
Mines Safety and Protection Regulations 1985. Part III, (2)(3.16)	The proponent shall remove or properly dispose all hazardous substances from the site.
Mines Safety and Protection Regulations 1985. Part III, (2)(16.35)	After the mine is abandoned, rehabilitation sites are to be inspected and monitored at such intervals and in such a way as is approved by the State mining engineer.
Aboriginal Heritage Act 1978. Part IV	Heritage sites are not to be altered, excavated, damaged, concealed or any portion of the site removed in any way, unless granted via Section 16 or 18 under the *Aboriginal Heritage Act 1978*.
Soil and Land Conservation Act 1945. Part V (32)	The proponent shall take adequate precautions to prevent or control soil erosion, salinity or flooding; or the destruction, cutting down or injuring of any tree, shrub, grass or any other plant on land where land degradation is occurring or likely to occur.
Dangerous Goods Safety Act 2004. Part II (8)	The proponent has a duty to minimise risk during the handling or transporting of dangerous goods.
Dangerous Goods Safety Act 2004. Schedule 1. (cl 6 and 7)	When removing dangerous goods from the site, it must be done so in accordance with schedule 1.
Wildlife Conservation Act 1950 (16 and 23F)	A person may not take for any purpose, including mine closure activities, protected fauna or flora without a licence, or rare and endangered flora without the written consent of the Minister.
Health Act 1911.Part IV (2) (87)	The proponent shall ensure (stagnant) pools, ponds, open ditches, and drains do not become offensive to the public or allow these areas to become prejudicial to human health.
Health Act 1911. Part IV (3) (95) *Environmental Protection (Controlled Waste) Regulations 2004*. Part III	Removal of sewerage systems is to be conducted in accordance with Local Government Law and by a licensed contractor in accordance with the *Environmental Protection (Controlled Waste) Regulations* 2004.
Environmental Protection (Controlled Waste) Regulations 2004	Disposal of asbestos is to be separated, wrapped and labelled and disposed in accordance with Part III,(6)(44)
Environmental Protection (Controlled Waste) Regulations 2004	The proponent is to treat all products listed in schedule 1 of the *Environmental Protection (Controlled Waste) Regulations 2004* as a controlled waste.

MINING TENEMENT CONDITIONS

The following Mining Tenements have been granted upon which the Project is implemented; M 04/416, M 04/417 and L 04/29. The conditions of each of these tenements have been reviewed and the conditions relevant to closure included within Table 13-2.

Table 13-2: Mining Tenement Closure Conditions.

Tenement No.	Condition No.	DMP Tenement Conditions:
L 04/29	1/1	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
	3/1	Development and operations, as approved by the Inspector, being carried out in such a manner so as to create the minimum practicable disturbance to the existing vegetation and natural landform.
	22/1	The development and operation of the project being carried out in such a manner so as to create the minimum practicable disturbance to the existing vegetation and natural landform.
	23/1	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.
	24/1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
	26/1	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 Director, Environment Division, DoIR.
	28/3	The Licensee(s) submitting to the Executive Director, Environment Division, DMP, a brief annual report outlining the project operations, mine site environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March
	30/2	A Mine Closure Plan is to be submitted in the month and year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • September 2015.
L 04/68	4/1	All topsoil that may be removed ahead of pipelaying operations to be stockpiled for replacement in accordance with the directions of the Environmental Officer, Department of Mines and Petroleum.

Tenement No.	Condition No.	DMP Tenement Conditions:
	12/1	On the completion of the life of mining operations in connection with this licence the holder shall: • 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 Environmental Officer, Department of Mines and Petroleum and properly maintain same until the Environmental Officer advises regrowth is self supporting; unless the Minister responsible for the Mining Act 1978 orders or consents otherwise.
	14/1	A Mine Closure Plan is to be submitted in the Annual Environmental Reporting month specified in tenement conditions in the year specified below, unless otherwise directed by an Environmental Officer, DMIRS. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMIR's website: • 2019
M 04/416	2/1	All surface holes drilled for the purpose of exploration are to be capped, filled or otherwise made safe after completion.
	3/1	All costeans and other disturbances to the surface of the land made as a result of exploration, including drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Industry and Resources (DoIR). Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DoIR.
	4/1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.
	5/1	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
	11/1	At agreed intervals, not greater than 12 monthly, the lessee providing a brief report to the Director, Environment, DoIR outlining the progress of the operation and rehabilitation program and the proposed operations and rehabilitation programs for the next 12 months.
	12/1	Prior to the cessation of the exploration/prospecting activity in the designated area, the lessee notifying the Environmental Officer, DoIR and arranging an inspection as required.
	24/1	Prior to the cessation of exploration activity the lessee notifying the Director, Environment, DoIR and the Regional Manager, CALM and arranging an inspection as required.
	25/1	If in the opinion of the Director, Environment, DoIR the exploration operations are causing any damage to or undue interference with living marine resources or their environment on any part or parts of the lease area, the lessee ceasing exploration on such part or parts within 24 hours of notification from the Director, Environment, DoIR.

Tenement No.	Condition No.	DMP Tenement Conditions:
	28/1	At the cessation of operations, unless alternative tenure and approvals are obtained for continued use of the airfield post-closure, all airfield infrastructure is to be removed and the landform rehabilitated as per waste dump rehabilitation requirements.
	30/1	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.
	31/1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
	33/1	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 Director, Environment Division, DoIR.
	36/3	The Lessee submitting to the Executive Director, Environment Division, DMP, a brief annual report outlining the project operations, mine site environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March
	38/2	A Mine Closure Plan is to be submitted in the month and year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • September 2015.
	41/1	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.
	42/1	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.
	43/1	At the cessation of operations, unless alternative tenure and approvals are obtained for continued use of the airfield post-closure, all airfield infrastructure is to be removed and the landform rehabilitated as per waste dump rehabilitation requirements.
M 04/417	2/1	All surface holes drilled for the purpose of exploration are to be capped, filled or otherwise made safe after completion.
	3/1	All costeans and other disturbances to the surface of the land made as a result of exploration, including drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, DMP. Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DMP.

Tenement No.	Condition No.	DMP Tenement Conditions:
	4/1	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.
	5/1	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
	26/1	
	28/1	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.
	29/1	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
	31/1	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 Director, Environment Division, DoIR..
	35/4	The Lessee submitting to the Executive Director, Environment Division, DMP, a brief annual report outlining the project operations, mine site environmental management and rehabilitation work undertaken in the previous 12 months and the proposed operations, environmental management plans and rehabilitation programmes for the next 12 months. This report to be submitted each year in: • March
	43/1	At the time of decommissioning the mine site and prior to rehabilitation, a further seawall embankment review report by a geotechnical or engineering specialist shall be submitted to DMP. This report should review the status of the structure, and examine and address the implications with respect to site abandonment and operational issues associated with the proposed closure strategy.
	47/2	A Mine Closure Plan is to be submitted in the month and year specified below, unless otherwise directed by an Environmental Officer, DMP. The Mine Closure Plan is to be prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" available on DMP's website: • September 2015
	50/1	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.
	51/1	On the completion of operations or progressively when possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.

Tenement No.	Condition No.	DMP Tenement Conditions:
	53/1	At the cessation of operations, unless alternative tenure and approvals are obtained for continued use of the airfield post-closure, all airfield infrastructure is to be removed and the landform rehabilitated as per waste dump rehabilitation requirements.

ENVIRONMENTAL MANAGEMENT PLAN COMMITMENTS

The Koolan Island Mine and Port Facility has been formally assessed by the Environmental Protection Authority in accordance with the provisions of the Environmental Protection Act 1986. The specific Environmental commitments relevant to closure of the Project from the Environmental Management Plan (EMP) associated with the conditions of mining tenements are contained within Table 13-3. It should be noted that this plan has recently been reviewed and updated. The revised EMP was submitted and accepted by the EPA in January 2015 for the purpose of meeting compliance with schedule 2 of MS715. Tenement conditions continue to refer to the original EMP and for this reason commitments made in both documents have been identified. Table 13-4 identifies the commitments relevant in the updated EMP recently accepted by the EPA.

Table 13-3: Environmental Management Plan Commitments (mining tenure).

EMP No.	Environmental Management Plan:
EMP 05	Disturbed areas will be rehabilitated as soon as practicable to facilitate fauna habitat restoration
EMP 05	Areas that have been disturbed will be checked for rehabilitation progress on a routine and ongoing basis by the Environmental Officer
EMP 08	Topsoil will be stripped and stockpiled, and vegetation debris, logs and leaf litter will be retained for reuse during rehabilitation. Topsoil will be managed in accordance with EMP-12 Topsoil Management.
	Topsoil and vegetation direct returned or stockpiled for later use.
	Vegetation and topsoil direct return or stockpiled in suitable locations.
EMP 11	The Marine Management Plan will include monitoring programmes for benthic communities and marine water quality, define trigger values for key parameters, and identify marine rehabilitation techniques.
EMP 12	As a priority, topsoil and cleared vegetation will be directly returned to areas being rehabilitated if possible. If this is not possible, topsoil will be stockpiled for later use.
	Topsoil and subsoil will be stockpiled separately and replaced in the correct order during construction and rehabilitation.
	Topsoil and vegetation direct returned or stockpiled for later use.
	Progressive rehabilitation of available areas (EMP-17 Rehabilitation).
	The area disturbed and volume of topsoil stripped will be recorded in R015 Topsoil and Rehabilitation Register by the Environmental Officer.
EMP 13	All haul roads and tracks will be rehabilitated on completion of use.
	Topsoil and vegetation direct returned or stockpiled for later use.
	Progressive rehabilitation of available areas (EMP-17 Rehabilitation).
EMP 14	Where costeans are dug to determine quality and volume of borrow material, vegetation disturbance will be kept to a minimum and backfilled when no longer required
	Topsoil stockpiles will be no higher than 1.5 metres and will be located 2 metres from the borrow pit boundary to allow for battering during rehabilitation.
	Borrow pits will have slopes graded to permit safe passage of animals (maximum incline of 20 %).
	The final pit floor will be free draining.
	Rehabilitation will be undertaken progressively or as soon as possible following pit closure.
	The sides of the pits will be battered to a maximum slope of 3H:1V.

EMP No.	Environmental Management Plan:
	Diversion drains and upslope windrows, will be utilised to divert surface water flow from entering the pit causing ponding and erosion.
	Topsoil will be spread evenly over the pit floor/edges and access track and then ripped on contour to promote runoff infiltrations.
	Areas will not be driven on after being ripped.
	Local provenance seed will be broadcast to promote re-vegetation.
	All available topsoil and vegetation direct returned or stockpiled for later use.
	Borrow pits progressively rehabilitated as soon as possible following pit closure.
	All areas disturbed by Aztec will be rehabilitated.
	Where practicable, disturbed areas will be progressively rehabilitated to ensure that the rate of rehabilitation is similar to the rate of clearing.
	Long-term visual impact will be minimised by creating landforms which are compatible with the adjacent landscape.
	Stakeholders will be consulted during the life of mine regarding existing landform / landscape values.
	Rehabilitation will be undertaken as soon as practicable to facilitate fauna habitat restoration.
	Habitat niches (including nest boxes) within undisturbed areas will be created and monitored, where feasible and in consultation with DEC, to encourage the relocation and rehabilitation of native fauna.
	Rehabilitation and closure procedures will include measures to address specific habitat types of listed fauna.
	Reshaped land will be formed so that it is inherently stable, adequately drained and suitable for the desired long-term use.
	Where practicable, natural drainage patterns will be reinstated
	Compacted surfaces will be ripped to a depth of approximately 300 mm or greater should ground condition and hydrology allow.
EMP 17	Cleared vegetation and topsoil will be utilised in rehabilitated areas.
	Disturbed areas to be recovered with topsoil to a depth of 100 mm.
	Local provenance seed and plants will be utilised to boost flora density.
	Management of noxious or environmental weeds in rehabilitated areas will be in accordance with EMP-06 Weed and Pest Management
	Aztec will monitor and manage rehabilitated areas until such time as criteria for relinquishment are met, in accordance with relevant government agencies.
	Trial rehabilitation methods will be conducted during the life of mine to ensure future rehabilitation is optimised.
	Rehabilitation implemented in adherence to the Australian And New Zealand Mineral And Energy Council principles for mine rehabilitation.
	Progressive rehabilitation of disturbed areas.
	Monitoring of rehabilitated areas at set intervals using standard sampling techniques.
	The Environmental Officer will routinely inspect rehabilitation areas as per F008 Environmental Inspection Report.
	Monitoring of each major rehabilitation area will be undertaken systematically at regular intervals 12 months after rehabilitation and again in years 2 and 5.

EMP No.	Environmental Management Plan:
	A record of rehabilitation undertaken will be maintained in R015 Topsoil and Rehabilitation Register.
EMP 19	Contaminated soil will be collected and treated onsite at the licensed bioremediation land farm.
EMP 25	Waste dumps will be constructed and rehabilitated in accordance with DoIR Guidelines for Mining in Arid Environments (DME, 1996).
	Final waste dumps will not exceed the height of adjacent ridges.
	Waste rock dumps, where practicable, will be constructed with sufficient surface to groundwater table distance (with considerations to hydro conductivity of the geology) to minimise the potential for groundwater contamination.
	Where practicable, areas will be progressively rehabilitated.
	Where practicable, waste dumps will be constructed with a rounded footprint and blended into existing hill slopes.
	Slopes will be graded to allow for the safe passage of animals.
	The boundaries of pits will be fenced or bunded to deter larger animals such as goannas from gaining access.
	Minimal visual impact of waste dumps.
	Progressive rehabilitation of dumps.
	Monitoring of rehabilitation will occur as per EMP-17 Rehabilitation
	Waste dumps located near drainage channels will be monitored and rock armoured if necessary to prevent scouring and erosion.

Table 13-4: Environmental Management Plan Commitments (MS715)

EMP No.	Environmental Management Plan:
EMP 08	Disturbed areas will be revegetated as soon as possible to facilitate fauna habitat restoration.
EMP 09	All soil resources shall be recovered where practicable and safe to do so without risk to machinery and personnel.
	Topsoil shall be recovered as soon as practicable following vegetation clearance.
	Topsoil shall be stockpiled in discreet cells no higher than 2m and deep ripped.
	Erosion control shall be considered to avoid loss of topsoil during the wet season.
	Weed monitoring and control shall be undertaken throughout the year on stockpiles.
	All available topsoil or vegetation directly returned or stockpiled appropriately for later use.
	A register of topsoil stockpiles will be maintained on site and shall record the stockpile number, the date placed, the source location, the type (topsoil/subsoil) and comments (including rehandling/relocation, seeding etc).
	Signage shall be placed at topsoil stockpiles to indicate the date and source of the material.
	Active stockpiles will be inspected regularly for erosion and weed control.
	Information on the volume of topsoil stripped and stockpiled will be recorded and reported in the annual environment report along with the status of stockpiles.

EMP No.	Environmental Management Plan:
EMP 11	Waste material handling guidelines will be applied with regard to the management of dispersive, erosive and saline waste rocks.
	Waste dumps shall be designed and constructed in a manner where they do not adversely impact on downstream environments due to disruption of drainage line or loss of erodible material.
	Hostile materials such as hyper-saline, fibrous, potentially acid forming and dispersive materials shall be encapsulated where practicable and in consultation with the DMP.
	Waste Rocks Dumps shall be designed and constructed so that the final landform does not encroach off the mining lease or extend beyond approved ministerial boundaries.
	Waste Dump Plan will be prepared and approved by the Technical Services Manager and the Mine Manager prior to construction in consultation with the Environment Superintendent.
	Rehabilitation plans shall be developed consistent with criteria approved in the Koolan Island Mine Closure Plan and in consultation between MGX Mine Planners, Site Technical Services, Site Production and the Environment Superintendent.
EMP 14	Culverts will be placed under roads, embankments and formations to permit free flow of drainage water and to assist in water shedding from the site where applicable.
	Cleared vegetation and topsoil stockpiles will be kept away from watercourses and in discrete stockpiles to minimise interference to surface flows.
EMP 20	All contaminated and potentially contaminated sites will be identified and recorded on the contaminated sites layer on GIS.
	The extent of contamination will be assessed; this will be based on evaluation against the National Environmental Protection Measure (NEPM) for the Assessment of Site Contamination.
	Where evaluation of the investigation levels indicates likelihood of adverse effects on human health or ecological values, a specific health and ecological risk assessment will be conducted based on NEPM investigation levels, DER licence conditions and general provisions of the Environmental Protection Act 1986, and associated Contaminated Site Management guidelines.
EMP 21	Disturbed areas will be deep ripped and progressively rehabilitated, when available, with applicable surface treatments and topsoil, wherever available.
	Where possible, overburden slopes will be progressively battered, spread with stored topsoil and vegetation (where available) and stabilised to prevent surface water erosion and encourage vegetation establishment.
	Where possible, topsoil will be respread to a depth of 100mm to encourage revegetation.
	Where possible dead vegetation recovered during clearing will be scattered on replaced topsoil to encourage biological activity and promote revegetation.
	Compacted surfaces no longer required post construction will be ripped to promote water infiltration and the catchment of seed and organic matter.
	Rehabilitated areas will be indicated by signage and rehabilitation records will be maintained. Records will include survey of rehabilitated areas.
	Rehabilitated areas shall be free draining and erosion resistant.
	Rehabilitated areas shall have signage placed to control access.
	Locally provenant seeds shall be used in direct seeding of rehabilitated landforms.

EMP No.	Environmental Management Plan:
	Earth windrows will be placed across disused access tracks which cross the contour to reduce the rate of runoff and discourage use.
	The Environment Superintendent will check areas that have been disturbed for rehabilitation potential on a regular basis.
	Site inspections to be undertaken to ensure rehabilitation is completed progressively; in accordance with approved Rehabilitation Plans.
	Landscape Function Analysis or similar will be conducted annually on rehabilitated areas to monitor for rehabilitation success.
	Rehabilitation shall be routinely monitored for weeds and treated where required. Remedial works shall be undertaken to address erosion where practicable.

MINISTERIAL STATEMENT 715

The Koolan Island Mine and Port Facility has been formally assessed by the Environmental Protection Authority in accordance with the provisions of Part IV of the *Environmental Protection Act 1986* and approved by the Minister for Environment. MS 715 documents the approval to implement the proposal subject to a number of conditions. The specific conditions relevant to closure of the Project are contained within Table 13-5.

Table 13-5: Ministerial Statement 715 Closure Conditions.

MS No.	Conditions relevant to Closure
MS 6-1	Prepare a Closure Plan within 12 months following the formal authority issued to the decision-making authorities under section 45(7) of the Environmental Protection Act 1986. The proponent shall prepare a Closure Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority, the Department of Conservation and Land Management and the Department of Industry and Resources.
MS 6-1-1	The Plan shall set out procedures to manage the ground and surface water systems affected by the implementation of the proposal to ensure that there are no long-term impacts.
MS 6-1-2	The Plan shall set out procedures to ensure that the areas in the marine environment impacted by the implementation of the proposal display similar floral, faunal and benthic habitat diversity, health and water quality as surrounding marine ecosystems following rehabilitation.
MS 6-1-3	The Plan shall set out procedures to rehabilitate all areas disturbed by the implementation of the proposal to a standard suitable for the agreed end land use(s), with consideration of the characteristics of the pre-mining ecosystems within Koolan Island (through research and baseline surveys); and incorporation of best practice rehabilitation techniques, including topsoil management, used elsewhere in the mining industry.
MS 6-1-4	The Plan shall set out procedures to identify completion criteria, which ensure that there is adequate rehabilitation of the landforms disturbed during implementation of the proposal and that appropriate species are used in rehabilitation.
MS 6-1-5	The Plan shall set out procedures to monitor rehabilitation to assess the performance of all rehabilitated areas against the completion criteria.
MS 6-1-6	The Plan shall set out procedures to report on the rehabilitation and monitoring results.

MS No.	Conditions relevant to Closure
MS 6-1-7	The Plan shall set out procedures to identify and manage any contaminated material, soil or sediment caused by or disturbed during the implementation of the proposal.
MS 6-1-8	The Plan shall set out procedures to develop management strategies and/or contingency measures in the event that operational experience and/or monitoring indicate that a closure objective is unlikely to be achieved.
MS 6-2	The proponent shall review and revise the Closure Plan required by condition 6-1 at intervals not exceeding four years.
MS 6-3	The proponent shall implement the Closure Plan required by condition 6.1 and subsequent revisions required by condition 6-2.
MS 6-4	The proponent shall make the Closure Plan required by condition 6-1 and subsequent revisions required by 6-2 publicly available.
MS 7-1	Prior to the commencement of activities which may affect the marine environment, the proponent shall prepare a marine management plan to the requirements of the minister for the environment on advice of the environmental protection authority, the department of conservation and land management and the department of fisheries. The objectives of this plan are to manage the impacts to the marine environment that arise from the implementation of the proposal to: • maintain the ecological integrity and biodiversity of the marine environment • avoid impacts that arise from the implementation of the proposal on the coral pool community at the mangrove inlet; and • manage project activities to ensure that impacts on marine habitats, communities and biota outside the project footprint are avoided.
MS 8-1	Prior to dewatering or groundwater abstraction, the proponent shall prepare a water management plan to the requirements of the minister for the environment on advice of the environmental protection authority. The objective of this plan is to maintain the quality and quantity of water so that existing and potential environmental values, including ecosystem maintenance are protected.
MS 9-2	Prior to ground disturbing activities in a particular staged area to be cleared, the proponent shall prepare a significant species management plan for conservation-significant flora or fauna species recorded during the staged pre-land clearing surveys required by condition 9-1, to the requirements of the minister for the environment on advice of the EPA, the department of conservation and land management and the western Australian museum. The objective of this plan is to maintain the abundance, diversity, geographic distribution, conservation status and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
MS 10-2	In the event that subterranean fauna have been identified, in meeting the requirements of condition 10-1, the proponent shall prepare a subterranean fauna management plan prior to any dewatering or

MS No.	Conditions relevant to Closure
	groundwater abstraction, to the requirements of the minister for the environment on advice of the environmental protection authority and the department of conservation and land management. The objective of this plan is to maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna at species and ecosystem levels through the avoidance or management of adverse impacts and through improvements in knowledge.
MS 11-1	Prior to ground disturbing activities, the proponent shall prepare a quarantine management plan to the requirements of the minister for environment on advice of the environmental protection authority, the department of conservation and land management and the department of agriculture. The objectives of this plan are to manage the environmental impacts concerning introduced flora and fauna species that arise from the implementation of the proposal to: • prevent the spread of existing introduced flora and fauna species within Koolan Island and between the Island and the mainland, • prevent the further establishment of introduced flora and fauna species on Koolan Island as a result of the implementation of the proposal, and • control or eradicate introduced flora and fauna species on Koolan Island.
MS 13-1	Prior to ground disturbing activities, the proponent shall prepare a contamination management plan to the requirements of the minister for the environment on advice of the environmental protection authority. In this condition, 'contamination', has the same meaning as in section 4 of the contaminated sites act 2003. The objective of this plan is to identify and manage contamination that may be disturbed by the implementation of the proposal to manage the risks to human health and the environment.
Schedule 2 #7	Consult with stakeholders to assess existing landform/landscape values and how these will be affected by the proposal. Note: Stakeholders include but are not restricted to Kimberley Environs, Dambimangari native title claimants, conservation council, wildflower society, local government.

MANAGEMENT PLANS

MS715 requires a range of management plans to be developed and implemented. The management plans set overall objectives which are relevant to mine closure outcomes and there are a number of obligations made within these plans which are specific mine closure obligations which are summarised in Table 13-6.

Table 13-6: Management Plan obligations relevant to closure.

Management Plan	Obligation relevant to Closure
Quarantine Management Plan	Progressive rehabilitation will be undertaken to minimise the time between disturbance and rehabilitation
	Local provenant, weed free seed will be used for rehabilitation
Significant Fauna Species Management Plan	Topsoil stripped (where terrain permits), stripping avoided during or immediately following heavy rains, or in very dry, windy conditions. Direct return of topsoil where possible. If topsoil stockpiling required, stockpiles not to exceed a height of 2 metres to maintain aeration and biological activity, stockpiles clearly marked topsoil, with areas of known weed infestation stockpiled separately.
Significant Flora Species Management Plan	Topsoil stripped (where terrain permits), stripping avoided during or immediately following heavy rains, or in very dry, windy conditions. Direct return of topsoil where possible. If topsoil stockpiling required, stockpiles not to exceed a height of 2 metres to maintain aeration and biological activity, stockpiles clearly marked topsoil, with areas of known weed infestation stockpiled separately.
	Progressive rehabilitation will be undertaken to minimise the time between disturbance and rehabilitation, use local provenant seed for rehabilitation
	Conduct rehabilitation trials for priority species
Stygofauna Management Plan	Monitor stygofauna abundance and species richness, annually following the wet season (approximately may/June) from the year prior to proposed dewatering or if monitoring conducted as per the water management plan indicates a declining trend in water levels or quality that may be detrimental to stygofauna until operations cease, water levels return or no impact to habitat is established. In either of these cases an appropriate monitoring regime will be determined in consultation with the OEPA. Remedial actions will be investigated and implemented where there are occurrences of significantly elevated levels of nutrients, heavy metals or pollution contaminants using the WA water quality guidelines for fresh waters - EPA 1993.
Northern Quoll Management Plan	Conduct progressive rehabilitation using local provenance seed to minimise the time between disturbance and rehabilitation
	Vegetation is collected with top soil, when and where available. This mixture of top soil and vegetation is stored until required and then respread on rehabilitation areas
	When available felled timber will be used in rehabilitation where practical (not mulched)

MINING PROPOSALS

The Koolan Island Mine and Port Facility has been formally assessed by the Department of Mining and Petroleum in accordance with the provisions of the mining tenement conditions M 04/416, M 04/417, L 04/29. The specific mining proposal commitments relevant to closure of the Project are contained within Table 13-7.

Table 13-7: Mining Proposal Commitments

Mining Proposal	Condition No.	Conditions relevant to Closure
Environmental Referral Document (MP 5194)	1	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities – Implement Quarantine Management Plan and Significant Flora Management Plan.
	7	Maintain the general abundance and diversity of species and maintain the general abundance, species diversity and geographical distribution of terrestrial fauna – Implement Significant Fauna Species Management Plan and Northern Quoll Management Plan.
	8	Maintain the abundance, species diversity, geographic distribution of subterranean fauna – Implement Subterranean Fauna Management Plan.
	9	Maintain the abundance, species diversity, geographic distribution of marine fauna – Implement Marine Management Plan.
	11	Maintain the quantity of groundwater so that existing and potential uses, including ecosystem maintenance are protected – Implement Water Management Plan.
	12	Ensure no net loss of Benthic Primary Producer Habitat (BPPH) and where possible to generate a net gain in BPPH and or their associated BPP communities – Implement Marine Management Plan.
	13	Manage and mitigate impacts to landscape values and maintain the integrity, ecological functions and environmental values of soil and landform – Implement Mine Closure Plan.
	14	To identify contamination, assess any associated risks to the environment and / or human health and remediate where necessary – Implement Contamination Management Plan.
	15	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC, 2000) – Implement Water Management Plan.
Mining of Main & Mullet Pits below the water table (MP 31828)	1	Upon completion of mining activity a rehabilitation program will be implemented and include respreading of vegetation and topsoil material and deep ripping the area along the contours.
	2	The rehabilitation area will be inspected periodically and any remedial works identified will be implemented immediately.
	3	The rehabilitation area will be reported within the Annual Environmental Report.

Mining Proposal	Condition No.	Conditions relevant to Closure
	6	Vegetation and topsoil will be cleared prior to the commencement of clearing activities, flagged for protection and strategically located to prevent erosion.
Additional Infrastructure & Clearing (MP 31899)	1	Upon completion of mining activity a rehabilitation program will be implemented and include respreading of vegetation and topsoil material and deep ripping the area along the contours.
	2	The rehabilitation area will be inspected periodically and any remedial works identified will be implemented immediately.
	3	Rehabilitation will be reported within the Annual Environmental Report.
	6	Vegetation and topsoil will be cleared prior to the commencement of clearing activities unless impractical or unsafe such as on cliff faces. The top soil will be stockpiled, signposted for protection and strategically located to prevent erosion.
Acacia East Pit cutback (MP 34572)	1	Upon completion of mining activity a rehabilitation program will be implemented which will include respreading of vegetation and topsoil material and deep ripping along the contours.
	2	The rehabilitated area will be inspected periodically and any remedial earth works identified will be implemented immediately.
	3	Rehabilitation works will be reported within the Annual Environmental Report.
	4	Stormwater at Mullet Pit post-closure will be controlled by specifically placed drainage channels that will allow control of the discharge waters and reduction of turbidity levels to < 20 mg/L TSS.
	7	Vegetation and topsoil will be cleared prior to the commencement of clearing activities, stockpiled adjacent to the area to ensure material is respread over the same area, flagged for protection with flagging only removed upon commencement of rehabilitation and strategically located to prevent erosion.
Construction of Bioremediation Facility & Emergency Response Training Area (MP 47723)	21	On completion of bioremediation of contaminated soils and removal of the remediated soil, the natural ground surface beneath the hydrocarbon contaminated area will need to be validated by sampling and analysis to ensure that no leaching of hydrocarbons into *in situ* soils has occurred.
Environmental Referral Document (MP 5194)	12	Develop and implement a Marine Management Plan that includes monitoring programs, management actions to be implemented if triggers are exceeded, and marine rehabilitation techniques.
	13	Consult with stakeholders to assess existing landform/landscape values, how these will be affected by the proposal and during the preparation of any required management plans required by the conditions. Consult with stakeholders during the life of the mine. During the life of the project the traditional owners and relevant stakeholders will be invited to an annual presentation, to be held in Derby. The presentation will report on activities in the past 12 months and how these compare to the EMP as a result of the work undertaken.

Additional commitment language identified during the review of the MPs relevant to closure of the Project has been provided in Table 13-8.

Table 13-8: Additional Mining Proposal Commitment Language

<table>
<tr><th>Mining Proposal.</th><th>Conditions relevant to Closure</th></tr>
<tr><td rowspan="3">Optimisation of Waste Rock Placement (MP 53093)</td><td>Caution will be taken with material which is known to be erodible and this will either be encapsulated within the waste dump or where it's purposefully placed on an engineered flat area, which will serve to effectively prevent dispersive and erodible materials from being lost off site.</td></tr>
<tr><td>Where possible, flat areas will be maximised to increase surface stability and further encourage the sustainable growth of vegetation post mining. Trials will be undertaken to inform the most effective design for the materials utilised.</td></tr>
<tr><td>Rehabilitation of the Anomaly areas will adopt the following commitments and relevant actions:
incorporation of the area into closure planning and monitoring programs,
primary earthworks to create post mining landforms that are geotechnically stable,
respreading topsoil onto final shaped slopes,
deep ripping along contours in revegetation areas to assist with retention of water and establishment of vegetation,
placement of large boulders and logs to assist with soil stability and the creation of habit, and
periodic inspection of the area to check:
the occurrence and extent of any erosion,
coverage of vegetation and its growth,
remedial works to fix any identified issues; and
reporting rehabilitation data in Annual Environmental Report and under Mine Rehabilitation Fund.</td></tr>
<tr><td>Acacia East Pit cutback (MP34572)</td><td>The final WRL surface will be contoured through a range of slopes with a maximum slope of approximately 20 degrees. The final surface will contain specified drainage channels to control storm water and ensure turbid water above the approved level (as per the approved MP 31828) is not discharged to the external environment.</td></tr>
<tr><td rowspan="2">Construction of Bioremediation Facility & Emergency Response Training Area (MP 47723)</td><td>Prior to commissioning, baseline soil samples of the clay / silt liner will be taken to measure hydrocarbon and glycols.</td></tr>
<tr><td>The management of the facility at closure will be as discussed in Section 4.8 and Table 2, number 21. Such that on completion of bioremediation and removal of the remediated soil, the natural ground surface beneath the hydrocarbon contaminated area will need to be validated by sampling and analysis to ensure that no leaching of hydrocarbons has occurred into the in-situ soils. Sampling and analysis shall be conducted as per 'Development of sampling and analysis programs (DoE, 2001)' with laboratory results initially compared to Assessment levels for soil, sediment and water – version 3 (DEP 2003).</td></tr>
</table>

Mining Proposal.	Conditions relevant to Closure
Construction of Landfill Trenches (MP 40234)	A minimum of 15cm of soil cover will be used when progressively filling the trenches. As each trench will be surveyed, the records will be available for use when reviewing and updating the mine closure and rehabilitation plan. This will ensure that in areas where landfill trenches have been excavated and subsequently filled with waste materials, a suitable amount of cover material can be placed over the former landfill trenches. The amount of cover material will be dependent on the requirements of the mine closure plan. The height of the cover material will be at least 1 m.
	All trenches will be surveyed to ensure that a record of its location is maintained and to prevent the landfill trench areas from being used for other purposes which will affect closure outcomes.
	No landfill trenches will be located in areas of potential contamination as identified by the Koolan Island Contamination Management Plan.
Project Infrastructure NOI (MP 5312)	Topsoil, where available, will be salvaged and managed according to procedures in the approved Environmental Management Plan. The more competent, stable material will be placed on the outer extremities of the waste dump to assist in stability.
	The waste dumps will be constructed in 20 m lifts. An initial slope angle of 37 degrees (the natural rill angle) will be applied to each lift; this will be battered down to an angle of 20 degrees before any rehabilitation is applied. Waste Dumps will be rehabilitated to a self-sustaining system. This will involve land-forming, topsoil spreading and if required, seeding with provenance species. During the LOM, rehabilitation trials will be conducted in consultation with DoIR to determine appropriate closure criteria and rehabilitation techniques.
	All project infrastructure will be removed from the Island and the cleared land rehabilitated.
Scree Stripping M04/416 (MP 23857)	All vegetation and any topsoil encountered will be stockpiled adjacent to the area and respread over the clearing immediately upon completion of Scree Stripping activities.
	Rehabilitation of the drainage sump will only occur after all other areas have been rehabilitated to ensure surface drainage is contained within the cleared area for the entire duration of the activity.
	Upon completion of the Scree Stripping activity a rehabilitation program will be implemented and include respreading of vegetation and topsoil material and deep ripping the area along the contours. The rehabilitated area will be inspected periodically and any remedial works identified will be implemented immediately. Rehabilitation of this area will be reported within the Annual Environmental Report.
Ship Loading Facility (MP 5261A)	All infrastructure associated with the ship loading facility will be removed from the Island and the marine environment rehabilitated as described in the Marine Management Plan

Mining Proposal.	Conditions relevant to Closure
Phase 1 dewatering and seawall construction (MP 56401)	All project infrastructures will be removed from the Island and cleared land rehabilitated. The built seawall for mining purposes can be readily adapted to suit closure form using the operational design as its progenitor. Upon reconstruction, the 2017 seawall design would form a platform for a bund across ther reconstructed section due to competent and massive amounts of quartzite materials. The rock armour would be selected with the intent that this material would be suitable upon closure and the seepage barrier is placed inland from the seaward crest which will limit the potential for scouring and erosions of the internal seepage barrier.
	Closure of the Main Pit at completion of MGX mining would preferably involve creating a small channel through the natural earth at the south-eastern side of the Main Pit adjacent to the ocean into a location outside at least 50m from the engineered seawall.
Environmental Referral Document (MP 5194)	Waste dumps will be designed to a flat crest and will be no higher than the general terrain.
	Rehabilitation will be undertaken using seed collected from Koolan Island.
	Vegetation, debris, logs and rocks will be returned to areas which have been disturbed as they assist in rehabilitation by providing microhabitats for recolonising fauna.
	The primary management strategy involved in addressing clearing of vegetation and fauna habitats on Koolan Island will be an ongoing rehabilitation programme. The aim of the programme will be to rehabilitate disturbed areas to an array of vegetation types and fauna habitats that reflect the pre-disturbance state as closely as possible in order to create a stable long-term environment.
	All disturbed areas including waste dumps, disused access tracks and other work areas will be rehabilitated. Rehabilitation will occur progressively where possible and also following the removal of all structures and equipment upon decommissioning.
	All drill holes will be temporarily capped on completion of drilling and permanently capped as soon as possible. Drill holes will be regularly monitored to ensure the cap remains in place. Where drill holes are no longer required they will be completely infilled so as to remove the potential threat to fauna.
	Upon completion of construction, areas no longer required will be contoured and slopes stabilised and revegetated.
	Overburden will be stored and rehabilitated and waste dumps will be constructed and rehabilitated in accordance the DoIR (i.e. Slopes of no greater than 20 degrees with benches every 7-10m of vertical height to ensure final landforms are geotechnically stable, not prone to erosion and are able to be successfully rehabilitated) as well as the soil characteristics, rainfall, drainage and topography of the landform.
	Rehabilitation trials will be conducted throughout the life of mine, in consultation with DoIR, to determine appropriate rehabilitation techniques for the area.
	Aztec will consult with all stakeholders and interested parties throughout the life of the project.

Mining Proposal.	Conditions relevant to Closure
Airfield Construction and Operation (MP 79171)	Any scour erosion of the WRL will be managed within the life of the WRL and in accordance with existing approvals and Closure Commitments for WRLs.
	Any available topsoil will be harvested prior to ground disturbance and managed in accordance with MGX's Clearing Permit Operating Procedure and Ground Disturbance Procedure.
	Placement of less erosive Quartz on the outer batters of waste dumps and encapsulating siltstone within waste rock dumps.
	Any saline waste material identified during cut and fill activities will be encapsulated within the landform.
	Reshaping and amalgamating the landforms will not alter the stability of landforms for the life of mine.

The Environmental Referral Document (MP 5194) summarised what was considered to be the management actions for mine closure at the time the document was submitted. There are various commitments and obligations within this summary and these presented below in Table 13-9.

Table 13-9: Environmental Referral Document (MP 5194) Summary of Management Actions for Mine Closure

Aspect	Objective(s)	Management Actions
Consultation	Enable all stakeholders to have their interests considered during the mine closure process.	The aim of the closure plan is to provide a strategic framework for the closure of Aztec's Iron Ore Project by providing a basis for consultation with regulators and identified stakeholders regarding the post-mining land uses of the project area and the development of agreed completion criteria.
Legal Obligations	Ensure that the closure of Aztec's Iron Ore Project meets all legal requirements a review was undertaken to identify legislation and guidelines applicable to mine closure.	As part of the review of the Mine Closure Plan during the project life legislation and other requirements will be reviewed to identify any new requirements.
Completion Criteria	Establish a set of indicators which will demonstrate the successful completion of the closure process and facilitate the release of the mining operator from further environmental obligations.	Aztec will consult with all stakeholders and interested parties throughout the life of the project to develop agreed completion criteria.
Decommissioning	Remove or dispose of infrastructure associated with Aztec's Iron Ore Project; and dispose of waste material appropriately.	During the decommissioning phase of the project all infrastructure that cannot be used by another land user will be removed, including concrete footings, and the disturbed areas rehabilitated. Steel will be stored until the mine is decommissioned and shipped off the Island for recycling. The dismantling of infrastructure will generate scrap and waste materials that will be disposed in the following manner: • Steel will be stored until the mine is decommissioned and shipped off the Island for recycling; • Inert material that is not reusable (such as concrete, building rubble) will be buried in the landfill site; and • Hazardous materials, such as asbestos, will be removed from the Island and disposed of in accordance with appropriate governing regulations. Left over fuel, oils and chemicals will be removed from site and returned to the supplier. Waste oils, fuels and chemical will be removed from site and disposed of at an appropriate waste facility or reused where possible.

Aspect	Objective(s)	Management Actions
Contaminated Sites	A process is developed with the DoE for the management of any areas identified as contaminated by BHP's previous activities. No areas disturbed by Aztec to be classed as a contaminated site as per the Contaminated Sites Act 2003.	To ensure that the site is not classed as contaminated due to Aztec's operation, investigations will be undertaken as part of closure to determine whether contamination exists. A Contaminated Sites Assessment process will be undertaken as per the DoE Contaminated Sites Guidelines which incorporates the following: • Investigation: determine the nature and extent of any soil and/or groundwater contamination, • Assessment: evaluate the risks of any identified contamination to human health or the environment, • Action Plan: develop and document an operations plan and implementation schedule which addresses all necessary activities including disposal of contaminated material, monitoring and criteria for completion, • Consultation: discuss all aspects of the program and obtain agreement from DEP (as the responsible regulatory agency), together with other agencies as appropriate, • Implementation: undertake all aspects of the program in compliance with the documented plan and any relevant standards such as Australian Standard 4482.1 – 1997 related to the sampling and investigation of contaminated soils, • Validation: undertake monitoring and/or testing, using appropriate, recognised methods, to demonstrate reduction of contamination to an acceptable levels using an independent consultant; and • Closure: Obtain regulatory signoff that the remediation process has been effective and the site is no longer contaminated.
Development of Final Landforms	Post mining landforms are geotechnically stable and respond to erosion agents in a similar manner to naturally occurring landforms composed of similar rock types. Landforms are compatible with the adjacent landscape. Runoff from surface waters within and running off the site have similar quality to runoff from undisturbed sites.	Reshaping of landforms will be undertaken to: • Prepare landforms and disturbed areas to acceptable standards prior to the implementation of revegetation procedures, • Ensure post mining landforms are geotechnically stable and respond to erosion agents in a similar manner to naturally occurring landforms composed of similar rock types, • Minimise long-term visual impact by creating landforms which are compatible with the adjacent landscape, • Reinstate, where practicable, natural drainage patterns, • Ensure runoff from surface waters within and running off the site have similar quality to runoff from undisturbed sites, and • Batter free-standing waste dump slopes to an angle of 20 º or less.

Aspect	Objective(s)	Management Actions
Rehabilitation	All areas disturbed by Aztec's operation will be rehabilitated. Species native to Koolan Island will only be used in the rehabilitation. Rehabilitation will be undertaken as soon as practicable to facilitate fauna habitat restoration. Rehabilitated areas to achieve: • A floristic richness of 50 % of pre-disturbance, and • A Total Cover Index exceeding 25 % after 4 years.	Rehabilitation will consist of: • Where available, topsoil will be utilised to provide a foundation into which native vegetation will be planted and/or seeded. Topsoil will be applied at a minimum of 100 mm, • Vegetation debris, logs and leaf litter from the clearing of areas will be spread over rehabilitated areas to provide fauna habitat, • Ripping on contour is required to relieve compaction and improve water infiltration. Deep ripping to a depth of 1m will be undertaken where the soil or waste material is of low permeability. In areas where the soil or waste material is of high permeability cultivation on contour will be undertaken. On steep slopes this may require terracing or benching. All ripping, terracing or benching will be surveyed to ensure that they are on contour, • Direct seeding and/or planting will be undertaken to encourage vegetation growth to stabilise surfaces and aid the integration of landforms into the surrounding landscape. Seeding and/or planting will be undertaken prior to the wet season as soon as possible after earthworks using seed and plants native to Koolan Island, • Where necessary, fertilizer will be applied to offset the loss of nutrients and soil microbiota associated with loss of topsoil, and • Rehabilitation and closure procedures will include measures to address specific habitat types of listed fauna.
Mine Pits	As far as practicable, ensure the pit void and walls are structurally stable. Ensure public safety by restricting access to the remaining pit.	Geotechnical investigations will be undertaken to determine the structural integrity of the mine pit walls. An abandonment bund wall will be constructed around the perimeter of open pit voids greater than 5 m in depth. The bund wall will be constructed outside the area designated as being susceptible to wall collapse. The location and design of the abandonment bund will be in accordance with procedures detailed in "Safety Bund Walls around Abandoned Open Pit Mines". Hand seeding will be undertaken where access is available to improve long term stability, particularly in erosion material.
Seawall	To remove the seawall to below the low water level to reinstate the natural tidal movement of the area.	The removal of the seawall will be designed to minimise the impact to coastal habitats and allow for re-establishment of marine biota on disturbed areas.

Aspect	Objective(s)	Management Actions
Waste Dumps	To ensure that the profile of the waste rock dump final structure is safe, stable, blends into the surrounding landscape and not prone to erosion. The waste rock and slope gradients will be capable of withstanding the intense rainfall events of the wet season. A sufficient cover of vegetation will be established to minimise erosion resulting from the impact of severe rains on dry soils.	The waste dumps will require extensive earthworks and subsequent seeding and revegetation to ensure they are stable and blend into the surrounding landscaped. Waste Dumps will be designed to ensure that the profile of the final structure is safe, stable and not prone to erosion. Dumps will be designed so that after rehabilitation they blend into the surrounding landscape. Adequate drainage control will be implemented to ensure that erosion does not occur. Outslopes will be designed at less than 20 ° or lower if required for geotechnical reasons. The tops of the waste dumps will be designed to contain run-off so as not to cause erosion on the sides of the dumps. Dump surface will be covered with clean fill and if available, soil to a depth of 100 mm. Both the tops and the side of the waste dump will be contour ripped to encourage infiltration of rainfall. Waste dumps will be seeded or planted with local species.
Borrow Pits	To ensure that the profile of borrow pits final structure is safe, stable, blends into the surrounding landscape and not prone to erosion. A sufficient cover of vegetation will be established to minimise erosion resulting from the impact of severe rains on dry soils.	Borrow pits will be progressively rehabilitated as soon as possible following pit closure. The sides of the pits will be battered to a maximum slope of 20 °. If required, diversion drains and upslope windrows, will be utilized to divert surface water flow from entering the pit causing ponding and erosion. Pits will be rehabilitated as per the strategy detailed in Section 9 of the Closure Plan.
Dewatering	All infrastructure associated with dewatering is removed. Impact on the marine environment from dewatering operations is minimised.	All infrastructure associated with dewatering will be removed and disposed of appropriately.
Haulage & Ore handling	All infrastructure associated with haulage and ore handling is removed. Disturbed areas are reshaped to blend into the	All infrastructure associated with haul roads and ore handing will be removed. Haul roads, ROM pad and stockpile and other disturbed area will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.

Aspect	Objective(s)	Management Actions
	landscape and manage drainage and rehabilitated.	
Ore Processing	All infrastructure associated with ore processing is removed. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with ore processing will be removed. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Ship Loader	All infrastructure associated with ship loading is removed. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated. Disturbed marine areas recolonised by marine flora and fauna.	All infrastructure associated with the ship loader, including any structures in the ocean will be removed. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated. Marine areas will be left to naturally recolonise.
Wharf and Jetty	All infrastructure associated with wharf and jetty is removed unless wharf and jetty are left for use by local communities and shire.	All infrastructure associated with the wharf and jetty, including any structures in the ocean will be removed. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated. Marine areas will be left to naturally recolonise.
Power Station	All infrastructure associated with the power station is removed. The area is investigated to determine if any contamination is present and if so remediation strategies are developed and agreed with the DoE. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with power station will be removed. Once the infrastructure is removed an investigation for contamination will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.

Aspect	Objective(s)	Management Actions
Fuel & Bulk Storage Facilities	All infrastructure associated with fuel and bulk storage facilities is removed. Storage areas are investigated to determine if any contamination is present and if so remediation strategies are developed and agreed with the DoE. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with fuel and bulk storage facilities will be removed. Once the infrastructure is removed an investigation for contamination will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Workshops	All infrastructure associated with the workshop is removed. Workshop areas and the wash-down bay are investigated to determine if any contamination is present and if so remediation strategies are developed and agreed with the DoE. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with workshops will be removed. Once the infrastructure is removed an investigation for contamination will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Explosive Storage	All infrastructure associated with the explosive storage is removed. Explosive storage areas are investigated to determine if any contamination is present and if so remediation strategies are developed and agreed with the DoE.	All infrastructure associated with explosive storage will be removed. Once the infrastructure is removed an investigation for contamination will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.

Aspect	Objective(s)	Management Actions
	Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	
Landfill	All infrastructure associated with the landfill is removed. The site is compacted and stable. Landfill site is investigated to determine if any contamination of soil and groundwater present and if so remediation strategies are developed and agreed with the DoE. Landfill site is capped by a cover of low permeable material to a depth of 300 mm. Landfill area is reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with landfill site will be removed. Once the infrastructure is removed an investigation for contamination will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. DoE Karratha has advised that there is not a requirement to undertake testing for landfill gases. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Bioremediation Facility	All infrastructure associated with the Bioremediation Facility is removed. Bioremediation Facility is investigated to determine if any contamination of soil and if required groundwater, is present and if so remediation strategies are developed and agreed with the DoE. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	Closure of the bioremediation landfarm will not be undertaken until all areas where contamination may occur have been investigated and remediated to agreed levels with the DoE. On completion of bioremediation, the remediated soil will be removed and utilised in rehabilitation of disturbed area. Sampling of the natural ground surface beneath the bioremediation facility will be undertaken to determine if any contamination is present. Groundwater monitoring may be required if impacted material has leached into underlying soils and the potential exists for groundwater contamination. Once the bioremediation landfarm area has been investigated and any contamination remediated, infrastructure associated with bioremediation landfarm will be removed and the area reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.

Aspect	Objective(s)	Management Actions
Accommodation	If not required by another party, all infrastructure associated with the accommodation facility will be removed. Areas where sewerage and grey water were managed will be investigated to determine if any contamination of soil and if required groundwater, is present and if so remediation strategies are developed and agreed with the DoE. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with accommodation facility will be removed, if not required by another party. Once the infrastructure is removed an investigation for contamination in the areas where sewerage and grey water were managed will be undertaken. If soil or water contamination is identified a remediation plan will be developed and agreed with the DoE. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Administration Offices	If not required by another party, all infrastructure associated with the administration offices will be removed. Disturbed areas are reshaped to blend into the landscape and manage drainage and rehabilitated.	All infrastructure associated with administration offices will be removed, if not required by another party. There will be no storage or use of chemicals within the office areas and hence the site will not need to be investigated for contamination. Disturbed areas will be reshaped to ensure they blend into the surrounding landscape and to control rainfall run-off. Areas will then be rehabilitated.
Public Access and Safety Aspects	To ensure that disturbed areas are left stable and free of infrastructure and waste. To restrict access to areas that cannot be made safe through rehabilitative techniques.	Signs clearly stating the risk to public safety and prohibiting unauthorised public access will be erected around the site, particularly in areas near open pits. On cessation of mining all roads leading to the pits will be closed. Additional safety bunds will be constructed to minimise the potential risk to the public safety of inadvertent access to abandoned open pits.
Records Management and Reporting Schedules	To provide clear, detailed and comprehensive information on all aspects	Records of the history of the site following closure will be preserved to facilitate future land use planning. Reporting procedures will be established to ensure that results of all trials and actions including remediation works and monitoring are properly recorded, referenced, and available for long-term reference. Prior to

Aspect	Objective(s)	Management Actions
	of the mines operating and closure history.	relinquishment or surrender of tenure, records of the site development will be submitted to the Responsible Authority. The types of records required by the Responsible Authority will include the following: • Geological records, including drilling data; • Plans and surveys of surface facilities; • Mining and production records; • Locations, quantities and qualities of stored waste dumps; • Location, quantities and types of waste disposed in the landfill; • Site specific surveys or studies; and • Mine Closure Plan
Monitoring	To provide feedback on: • final landform stability; • marine environment recolonisation and water quality; • surface and groundwater quality; • public safety issues; and • rehabilitation and revegetation programs. • identify potential and actual impacts in order that remedial work can be implemented.	The implementation of a monitoring programme is crucial in recording the success or otherwise of the completion criteria, as well as validating agreed criteria for relinquishment (Chamber of Minerals and Energy, 1999). Monitoring will address the following areas: • Biological (flora and fauna); • Marine environment; • Surface and groundwater; • Public safety; and • Landform stability. In summary the monitoring proposed is as follows: • Annual assessment of rehabilitated areas to monitor the re-establishment of vegetation on all areas disturbed by mining activities i.e. waste dumps, stockpiles, pit walls, infrastructure area, haul and access roads etc, • Annual assessment of surface and groundwater quality to ensure water quality in disturbed areas is similar to that in undisturbed areas, • Once off assessment of the stability of final landforms by a suitable qualified engineer. Monitoring will then be undertaken as per the stability assessment recommendations,

Aspect	Objective(s)	Management Actions
		• Annual assessment of rehabilitated coastal habitats to monitor the re-establishment of marine biota and water quality in areas disturbed by the seawall and ship loader, • Assessment of identified aboriginal heritage site on closure of the sites to ensure they have not been disturbed, • Assessment of weeds and pests on closure of the site to identify if any new outbreaks have occurred due to Aztec's operations, • Assessment of flora and fauna on closure of the site to identify if any impacts have occurred due to Aztec's operations, and • Monitoring of all safety bunds, fencing and signage on an annual basis to ensure that all public safety aspects are adequately addressed. Monitoring will identify the need for remedial work at an early stage. Monitoring plans will be developed in consultation with the appropriate regulatory agency and will include agreed actions should monitoring identify issues that could lead to agreed completion criteria not being met. Monitoring will be undertaken by Aztec until the agreed completion criteria have been met.

APPENDIX B: DMIRS FEEDBACK ON MINE CLOSURE PLAN VERSION 4

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

APPENDIX C: COMPREHENSIVE GROUNDWATER QUALITY DATA

APPENDIX D- POTENTIALLY CONTAMINATED AREAS PRIOR TO KIO OCCUPATION

Identification No.	Identified Potential Source Area	Phase I		Phase II		
		Potential Issues Identified	Potential Contaminants	Test Pits Excavated	Scope of Soil Analyses	Materials encountered and analytical results above investigation levels
A	Old Tyre Tip	Disused tyres disposed of at the western most extent of the former mining activities. No access at present to the tip. Considered only an issue if tyres start to burn resulting in leachates containing sulphur compounds, PAHs, particulates and aromatic hydrocarbons. Burning of tyres has not occurred to date.	None expected unless on fire resulting in : • Sulphur compounds • PAHs • Aromatic hydrocarbons	• No access	• Not applicable	
B	Two Mullet Industrial Tips	No anecdotal information on contents of tips but expect it to be metals, wood, packaging and general engineering waste. Exact location unknown as general area is a large expanse of mining waste. Anecdotal reports indicate that any vehicles buried would have had lubricating oils removed prior to placement in landfill.	• Asbestos • TPH/BTEX • Metals • PAHs/Phenols • OC/OP Pesticides • Herbicides	• TP11 to TP18	• 1 No asbestos samples • 3 No TPH/BTEX • 3 No Metals	Excavated materials generally consisted of mining waste with occasional electrical cable and sheet metal • None
c	Marion Shovel	Buried shovel, which after it broke down was buried where it stood.	• TPH/BTEX	• TP19	• No samples were analysed as the shovel could not be located.	Excavated materials consisted of mining waste.
Di and Dii	Two Salvage Industrial Pit	Located just south of the former support area (oil storage, power station maintenance shed). Anecdotal information would imply disused and broken down vehicle (utes and haul trucks) present.	• TPH/BTEX • PAHs/Phenols • Metals	• Di -TP33. TP34 • Dii - TP35. TP36. TP65 to TP67	• 12 No TPH/BTEX • 4 No PAHs/Phenols • 4 No Metals	Mining waste with metal wire, sheet and car door debris, with: • TP36_0.4-0.5: TPH C15-C2s = 4,180 mg/kg • TP36_1.9-2.0: TPH C15-C2s = 2,590 mg/kg • TP36_2.9-3.0: TPH C15-C2s = 2,880 mg/kg • TP65_0.9-1.0: TPH C10-C14 = 590 mg!kg, TPH C15"" C2s = 7,620 mg/kg • TP65_5.9-6.0: TPH Cw-C" = 4.240 mgikg. TPH CwC2s= 21,200 mg/kg
E	Support Area	*Main Fuel storage Ei* - main petroleum hydrocarbon storage facility on site, in the order of 2 million litres of fuel oil, diesel and petrol. Fuel piped from shore facility up to support area, fuel then distributed via pipelines to powerhouse and mechanical workshop. No Spills known to have occurred.	• TPH/BTEX • PAHs/Phenols	• TP26 to TP31	• 8 No TPH/BTEX • 2 No PAHs/Phenols • 1 No Asbestos	Shallow bedrock with covering of mining waste containing metal sheet, wire and bars, and concrete, with: • TP28_0.0-0.1: Asbestos detected
		Power House Eii- Former electrical production facility for the island, with four 1000 gallon fuel oil ASTs. Facility is believed to have obtained a number of subsurface vaults which were only backfilled and not excavated and removed upon decommissioning. Dangerous Goods records illustrate tank bunding to be present but not effective as historical heavy TPH staining on bund walls and surrounding soils.	• TPH/BTEX • PAHs/Phenols • Asbestos (insulation) • Metals	• TP22 to TP25	• 8 No TPH/BTEX • 2 No PAHs/Phenols • 5 No Asbestos • 6 No Metals	Subsurface concrete vaults, but no impact identified except surface asbestos. • TP22_0.0-0.1: Asbestos detected • TP22_0.0-0.1_A: Asbestos detected • TP22_0.0-0.1-B: Asbestos detected • TP22_0.0-0.1-C: Asbestos detected • TP22 0.0-0.1 D: Asbestos detected
		Mechanical Workshop Eiii - Heavily engineered structure for the maintenance and repair of mining plant and general vehicles. Super- structure understood to have removed from the island upon decommissioning with reinforced concrete floor slab broken out and removed to Barramundi Pit. Facility consisted of an UST (size unknown) for collection of waste lubricating oils. From USTs waste oils piped to shore storage area for ultimate transportation off the island.	• TPH/BTEX • PAHs/Phenols • VOCs (chlorinated solvent degreases) • Metals	• TP20	• 6 No TPH/BTEX • 2 No PAHs/Phenols • 2 NoVOCs • 6 No Metals • 1 Asbestos	Mining waste over shallow bedrock. • None
				• TP68 to TP109	• 5 No TPH/BTEX • 5 No PAHs/Phenols • 5 No Metals	UST located with minimal diesel / lube oil impacts encountered: • TP93 1.0-1.1: TPH C10-C14 = 660 mg!kg, TPH C15"" C2s = 2,800 mg!kg, TPH c29-c36 = 180 mg!kg • TP102A 1.0-1.1: TPH c, c" = 230 mgikg. TPH CwC2s= 1,410 mg!kg, TPH C29-C36 = 610 mg/kg • TP102B 1.0-1.1: TPH c, c" = 910 mgikg. TPH CwC28 = 3,200 mg!kg, TPH C29-C36 = 460 mg/kg • TP102C 1.5-1.6: TPH Cw-C" = 580 mgikg. TPH CwC2s = 2,280 mg!kg, TPH C29-C36 = 530 mg/kg
		Stores Eiv- Understood to be used for the former storage of raw materials in dry and liquid (200 litre drum) form. No spills known to have occurred.	• TPH/BTEX • OP/OC Pesticides • Herbicides • Metals	• TP21	• 4 No TPH/BTEX • 4 No OP/OC Pesticides • 4 No Herbicides • 2 No Metals	Mining waste, with concrete, metals and plastic debris over shallow bedrock, with: • TP21-0.0-0.1: Asbestos detected • TP21_0.7-0.8_E: Dieldrin= 1.62 mg/kg
		Administration Building Ev - On the raised platform adjacent to other facilities. No issues identified as just office support activities. Building may have consisted of asbestos elements.	• Asbestos	• TP32	• 4 No Asbestos	Shallow bedrock, with: • TP32_0.0-0.1_A: Asbestos detected • TP32_0.0-0.1-B: Asbestos detected • TP32_0.0-0.1-C: Asbestos detected • TP32 0.0-0.1 D: Asbestos detected

F	Acacia Eastern Dumps	*Domestic Tip Fi* former historical domestic landfill facility. No access to tip presently available.	• TPH/BTEX • PAHs/Phenols • Metals • OP/OC Pesticides • Herbicides	• No access	• Not applicable	Should access become available in the future, than this area will require investigation.
		Industrial Tip Fii understood to have been utilised at the final stages of the mining and the decommissioning works. Anecdotal information would indicate that remnants of waste oil not removed from island was placed in 200 litre drums and buried into this tip.	• TPH/BTEX • Metals • PAH/Phenols • VOCs • OP/OC Pesticides • Herbicides	• No access	• Not applicable	Should access become available in the future, than this area will require investigation.
G	Wharf Side	*Wharf side petroleum hydrocarbon storage Gi* - five ASTs in total containing waste lube oil and recently delivered fuel oil and other petroleum hydrocarbons. Raw materials transferred to wharf side ASTs from near shore storage barge. July 1988 leakage of fuel occurred from ASTs. Estimated that 10 tonnes of fuel escaped with seepage through soil bunds into the marine environment.	• TPH/BTEX • PAH/Phenols • Metals	• TP03 to TP05	• 12 No TPH/BTEX • 4 No PAHs/Phenols • 2 No Metals	Mining waste over bedrock in places, with: • TP04_1.9-2.0_N: TPH Cw-C" = 1.560 mgikg. TPH CwC28 = 6,760mg/kg • TP04_2.9-3.0_N: TPH Cw-C"= 1.410 mgikg. TPH C15-C2s= 5,630mg/kg • TP04_5.9-6.0_N: TPH Cw-C" = 1.120 mgikg. TPH C15-C2s= 2,860mg/kg • TP05_0.4-0.5_N: TPH C 10-C14 = 600 mg!kg, TPH CwC2s = 3,190 mg/kg • TP05_0.9-1.0_N: TPH C 10-C14 = 560 mg!kg, TPH CwC2s = 3,060 mg/kg • TP05_1.9-2.0_A: TPH c, c" = 1.350 mgikg. TPH CwC2s = 4,240 mg/kg • TP05_1.9-2.0_B: TPH c, c" = 750 mgikg. TPH CwC2s= 2,310 mg/kg • TP05_1.9-2.0_N: TPH Cw-C" = 1.990 mgikg. TPH CwC2s = 6,390 mg/kg
		Ore Bin Petroleum Hydrocarbon Facilities Gii Adjacent to Ore Bin on level ground to east. Facilities consist of two ASTs, a filling station and transformer	• TPH/BTEX • PAH/Phenols • PCBs	• TP06	• 1 No TPH/BTEX	Predominantly mining waste. • None
H	Ore Bin	*Ore Bin Hi* - Located on the high ground adjacent to main pit. Bins believed to be approximately five storeys high. From the bins the ore travelled along a conveyor belt which passed through the natural rocks mass coming out at just above sea level adjacent to Wharf Side storage and then along shoreline conveyor to wharf. Anecdotal information indicates that majority of machinery removed from bins before being backfilled with rubble. No access to bins but may contain remnant lube oils and associated petroleum hydrocarbons.	• TPH/BTEX • PAHs/Phenols	• No access	• Not applicable	
		Ore Crusher Hii- adjacent to Ore Bins. Remnant petroleum hydrocarbons from machinery and single "filling station".	• TPH/BTEX • PAHs/Phenols	• TP07 and TP08	• 4 No TPH/BTEX • 2 No PAHs/Phenols	Mining waste over bedrock. • None
		Quarry Petroleum Hydrocarbon Storage Hiii Extent of facility unknown but historical Dangerous Goods records illustrate that at least two ASTs present with heavy staining at base of tanks and along pipework and associated structures	• TPH/BTEX • PAHs/Phenols	• TP09 and TP10	• 6 No TPH/BTEX • 2 No PAHs/Phenols	Mining waste over relatively shallow bedrock. • TP10_1.4-1.5_E: TPH C15-C2s = 1,010 mg/kg
I	Roche Area	*Industrial Tip Ii* - little information on this former tip, but given location expect waste was end tipped down coastal cliff. No access as shore line steeply inclined (>45°) and 20 to 30m high cliffs made up of mining waste.	• TPH/BTEX • PAHs/Phenols • OP/OC Pesticides • VOCs • Herbicides	• No access	• Not applicable	Observations from marine waters in December 2005 indicate that both Area Ii and Iii appear as undisturbed rock faces either side of a section of waste rock pushed over the cliff edge. There were no visual signs of general rubbish, metal infrastructure, vehicle parts or any major pieces of plant. There were also no visible signs of leachate / runoff from the undisturbed rock faces or the waste rock slide.
		P.H. Shovel & Drill Iii- shovel and drill abandoned after plant accidentally ran off access road down cliff face. No signs of plant at this present time as covered by mine waste. No access to location due to steeply inclined cliff sides of mining waste. Remnant lube oil potentially still present.	• TPH/BTEX • PAHs/Phenols	• No access	• Not applicable	
Ji and Jii	Buried Plant	*P & H Shovel Ji and Haultrack Jii* -plant buried where abandoned. Remnant lube oil potentially still present.	• TPH/BTEX • PAHs/Phenols	• TP01 (Ji) • TP02 (Jii)	• 2 No TPH/BTEX • 0 No PAHs/Phenols	Mining waste covering boom of shovel. • None

F	Acacia Eastern Dumps	*Domestic Tip Fi* former historical domestic landfill facility. No access to tip presently available.	• TPH/BTEX • PAHs/Phenols • Metals • OP/OC Pesticides • Herbicides	• No access	• Not applicable	Should access become available in the future, than this area will require investigation.
		Industrial Tip Fii understood to have been utilised at the final stages of the mining and the decommissioning works. Anecdotal information would indicate that remnants of waste oil not removed from island was placed in 200 litre drums and buried into this tip.	• TPH/BTEX • Metals • PAH/Phenols • VOCs • OP/OC Pesticides • Herbicides	• No access	• Not applicable	Should access become available in the future, than this area will require investigation.
G	Wharf Side	*Wharf side petroleum hydrocarbon storage Gi* - five ASTs in total containing waste lube oil and recently delivered fuel oil and other petroleum hydrocarbons. Raw materials transferred to wharf side ASTs from near shore storage barge. July 1988 leakage of fuel occurred from ASTs. Estimated that 10 tonnes of fuel escaped with seepage through soil bunds into the marine environment.	• TPH/BTEX • PAH/Phenols • Metals	• TP03 to TP05	• 12 No TPH/BTEX • 4 No PAHs/Phenols • 2 No Metals	Mining waste over bedrock in places, with: • TP04_1.9-2.0_N: TPH Cw-C" = 1.560 mgikg. TPH CwC28 = 6,760mg/kg • TP04_2.9-3.0_N: TPH Cw-C"= 1.410 mgikg. TPH C15-C2s= 5,630mg/kg • TP04_5.9-6.0_N: TPH Cw-C" = 1.120 mgikg. TPH C15-C2s= 2,860mg/kg • TP05_0.4-0.5_N: TPH C 10-C14 = 600 mg!kg, TPH CwC2s = 3,190 mg/kg • TP05_0.9-1.0_N: TPH C 10-C14 = 560 mg!kg, TPH CwC2s = 3,060 mg/kg • TP05_1.9-2.0_A: TPH c, c" = 1.350 mgikg. TPH CwC2s = 4,240 mg/kg • TP05_1.9-2.0_B: TPH c, c" = 750 mgikg. TPH CwC2s= 2,310 mg/kg • TP05_1.9-2.0_N: TPH Cw-C" = 1.990 mgikg. TPH CwC2s = 6,390 mg/kg
		Ore Bin Petroleum Hydrocarbon Facilities Gii Adjacent to Ore Bin on level ground to east. Facilities consist of two ASTs, a filling station and transformer	• TPH/BTEX • PAH/Phenols • PCBs	• TP06	• 1 No TPH/BTEX	Predominantly mining waste. • None
H	Ore Bin	*Ore Bin Hi* - Located on the high ground adjacent to main pit. Bins believed to be approximately five storeys high. From the bins the ore travelled along a conveyor belt which passed through the natural rocks mass coming out at just above sea level adjacent to Wharf Side storage and then along shoreline conveyor to wharf. Anecdotal information indicates that majority of machinery removed from bins before being backfilled with rubble. No access to bins but may contain remnant lube oils and associated petroleum hydrocarbons.	• TPH/BTEX • PAHs/Phenols	• No access	• Not applicable	
		Ore Crusher Hii- adjacent to Ore Bins. Remnant petroleum hydrocarbons from machinery and single "filling station".	• TPH/BTEX • PAHs/Phenols	• TP07 and TP08	• 4 No TPH/BTEX • 2 No PAHs/Phenols	Mining waste over bedrock. • None
		Quarry Petroleum Hydrocarbon Storage Hiii Extent of facility unknown but historical Dangerous Goods records illustrate that at least two ASTs present with heavy staining at base of tanks and along pipework and associated structures	• TPH/BTEX • PAHs/Phenols	• TP09 and TP10	• 6 No TPH/BTEX • 2 No PAHs/Phenols	Mining waste over relatively shallow bedrock. • TP10_1.4-1.5_E: TPH C15-C2s = 1,010 mg/kg
I	Roche Area	*Industrial Tip Ii* - little information on this former tip, but given location expect waste was end tipped down coastal cliff. No access as shore line steeply inclined (>45°) and 20 to 30m high cliffs made up of mining waste.	• TPH/BTEX • PAHs/Phenols • OP/OC Pesticides • VOCs • Herbicides	• No access	• Not applicable	Observations from marine waters in December 2005 indicate that both Area Ii and Iii appear as undisturbed rock faces either side of a section of waste rock pushed over the cliff edge. There were no visual signs of general rubbish, metal infrastructure, vehicle parts or any major pieces of plant. There were also no visible signs of leachate / runoff from the undisturbed rock faces or the waste rock slide.
		P.H. Shovel & Drill Iii- shovel and drill abandoned after plant accidentally ran off access road down cliff face. No signs of plant at this present time as covered by mine waste. No access to location due to steeply inclined cliff sides of mining waste. Remnant lube oil potentially still present.	• TPH/BTEX • PAHs/Phenols	• No access	• Not applicable	
Ji and Jii	Buried Plant	*P & H Shovel Ji and Haultrack Jii* -plant buried where abandoned. Remnant lube oil potentially still present.	• TPH/BTEX • PAHs/Phenols	• TP01 (Ji) • TP02 (Jii)	• 2 No TPH/BTEX • 0 No PAHs/Phenols	Mining waste covering boom of shovel. • None

K	HWE Barramundi Domestic Tip	Two years of domestic waste from HWE's final years of mining and decommissioning works. No visual signs of tip having been covered by sediments from wet season floods	Metals • TPH/BTEX • OP/OC Pesticides • Herbicides • VOCs • PAHs/Phenols	TP41 to TP52	6 No Metals • 6 No TPH/BTEX • 2 No OP/OC Pesticides • 2 No Herbicides • 2 NoVOCs • 2 No PAHs/Phenols	Sediments containing domestic waste, plastics and metals. • None
L	Barramundi Industrial Tip	Anecdotal information indicates majority of decommissioning wastes deposited in this landfill. This included 26 of the approximately 160 former houses, believed to be made out of asbestos cement board. Tip also includes other infrastructure like former conveyor belt structures	Asbestos • Metals • TPH/BTEX • PAH/Phenols • OP/OC Pesticides • VOCs • Herbicides	TP53 to TP58 TP63 and TP64	2 No Asbestos 6 No Metals • 8 No TPH/BTEX • 2 No PAHs/Phenols • 3 No OC/OP Pesticides • 2 NoVOCs • 2 No Herbicides	Mining waste including large quantity of large scale decommissioning waste, along with metals sheet and cables, tyres and other machine parts, with: • TP54_2.9-3.0: TPH C15-C2s = 2,240 mg/kg • TP58_3.9-4.0: TPH CwC2s = 1,250 mg!kg, chromium = 429 mg!kg, copper= 338 mg!kg, zinc = 356 mg/kg • TP64 4.4-4.5: Asbestos detected
M	Eastern Industrial Tip	Industrial waste deposited and pushed down the valley. Observation would indicate that waste consists as a minimum of metal sheet, wood, general packaging.	Metals • TPH • PAH/Phenols • OP/OC Pesticides • VOCs • Herbicides	TP59 to TP62 Water sample M1/M2	6 No Metals • 8 No TPH/BTEX • 2 No PAHs/Phenols • 3 No OC/OP Pesticides • 2 NoVOCs • 2 No Herbicides • 1 No Asbestos	Mining waste with plastic and metal debris. Extent of waste observed to be about one third of the way down the valley, with: • TP61_0.4-0.5: Asbestos detected M1/M2 with: • Barium 0.034 mg/1, • copper= 0.001 mg/1, • manganese 0.004 mg/1
N	Eastern Domestic Tip	Domestic waste end tipped over cliff face. Anecdotal information also • indicates that incinerator located at the top of the cliff and used to formerly burn waste with ash discharge over cliff slopes.	Metals TPH PAH/Phenols OP/OC Pesticides VOCs Herbicides	Water sample N1/N2	1 No Metals • 1 No TPH • 1 No PAHs/Phenols • 1 No OC/OP Pesticides • 1 NoVOCs • 1 No Herbicides	Landfill deposits consisted of a large quantity of rusty cans, refrigerator compressors and metal sheet and bars. N1/N2 with: • Barium 0.023 mg/1, • copper= 0.003 mg/1, • manganese 0.002 mg/
O	Airstrip	Airstrip still present and operational. Waste oil and water mixture historically sprayed on soil surface to compact and reduce dust emissions. Aviation jet fuel formerly, stored in bunding at helipad, historical photos do not indicate signs of spillage	TPH/BTEX • PAHs/Phenols metals	TP 37 - TP40 Surface samples AIR 1 to AIR 6	4 No TPH/BTEX • 2 No PAHs/Phenols 6 No TPH 6 No metals	Compacted soil, with: • TP40 0.0-0.1: TPH C15""C2s = 3,460 mg/kg Compacted soil, with: • AIR1: TPH C10-C14 = 70 mg!kg, TPH C15""C2s = 8,190 mg!kg, TPH C2sr-C36 = 17,300 mg/kg • AIR2: TPH C15""C2s = 1,820 mg!kg, TPH C29-C35 = 3,780 mg!kg, chromium= 52 mg!kg • AIR3: TPH C15""C2s = 2,990 mg!kg, TPH C29-C35 = 6,200 mg!kg, chromium= 50 mg!kg • AIR4: TPH C10-C14 = 50 mg!kg, TPH C15""C2s = 2,440 mg!kg, TPH C2sr-C36 = 4,750 mg/kg • AIRS: TPH C15""C2s = 2,970 mg!kg, TPH C29-C36 = 5,340 mg/kg • AIRS: TPH C15""C2s = 5,620 mg!kg, TPH C29-C35 = 11,700 mg/kg • Background Soil: chromium= 66 mg/kg
p	Township	Township formerly consisted of about 160 houses, many which were removed from the island, with about 26 believed to have been demolished and deposited in Barramundi Industrial Tip. Historical Dangerous Goods records show township contained a number of ASTs which were poorly contained and managed, resulting in discharges to ground. ASTs known to be present at three locations, the mess, the 'town' tank and the standby generator, all believed to contain diesel. Other asbestos features e.g. fencing, boarding, pipework etc. believed to be present, and understood to have been removed and deposited in Barramundi Industrial Tip. Town sewage treated resulting in sludge which was discharged to sea. Anecdotal information indicated that all sewage and underground structures excavated and removed.	• Asbestos • TPH/BTEX • PAHs/Phenols • Nutrients • OC/OP Pesticides • Herbicides	• Access poor with locations of three relatively small ASTs unknown.	• Not applicable	Outside Aztec Resources' mining lease and therefore not to be considered by these works.
Q	Boat Club	Each individual boat owner had their own locked 200 litre fuel drum. Drums not stored in secondary containment.	• TPH/BTEX • PAHs/Phenols	• No access	• Not applicable	Ramp eroded away with no visual signs of petroleum hydrocarbon impact. Outside Aztec Resources' mining lease and therefore not to be considered by these works.

APPENDIX E: CLOSURE RISK ASSESSMENT

Table E 1: Closure Risk Assessment

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
All of mine	Storage, stockpiling, or use of mineral materials	Non-benign materials exposed to air and water	Acid and metalliferous drainage	Possible	Moderate	Moderate	Regular sulfur assays of ore and mineral waste materials	Rare	Moderate	Low
	Revegetation	Insufficient supply of suitable growth media	Loss of ecosystem functioning Loss of fauna habitat Erosion and instability of landform surfaces Reduced amenity	Likely	Minor	Moderate	Stockpiling topsoil Maintain materials balance Revegetation trials Surface treatment trials Rehabilitation monitoring	Possible	Minor	Moderate
		Erosion of growth media prior to establishment of revegetation		Likely	Minor	Moderate		Possible	Minor	Moderate
		Insufficient seed supply		Possible	Minor	Moderate	Shade house trials to identify revegetation seed mix tailored to landform conditions Seed collection program Identification of alternative seed supplies (e.g. Buccaneer Archipelago, Dampier Peninsula) Progressive rehabilitation Manual reseeding by hand	Unlikely	Minor	Low
		Loss of topsoil seed viability		Possible	Minor	Moderate		Unlikely	Minor	Low
		Loss of stored seed viability		Likely	Minor	Moderate	Progressive seed collection Climate controlled seed storage	Unlikely	Minor	Low
		Weed invasion		Likely	Minor	Moderate	Annual weed monitoring Weed management program	Possible	Minor	Moderate
		Compaction of growth media		Likely	Minor	Moderate	Ripping growth media on contour prior to revegetation	Unlikely	Minor	Low
		Bushfire		Possible	Minor	Moderate	Maintain firebreaks Emergency response procedures	Unlikely	Minor	Low
	Weed control	Weeds further infest disturbed and / or rehabilitated areas	Revegetation failure Reduced amenity	Likely	Moderate	High	Minimise restriction of surface water flows Treatment weed infested topsoil stockpiles prior to spreading Vehicle hygiene Biological agent (if development completed and assessed as suitable)	Unlikely	Minor	Low
	Chemical storage and use	Spill of fuel or other bulk chemicals	Soil contamination	Almost certain	Minor	High	Contamination assessment Remediate soil in accordance with contamination management plan	Unlikely	Insignificant	Low
		Contaminated runoff from workshop due to inappropriate drainage		Almost certain	Minor	High		Unlikely	Insignificant	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		Spill of fuel or other bulk chemicals	Groundwater contamination	Unlikely	Moderate	Moderate	Groundwater monitoring program Groundwater contamination investigation if soil impacts identified at depth Remediate groundwater in accordance with contamination management plan	Rare	Minor	Low
		Contaminated runoff from workshop due to inappropriate drainage		Unlikely	Moderate	Moderate		Rare	Minor	Low
Open pits	Wall stability	Wall collapses into open pit	Injury or death	Unlikely	Severe	Moderate	Abandonment bunds restrict access to pits Abandonment bund strategy approved by DMIRS Resource Safety Branch Engineered barrier across Main Pit 'lake' marked by buoys and / or dolphins delineates 'No Go Zone', restricting vessel access to section at risk of rock fall.	Rare	Severe	Moderate
		Abandonment bund collapses into pit		Unlikely	Severe	Moderate		Rare	Severe	Moderate
	Main Pit 'lake'	Tidal Fluctuation of Pit Water Levels	Erosion of Main Pit walls	Possible	Moderate	Moderate	Geotechnical analysis of rising groundwater and fluctuating sea water levels pit wall stability prior to closure.	Possible	Moderate	Moderate
		Seawater intrusion into aquifers	Increased salinity of southern syncline groundwater	Rare	Moderate	Low	N / A	Rare	Moderate	Low
	Surface water management	Pit Wall Instability due to uncontrolled runoff into Main Pit	Erosion of Main Pit foot wall	Possible	Minor	Moderate	Monitor Main Pit footwall gullies as part of post-closure geotechnical monitoring programme.	Possible	Minor	Moderate
		Ponding of Water against abandonment	Scouring of Abandonment Bunds	Possible	Moderate	Moderate	Surface flow analysis and floodplain mapping may be undertaken following establishment of the abandonment bund location. Reshape land surface to divert water away from Main Pit abandonment bund if required Construct quartzite channels through abandonment bunds to direct flows from catchments adjacent to Main Pit.	Unlikely	Moderate	Moderate
	Pit voids	Open pits visible	Reduced visual amenity	Almost certain	Minor	High	Flood Main Pit	Almost certain	Insignificant	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Waste rock landforms	Engineered landform slope stability	Landforms erode, slump and / or collapse	Erosion of landform slopes Revegetation failure	Possible	Major	High	Geotechnical modelling to determine stability of the batter slopes under various rainfall and water content scenarios (SWC, 2014e). Modelling indicates berm overtopping unlikely Upper WRL surfaces sloped inwards Correct use of waste rock material when completing outer surfaces Batters at < 20°. Barramundi and East Pit backfill batters separated by (≈ 5 – 10 m) berms. Batters constructed competent coarse waste rock (e.g. quartzite) Berms have upper layer of growth material sourced from mined siltstone Surface treatment trials	Unlikely	Moderate	Moderate
		Uncontrolled Surface Water Flow	Tunnelling and sinkhole development on berms	Possible	Moderate	Moderate	Depth of focused siltstone placement is not deep enough with respect to the overall lift height to affect berm stability, as material below the upper portion of the berm will consist of waste rock material with much reduced potential for tunnelling development	Unlikely	Moderate	Moderate
		Excessive sediment loss and deposition into the marine environment	Decreased marine water and benthic habitat quality	Possible	Moderate	Moderate	Surface flow analysis on the design and ‘as-built’ Mullet Backfill land surfaces Void volume of 280,000 m^3 Marine Monitoring Program	Unlikely	Moderate	Moderate
	Abandonment bunds	Collapse of Abandonment Bunds into Pit Voids	Unrestricted access to landforms	Possible	Minor	Moderate	Abandonment bunds will be located at least 10 m outside the potentially unstable pit edge zone KIO is consulting with the DMIRS Resources Safety Division to determine a suitable abandonment bund strategy. Abandonment bunds will be constructed using competent (fresh) rock to a height of 2 m and a base of 6 m wide Abandonment bunds will not collapse into the backfilled Barramundi pit as the void will be filled completely.	Unlikely	Minor	Low
			Scouring of Abandonment Bunds by Ponding of Water against Bunds	Possible	Minor	Moderate	Positioning the bunds at high points to avoid surface run-off Surface flow analysis and mapping may be undertaken to determine if surface water is expected to pond against Abandonment Bunds. In areas where ponding is identified, the land surface or abandonment bund placement will be reviewed to divert water away from the bund.	Unlikely	Minor	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	Landform design	Visual amenity of the WRLs is not congruent with the surrounding land surface	Reduced visual amenity	Likely	Moderate	High	Mullet Pit landform face in line with natural fall of the pit crest Barramundi and East Pit landform faces follow local slopes or existing WRL forms to integrate with surrounding surfaces. Batter heights and berm widths are likely to vary across the surface of the backfilled pits for a more natural appearance. Backfilled pits have the potential to support a woodland ecosystem that will improve the visual amenity values of the rehabilitated areas for visitors to the Island. Location and outer surface design of WRLs designed to integrate with the surrounding landscape. Revegetation species specifically matched to the capabilities of the soil profile Monitoring of surface treatment trials and progressively rehabilitated areas	Unlikely	Moderate	Moderate
	Landform construction	Outer surface of WRLs not constructed according to the design	Erosion of landform slopes Revegetation failure Tunnelling and sinkhole development on berms Decreased marine water and benthic habitat quality Reduced visual amenity	Possible	Major	High	Monitoring of rehabilitated land surfaces against design specifications Inspection of completed landform surface waste rock material types by site environment personnel Actions taken where necessary to rectify any non-compliances.	Unlikely	Major	Moderate
		Operational complexity to reconstruct the surface soil profile	Landform doesn't adequately balance surface stability and growth requirements of the revegetation	Possible	Moderate	Moderate	Discussions with earthmoving operators will be undertaken prior to construction and shaping of the outer surface of the waste dump so that all personnel are aware of the need for adhering to the designs.	Unlikely	Moderate	Moderate
		WD1 spur may expand beyond approved disturbance and tenement boundaries if battered to 20°.	Direct impact on flora and vegetation Unapproved disturbance (regulatory non-conformance)	Likely	Minor	Moderate	Concave surface directs surface water away from outer batters, mitigating the potential for erosion and avoiding surface runoff to the outer batters Appropriate use of dozers and / or other plant and equipment to reshape the constructed landform (i.e. cutting and filling) within tenement and approved disturbance boundaries.	Unlikely	Minor	Low
Infrastructure (beneficial post-closure use)	Chemical storage and use	Spill of fuel or other bulk chemicals	Soil contamination	Possible	Moderate	Moderate	Contamination assessment Remediate soil in accordance with contamination management plan	Unlikely	Insignificant	Low
			Groundwater contamination	Rare	Moderate	Low	Groundwater monitoring program Groundwater contamination investigation if soil impacts identified at depth Remediate groundwater in accordance with contamination management plan	Rare	Minor	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Infrastructure (to be rehabilitated)	Rehabilitated and reshaped land surfaces	Uncontrolled surface water flow Ponding of rainfall on compacted clay liner underlying bioremediation facility Ponding on the Concrete Pad underlying the Processing Plant	Scouring and erosion of landform surfaces Revegetation failure Excessive Erosion and Gullying Tunnelling and Sinkhole Development	Possible	Low	Moderate	Removal of above ground infrastructure to ground level Reshaping of disturbance areas A surface water flow analysis for all rehabilitated and reshaped land surfaces Clay liner punctured in several locations Compacted surfaces ripped to ≈ 800 mm Compacted clay liner underlying bioremediation facilities will be left in place, the facilities filled in, and land surfaces reshaped according to the surface water flow analysis.	Unlikely	Minor	Low
	Chemical storage and use	Spill of fuel or other bulk chemicals	Soil contamination	Possible	Moderate	Moderate	Contaminated sites assessment at bioremediation facilities, processing plant, ore stockpile area, power plant and dewatering sites following decommissioning. Remediate soil in accordance with contamination management plan	Unlikely	Minor	Low
			Groundwater Contamination	Rare	Moderate	Low	Groundwater monitoring program Groundwater contamination investigation if soil impacts identified at depth Remediate groundwater in accordance with contamination management plan	Rare	Minor	Low
	Landform construction	Rehabilitated land surface not constructed according to the design	Revegetation failure Weed infestation Erosion of landform slopes Reduced visual amenity	Possible	Minor	Moderate	Monitoring of rehabilitated land surfaces against design specifications Inspection of completed landform surface waste rock material types by site environment personnel Actions taken where necessary to rectify any non-compliances	Unlikely	Minor	Low
		Soil conditions inadequate for re-establishment and growth of vegetation		Possible	Moderate	Moderate	Removal of all above ground infrastructure to ground level and reshaping of the disturbance areas. Natural disturbance surfaces deep ripped to ≈ 800 mm Concrete pads underlying processing plant and logistical support areas will be left in place or fragmented, depending on machinery capabilities, and covered with stable soil to sufficient depth for revegetation. Rehabilitated pads and processing plant area seeded with the revegetation species mix	Unlikely	Moderate	Moderate
Infrastructure – Ore stockpile area and processing plant	Rehabilitated and reshaped land surfaces	Slumping and collapse of the batter walls	Erosion of landform slopes Revegetation failure Excessive Erosion and Gullying Tunnelling and Sinkhole Development	Rare	Moderate	Low	OSA constructed primarily from competent, fresh, stable, non-erosive, waste rock to support heavy mine vehicles Competent nature of OSA rock will limit the extent and severity of erosion and gullying. Tunnelling and sinkhole development unlikely to occur due to engineered competent nature of the structure.	Rare	Moderate	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	Rehabilitated and reshaped land surfaces	Uncontrolled surface flows and / Ponding of rainfall on compacted clay liner underlying OSA	Scouring and erosion of rehabilitated areas Sediment loss into surrounding environment	Possible	Minor	Moderate	Competent, permeable waste rock used to construct the pads Deep ripping of upper surface, perimeter bunding around the edge and shaping upper surface into a concave shape	Unlikely	Minor	Low
	Landform construction	Rehabilitated land surface not constructed according to the design	Revegetation failure Weed infestation Erosion of landform slopes Reduced visual amenity	Possible	Minor	Moderate	Monitoring of rehabilitated land surfaces against design specifications Inspection of completed landform surface waste rock material types by site environment personnel Actions taken where necessary to rectify any non-compliances	Unlikely	Minor	Low
Infrastructure - Landfill	Rehabilitated and reshaped land surfaces	Uncontrolled surface water flow	Scouring and erosion of rehabilitated areas Erosion of landform surfaces Revegetation failure Excessive Erosion and Gullying Sediment loss into surrounding environment Tunnelling and Sinkhole Development	Possible	Moderate	Moderate	Removal of above ground infrastructure to ground level Compacted soil cap profiled to direct surface flows away from the landfill Surface water flow over the cap will be analysed to ensure it is constructed as designed to direct surface water flows away from the landfill cells. Marine monitoring program	Unlikely	Moderate	Moderate
		Landfill inadequately drains or consolidates before the deposition of new (fresh) material.		Possible	Minor	Moderate	All layers will be compacted prior to deposition of new material to reduce the risk of this occurring.	Unlikely	Minor	Low
	Landform construction	Soil Conditions are Inadequate for Re-establishment and Growth of Vegetation	Revegetation failure Weed infestation Erosion of landform slopes Reduced visual amenity	Possible	Moderate	Moderate	Cap comprised of ≤ 1 m compacted clean clay fill, overlain by ≤ 150 mm locally sourced topsoil Topsoil manually seeded with local provenance seed mix Ongoing monitoring of progressive rehabilitation	Unlikely	Moderate	Moderate
	Waste disposal to landfill	Leaching of contaminants into Soil or Groundwater	Soil contamination	Possible	Moderate	Moderate	The landfill has been constructed and managed as a Class II landfill in accordance with Licence (L8148/2006/4)	Unlikely	Moderate	Moderate
			Groundwater Contamination	Rare	Moderate	Low	Groundwater monitoring program will continue post-mine closure	Rare	Moderate	Low
Infrastructure - Seawall	Seawall construction	Scouring and erosion of engineered seawall section	Displacement of engineered seawall rocks fines Reshaping of engineered seawall	Almost certain	Minor	Low	The slope of the upper seawall section slope is steeper than the seawall toe, the upper section and toe being separated by a berm. The lower portion of the seawall is likely to be relatively stable, while the upper section will predictably continue to erode until a stable profile is reached	Almost certain	Minor	Low

Domain	Aspect	Hazard	Impact	Inherent Risk			Risk Treatment	Residual Risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		Uncontrolled and excessive rock and sediment loss into surrounding environment	Reduced marine water quality (increased turbidity) Reduced benthic habitat quality (sedimentation) Reduced benthic ecosystem functioning (reduced coral cover)	Almost certain	Moderate	High	Coral Rehabilitation Plan Once a stable seawall profile has developed, rock deposited from the seawall will form a new sea bed surface. As the rate of seawall erosion equilibrates with the local natural rate, so too will turbidity levels and sedimentation rates, which are functions of erosion. The return to natural conditions will allow benthic species to establish on the new sea floor. Regeneration will continue to be monitored in accordance with the marine monitoring plan	Almost certain	Insignificant	Low
	Constructing decommissioning cut	Decommissioning cut impacts marine environment	Reduced marine water quality (increased turbidity) Reduced benthic habitat quality (sedimentation) Reduced benthic ecosystem functioning (reduced coral cover)	Possible	Moderate	Moderate	Coral Rehabilitation Plan Marine monitoring program in accordance with the approved marine management plan (Marine management plan will be updated prior to closure to incorporate post-closure triennial monitoring of the existing marine monitoring sites	Unlikely	Moderate	Moderate
		Decommissioning cut not constructed according to the design	Marine ecosystem fails to establish in Main Pit lake	Possible	Moderate	Moderate	Monitoring program implemented to ensure decommissioning cut is constructed in accordance with design specifications Inspection of completed cut by site environment personnel to ensure that it is located and oriented correctly, utilising the correct material types Actions taken where necessary to rectify any non-compliances.	Unlikely	Moderate	Moderate
	Main Pit re-inundation	Main Pit 'Lake' Water Quality Unsuitable for Environmental Values		Possible	Moderate	Moderate	Hydrodynamic modelling of decommissioning cut configurations indicates complete mixing of upper layer in 12 – 14 days with preferred single cut Construction of a second cut to be investigated if future pit lake use includes aquaculture or other activities Marine management plan will be updated prior to closure to incorporate post-closure triennial monitoring of the Main Pit lake marine environment Where monitoring indicates the potential for adverse effects, remedial measures will be implemented	Unlikely	Moderate	Moderate

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