Rio Tinto Iron Ore

Yandicoogina closure study report

July 2011

Armoured rock chutes for drainage erosion management: a potential feature of Yandicoogina landform designs

Corporate closure planning statement

Rio Tinto Iron Ore (RTIO) considers closure planning to be an integral part of its business. The process of preparing for closure begins in the early stages of project development, and continues throughout the life of the mine.

A team of in-house rehabilitation and closure planning specialists has been established to manage this aspect of our operations. A Rehabilitation and Closure Working Group has been established to facilitate integration of closure planning into the broader mine planning framework, and to oversee the research and improvement projects recommended in each closure study. In this way, RTIO aims to continually improve both its understanding of closure risks, and the strategies employed to mitigate them.

This report documents the current closure knowledge base for Yandicoogina. It outlines the objectives that need to be met at closure, and the strategies and plans to be employed to achieve this.

However; this is not a static document. RTIO will continue to revisit its closure plans on a regular basis to ensure that the objectives to which it is working towards remain relevant and aligned to stakeholder expectations, and to revise its strategies and plans where appropriate to achieve improved closure outcomes.

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

Allan Jackson

General Manager, Climate Change Water and Environment

Mine closure plan checklist[1]

Q. No.	Mine Closure Plan Checklist	Yes/No	Page No.	Comments
1	Has the mine closure plan been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist.)	Y	i	
2	How many copies were submitted to DMP? (Section 1 for requirements)	Hard Copies = Electric Copies =		*N/A* *This document has been prepared to support the EPA environmental impact assessment process*
	Cover Page and Summary	Y	cover	
3	Does the cover page include, Project title Company name Contact details (includes telephone numbers and email addresses) Document ID number and version number Date of submission (needs to match the date of this checklist)	N	-	*N/A* *This document has been prepared to support the EPA environmental impact assessment process*
4	Has a Table of contents been provided?	Y	v - vi	
	Scope and Project Summary	Y	1-4	
5	Why is the MCP submitted? (as part of a Mining Proposal or a reviewed MCP or to fulfil other legal requirements)	Y	15	
6	Does the project summary include, Land ownership details, Location of the project, Comprehensive site plan(s), Background information on the history and status of the project.	Y	15, 19	*Does not include land ownership details.*
	Legal Obligations and Commitments			
7	Has a consolidated summary or register of closure obligations and commitments been included?	Y	26	
	D**ata Collection and Analysis**			
8	Has information relevant to mine closure been collected for each domain or feature (including pre-mining baseline studies, environmental and other data)?	Y	30	
9	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?	Y	101	

[1] Consistent with the Department of Mines and Petroleum (DMP) *Guidelines for Preparing Mine Closure Plans* (June 2011)

Q. No.	Mine Closure Plan Checklist	Yes/No	Page No.	Comments
	Stakeholder Consultation			
10	Have all stakeholders involved in Closure been identified?	Y	53	
11	Has a summary or register of stakeholder consultation been provided, with details as to who has been consulted and the outcomes of any consultation?	Y	63	
	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	66	
13	Does the MCP identify all potential (or pre-existing) environmental legacies, which may restrict the post mining land use (including contaminated sites)?	N/A		
	Identification and Management of Closure Issues			
14	Does the MCP identify all potential issues impacting mine closure objectives and outcomes?	Y	72	
15	Does the MCP include proposed management or mitigation options to deal with these issues?	Y	76	
16	Have the process, methodology, and rationale been provided to justify identification and management of the issues?	Y	76	
	Closure Criteria			
17	Does the MCP include a set of specific closure criteria and/closure performance indicators?	N		*Has included closure objectives but not criteria and performance indicators. Indicative criteria are under development*
	Closure Financial Provision			
18	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	101	
19	Does the MCP include a process for regular review of the financial provision?	Y	98	
	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	100	
21	Does the MCP include a closure work program for each domain or feature?	N/A		*Not appropriate at this early stage of mine closure planning.*
22	Have site layout plans been provided to clearly show each type of disturbance?	Y		*Site plans show plan views of above and below ground disturbances*
23	Does the MCP contain a schedule of research and trial activities?	Y	101	
24	Does the MCP contain a schedule of progressive rehabilitation activities?	Y	101	*Schedule is not dated.*

Q. No.	Mine Closure Plan Checklist	Yes/No	Page No.	Comments
24	Does the MCP include details of how unexpected closure (including care and maintenance) will be handled?	N	103	
26	Does the MCP contain a schedule of decommissioning activities?	N		*Commitment given to progressive decommissioning and rehabilitation as infra-structure becomes redundant at end of mine life*
27	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	101	
	Closure Monitoring and Maintenance			
28	Does the MCP contain a framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance?	N		*As closure design becomes finalised a framework will be developed within which to assess closure performance during life-of-mine and beyond*
	Closure Information and Data Management			
29	Does the mine closure plan contain a description of management strategies including systems, processes for the retention of mine records?	N		*Records are maintained on Rio Tinto corporate databases that operate independently of the mine site, and that will not be impacted by site closure.*

Contents page

1 OVERVIEW 1

2 SCOPE 1

2.1 What is a closure study 1

2.2 The closure planning process 2

2.3 Inclusions and exclusions 2

2.4 Past and future closure planning for the site 2

3 PURPOSE 4

4 PROJECT SUMMARY 5

4.1 Location 5

4.2 Adjacent mine sites 8

4.2.1 BHP Billiton Yandi (Marillana Creek) mine 8

4.2.2 Iron Ore Holdings proposed Phil's Creek mine 8

4.2.3 Brockman Iron's proposed Marillana Iron Ore project 8

5 DESCRIPTION OF OPERATIONS 8

5.1 Deposits 8

5.2 Current mine layout 8

6 LEASES APPLICABLE TO YANDICOOGINA 12

7 LEGISLATIVE FRAMEWORK 15

7.1 State agreement legislation 15

7.2 Ministerial statements 16

7.3 Mining proposals 16

7.4 Specific legal obligations 17

7.4.1 Decommissioning 17

7.4.2 Rehabilitation 17

7.5 Indigenous communities 19

7.6 Corporate closure planning requirements 19

8 CLIMATE 20

8.1 Weather station 20

8.2 Rainfall 20

8.3 Temperature 23

9 CLIMATE CHANGE PROJECTIONS 23

10 NATURAL LANDSCAPE 24

11 SITE GEOLOGY AND MATERIAL CHARACTERISTICS 26

11.1 General geological description 27

12 MATERIAL CHARACTERISTICS 27

12.1 Potential geochemical hazards 27

12.2 Material characterisation 28

12.3 Mineral Waste Risk Assessment – Acid and Metalliferous (AMD) Drainage Potential 28

13 HYDROLOGY 29

13.1 Completed studies 29

13.2 Baseline water systems 29

13.3 Pre-mining hydrogeology 30

13.4 Groundwater chemistry 32

13.5 Pre-mining surface hydrology 33

13.6 Ground and surface water interactions 34

13.7 Environmental and social values 34

13.7.1 Environmental values of water 34

13.7.2 Social values of water 35

13.7.3 The effect of mining on water systems 36

14 BIODIVERSITY 37

14.1 Completed studies 37

14.2 Flora 37

14.2.1 Baseline vegetation communities 37

14.2.2 Rare and priority flora 39

14.3 Fauna 41

14.3.1 Fauna habitats 41

14.3.2 Rare and priority fauna 42

14.4 Stygofauna and troglofauna 46

14.5 Biodiversity values 47

15 CONTAMINATED SITES 48

16 HERITAGE VALUES 49

17 STAKEHOLDER CONSULTATION 49

17.1 Profile of local community 49

17.1.1 Regional towns 49

17.1.2 Workforce 50

17.2 Relevant Aboriginal groups 50

17.3 Ethnographic values 53

17.4 Archaeological sites 53

17.5 Non-Indigenous cultural heritage values 53

17.6 Communication register 53

18 YANDICOOGINA CLOSURE OBJECTIVES 57

18.1 Description of objectives that apply to all RTIO sites 57

18.1.1 Cultural heritage values 57

18.1.2 Impacts to local communities 58

18.1.3 Completion criteria 58

18.1.4 Safe, stable and compatible landforms 58

18.1.5 Appropriate environmental outcomes 58

18.1.6 Workforce management 59

18.1.7 Cost effective closure implementation 59

18.2 Description of Yandicoogina specific objectives 60

18.2.1 Pit water quality 60

18.2.2 Fortescue Marsh 60

18.2.3 Compatibility with BHPBIO Yandi closure strategies 61

18.2.4 Erosion management 61

19 PROCESS FOR SELECTING A FINAL LANDFORM CONFIGURATION 62

20 FINAL LANDFORM CONFIGURATION 62

21 PROPOSED ADDITIONAL FINAL LANDFORM STUDIES 67

22 GENERAL REHABILITATION MANAGEMENT STRATEGIES 68

22.1 Progressive rehabilitation 69

22.1.1 Progressive rehabilitation schedule 69

22.1.2 Table of actions arising from Final Landform Plan 69

23 MANAGEMENT OF SPECIFIC BIODIVERSITY VALUES 71

23.1 Fortescue Marsh 71

23.2 Northern Quoll 71

23.3 Pilbara olive python 72

23.4 Stygofauna 72

23.5 Hamersley Lepidium 72

24 REVEGETATION PLANS 73

24.1 General rehabilitation methods 73

24.2 Topsoil management 73

24.3 Topsoil inventory 73

24.3.1 Management of the soil deficit 74

24.4 Seed management 74

24.4.1 Seed collection and storage 74

24.4.2 Seed mixes to be used in Yandicoogina rehabilitation 75

25 PLANS TO ACHIEVE BIODIVERSITY OBJECTIVES 75
25.1 Baseline surveys 75
25.2 Water quality should support natural ecosystems 75
25.3 Environmental values of Fortescue Marsh 76
25.4 Table of actions arising from Biodiversity Management Plan 76
26 OBJECTIVES AND TARGETS FOR HERITAGE MANAGEMENT 78
26.1 Heritage management strategies 78
26.2 Accountabilities for heritage management 79
27 TABLE OF ACTIONS ARISING FROM THE HERITAGE MANAGEMENT PLAN 79
28 RISK ASSESSMENT 81
28.1 Risk 1: Currently unidentified heritage issues 81
28.2 Risk 2: Development of saline pit lakes 82
28.3 Risk 3: Current status of closure planning delays JSW approval 82
28.4 Risk 4: Insufficient lead time to gain approvals 83
28.5 Risk 5: Inability to gain OEPA approval to change strategies 83
29 THE ROLE OF SUSTAINABILITY ASSESSMENT IN CLOSURE PLANNING 84
30 SUSTAINABILITY ASSESSMENT 84
30.1 Assessed closure options 84
30.1.1 Option 1: Retention of Junction Central and Oxbow pit voids 84
30.1.2 Option 2: Creation of a 'Channel' 85
30.1.3 Option 3: Backfill to ground level 86
30.2 Pit lake hydrogeological Modelling 86
30.3 Outcomes of the sustainability assessment 87
30.3.1 Assessment of economic factors 87
30.3.2 Assessment of environmental factors 87
30.3.3 Assessment of social factors 87
30.3.4 Consolidation of economic, environmental and social factors 87
31 PREFERRED CLOSURE OPTION 88
32 INDICATIVE COMPLETION CRITERIA 90
32.1 What are indicative completion criteria? 90
32.2 Process to develop completion criteria for Yandicoogina 90
32.3 Commitments regarding the setting of criteria 91
32.4 Achieving appropriate environmental outcomes 91
33 PRINCIPLES OF RTIO CLOSURE COST ESTIMATION 93

34 PLANS FOR MANAGEMENT OF OTHER CLOSURE ASPECTS 95
35 UNEXPECTED CLOSURE 95
36 CLOSURE MONITORING AND MAINTENANCE 95
36.1 Closure monitoring program 96
36.2 Phases of monitoring 96
36.3 Expected monitoring program 96
37 RESEARCH ACTIONS 97
38 MANAGEMENT OF INFORMATION AND DATA 98

Tables

TABLE 1 SUMMARY OF KEY CURRENT LEGAL OBLIGATIONS RELEVANT TO (PROJECT) CLOSURE 18

TABLE 2 LAND SYSTEMS OCCURRING IN THE YANDICOOGINA LOCALITY 26

TABLE 3 KEY GEOLOGICAL MATERIAL CHARACTERISTICS REPORTS 26

TABLE 4 KEY WATER REPORTS FOR THE YANDICOOGINA OPERATIONS 29

TABLE 5 KEY BASELINE BIODIVERSITY REPORTS AT YANDICOOGINA 37

TABLE 6 YANDICOOGINA BASELINE VEGETATION COMMUNITIES 38

TABLE 7 YANDICOOGINA CONTROL SITE VEGETATION STATISTICS (2009) 39

TABLE 8 RELEVANCE OF KEY YANDICOOGINA BIODIVERSITY VALUES IDENTIFIED IN THE RTIO BAP TO CLOSURE 47

TABLE 9 COMMUNICATION REGISTER 54

TABLE 10 YANDICOOGINA CLOSURE OBJECTIVES 57

TABLE 11 ACTIONS ARISING FROM FINAL LANDFORM PLAN 70

TABLE 12 SOIL STOCKPILE VOLUMES AND DEFICIT (AS OF 2010) 73

TABLE 13 ACTIONS ARISING FROM BIODIVERSITY MANAGEMENT PLAN 77

TABLE 14 OBJECTIVES AND TARGETS FOR CULTURAL HERITAGE MANAGEMENT 78

TABLE 15 HERITAGE MANAGEMENT STRATEGIES 79

TABLE 16 ACTIONS ARISING FROM YANDICOOGINA CLOSURE HERITAGE MANAGEMENT PLAN 80

TABLE 17 EXPECTED COMPONENTS OF THE CLOSURE MONITORING PROGRAM 96

TABLE 18 CONSOLIDATED TABLE OF RESEARCH ACTIONS 97

Figures

FIGURE 1 RTIO CLOSURE PLANNING PROCESS FLOWCHART 3
FIGURE 2 REGIONAL LOCATION OF YANDICOOGINA 6
FIGURE 3 LOCAL CURRENT AND PROPOSED MINING AREAS 7
FIGURE 4 LOCAL CURRENT AND PROPOSED MINING AREAS 9
FIGURE 5 CURRENT JUNCTION CENTRAL MINE LAYOUT 10
FIGURE 6 CURRENT JUNCTION SOUTH EAST MINE LAYOUT 11
FIGURE 7 PASTORAL LEASES AROUND YANDICOOGINA MINING AREA 13
FIGURE 8 YANDICOOGINA STATE AGREEMENT AREA (OVERLAYING BHPBIO MARILLANA STATION LEASE) 14
FIGURE 9 AVERAGE MONTHLY RAINFALL AT THEYANDICOOGINA MONITORING STATION (JAN 2000 TO JUNE 2011; STANDARD DEVIATION INDICATED BY VERTICAL BARS) 21
FIGURE 10 YANDICOOGINA RAINFALL EVENT 25-27 JANUARY 2003 – CUMULATIVE RAINFALL PLOT 21
FIGURE 11 YANDICOOGINA RAINFALL EVENT 24–26 JANUARY 2006 – 15 MINUTE INTERVAL RAINFALL FIGURES 22
FIGURE 12 YANDICOOGINA RAINFALL EVENT 7 MARCH 2004, 15 MINUTE INTERVAL RAINFALL FIGURES 22
FIGURE 13 MONTHLY AVERAGE TEMPERATURE AT THEYANDICOOGINA MONITORING STATION (JAN 2000 TO JUNE 2011; STANDARD DEVIATION INDICATED BY VERTICAL BARS) 23
FIGURE 14 TOPOGRAPHY IN THEYANDICOOGINA LOCALITY 25
FIGURE 15 OUTDATED CONCEPTUAL HYDROGEOLOGICAL MODEL (PRIOR TO 2008) 30
FIGURE 16 CURRENT YANDICOOGINA CONCEPTUAL HYDROGEOLOGICAL MODEL 31
FIGURE 17 GAUGING STATIONS IN THE YANDICOOGINA LOCALITY 32
FIGURE 18 FLAT ROCKS GAUGING STATION RATING CURVE 33
FIGURE 19 RELATIONSHIP BETWEEN RAINFALL AND GROUNDWATER LEVELS AT BORE YM117 34
FIGURE 20 SOIL WATER CONTENT RESPONSE OF SELECTED RIPARIAN TREES IN THE YANDICOOGINA AREA (GRIERSON 2009) 35
FIGURE 21 YANDICOOGINA FLORA SURVEY AREAS 39
FIGURE 22 LEPIDIUM CATAPYCNON (PHOTO FROM THE DEC FLORABASE WEBSITE) 40
FIGURE 23 RECORDED LOCATIONS OF LEPIDIUM CATAPYCNON IN THE YANDICOOGINA LOCALITY 41
FIGURE 24 THE NORTHERN QUOLL 43
FIGURE 25 NORTHERN QUOLL DISTRIBUTION 43
FIGURE 26 OLIVE PYTHON (LIASIS OLIVACEUS OLIVACEUS) 45
FIGURE 27 PILBARA OLIVE PYTHON DISTRIBUTION 45
FIGURE 28 NATIVE TITLE CLAIM GROUPS WITHIN THE YANDICOOGINA MINE AREA (TINDALE, 1974) 52
FIGURE 29 LONG TERM MINE PLAN SHOWING PROPOSED PIT OUTLINES 63
FIGURE 30 FINAL LANDFORM CONFIGURATION (TOP VIEW) 65
FIGURE 31 FINAL LANDFORM CONFIGURATION (TOP VIEW SHOWING PIT LAKE) 65
FIGURE 32 FINAL LANDFORM CROSS-SECTION 66
FIGURE 33 EXAMPLE OF A ROCK CHUTE STRUCTURE USED TO CONTROL WATER INGRESS INTO THE CHANNEL 66
FIGURE 34 COMPARISON OF CLOSURE OPTIONS IN THE SUSTAINABILITY ASSESSMENT 88

Scope and purpose

Rio Tinto Iron Ore (RTIO) considers that closure planning should be an integral part of its business. The process of preparing for closure begins in the early stages of project development, and continues throughout the life of the mine.

1 Overview

A team of in-house rehabilitation and closure planning specialists has been established to manage this aspect of RTIO operations. A Rehabilitation and Closure Working Group has been established to facilitate integration of closure planning into the broader mine planning framework, and to oversee the research and improvement projects recommended in each closure study. In this way, RTIO aims to continually improve both its understanding of closure risks, and the strategies employed to mitigate them.

This report documents the current closure knowledge base for the 100% Rio Tinto owned Yandicoogina Iron Ore operation. It outlines the objectives that need to be met at closure, and the strategies and plans to be employed to achieve this. .

However, this is not a static document. RTIO intends to continue to revisit its closure plans on a regular basis to ensure that the objectives to which it is working towards remain relevant and aligned to stakeholder expectations, and to revise its strategies and plans where appropriate to achieve improved closure outcomes.

2 Scope

2.1 What is a closure study

Rio Tinto considers that planning for closure of a site is a critical business process that demonstrates a commitment to sustainable development. Closure planning involves the development of strategies to avoid or mitigate potential social and environmental impacts associated with site closure, to an extent that is fiscally appropriate.

One output of the study is a conceptual closure plan cost estimate, prepared to an intended accuracy of ±30%. This estimate leads to the establishment of a closure provision for the site, ensuring that funds will be available to close the site effectively. This report outlines the process that has been used to develop the cost estimate, with the estimate itself contained in a separate and referenced report.

Closure studies are regularly updated on a 5 year basis[2] to incorporate changes to mine schedules. The detail of each study increases as the site knowledge base develops.

When the site moves to within five years of scheduled closure, a final decommissioning plan is prepared. The final decommissioning plan builds upon strategies developed in earlier studies and details how they are to be implemented.

[2] Rio Tinto Closure Standard, RTIO-HSE-0016299

2.2 The closure planning process

This study has been conducted in a manner that is consistent with the Rio Tinto Closure Standard, which outlines the expectations for closure planning within the business. This Standard applies to all operations globally, and is supplemented by a rigorous internal review process to facilitate continuous improvement to closure planning processes and outcomes. The RTIO closure planning process flowchart is presented in Figure 1.

2.3 Inclusions and exclusions

A description of the Yandicoogina site is provided in Section 4.

Yandicoogina comprises numerous deposits at various stages of operation or approval. A closure cost estimate has been prepared only for activities related to deposits in current operation (Junction Central and Junction South East). However, proposed mining areas (Junction South West, Oxbow and Billiard) have also been considered for the purpose of closure strategy development. Closure costs will be developed for these additional mining deposits once approvals to mine have been obtained, and will be subsequently incorporated into the broader Yandicoogina closure cost estimate.

The scope of this closure study includes:

- Junction Central pits and associated infrastructure,
- Junction South East pits and associated infrastructure, and
- Junction South West and Oxbow deposits, which are currently subject to project approvals processes, and
- Billiards deposits, which are not currently approved but feature in future mine plans.

The scope of this closure study excludes:

- Proposed upstream Meander and Snooker deposits, which are separated from other RTIO deposits by BHPBIO (BHP-Billiton Iron Ore) operating mines, and which do not currently feature in the long term mine plan, and
- Infrastructure associated with management of ore from the IOH Phil's Creek mine

2.4 Past and future closure planning for the site

Numerous closure-related studies have been undertaken for Yandicoogina mines. A 2003 closure plan developed for the Junction Central deposit was approved by the Western Australian Government in 2005. Also in 2005, the public environmental review (PER) for Junction South East included closure strategies and commitments relevant to the proposal. A separate report has been prepared that details the closure planning history for the site.

In accordance with Ministerial approval conditions, RTIO is required to develop and submit Yandicoogina closure plans to the Western Australian Government on a five yearly basis. This timing is consistent with Rio Tinto's internal Closure Standard, which also requires a new closure study to be conducted for each site every five years.

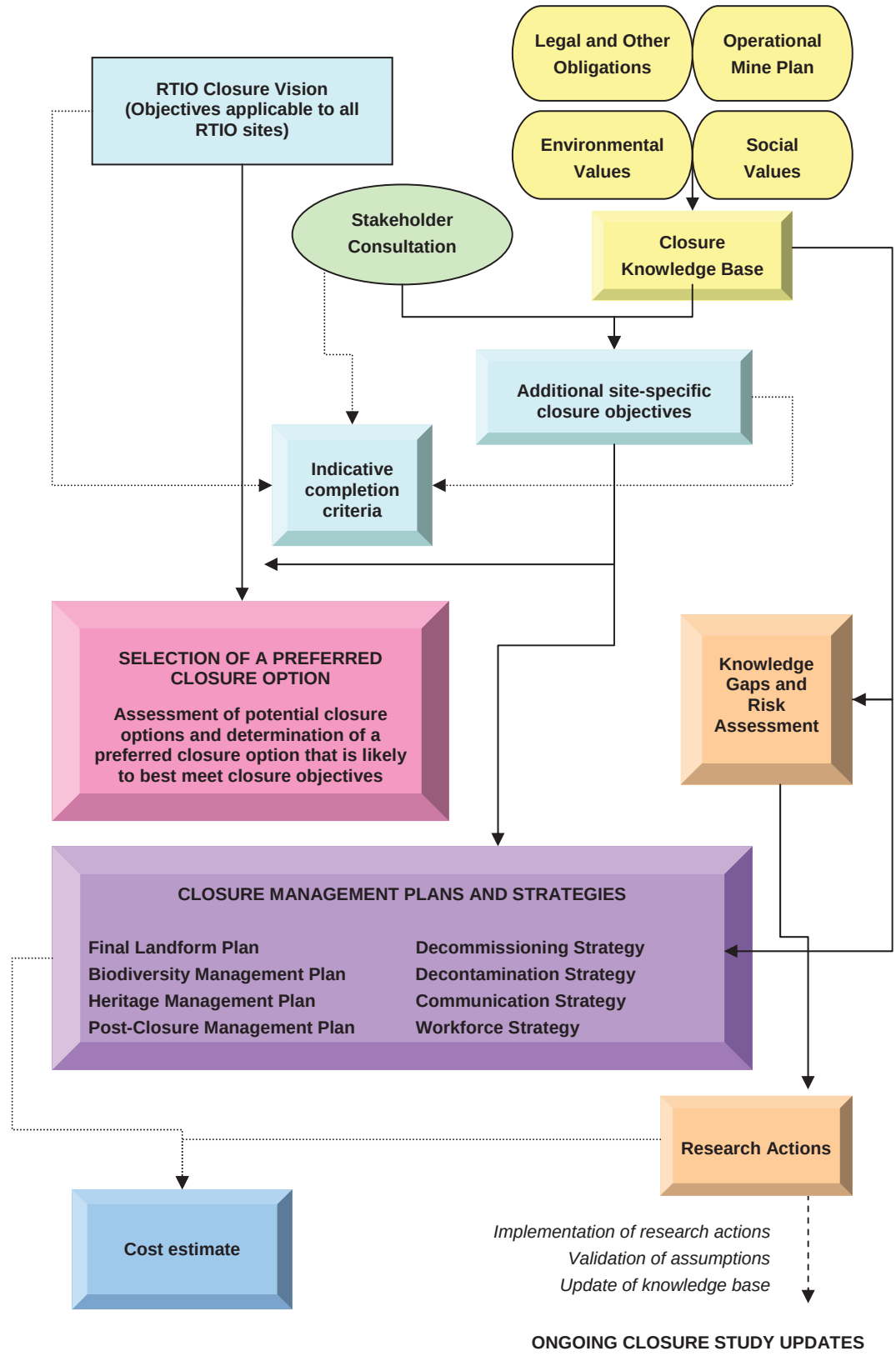


Figure 1 RTIO closure planning process flowchart

Future studies will:

- Incorporate improvements that have been made to the closure knowledge base in the course of mine development, and through the implementation of research projects
- Review closure objectives and indicative completion criteria to ensure that they remain relevant and consistent with stakeholder expectations
- Incorporate management strategies for various aspects of closure, prepared to an increasing degree of detail relevant to the stage of operation
- Update the closure cost estimate to an increasing level of accuracy as strategies are progressively developed, and underlying assumptions are validated.

A Final Decommissioning Plan will be prepared approximately five years prior to scheduled closure. This is a detailed plan for implementing the closure strategies that have been developed and refined throughout the course of mine life. Completion criteria will be finalised and endorsed by stakeholders at this stage.

3 Purpose

The report has been prepared with the following objectives in mind:

- Compliance with Condition 5-3 of Ministerial Statement 695, which applies to the Yandicoogina JSE expansion, and requires five-yearly closure plan revisions
- Support for project approvals currently being sought under Part IV of the *Environmental Protection Act 1986* (EP Act) for the Yandicoogina JSW and Oxbow Iron Ore Project Public Environmental Review (PER)
- To meet key Government expectations, as outlined in the Department of Mines and Petroleum *Guidelines for Preparing Mine Closure Plans* (June 2011)
- Compliance with the Rio Tinto corporate Closure Standard
- Early identification of likely site-specific closure issue
- Documentation of closure objectives for the site
- Early development of strategies to meet these objectives
- Assessment of risks associated with proposed closure objectives and strategies
- Identification of actions that should be conducted to mitigate these risks, and enable efficient and effective closure in the future
- Estimation of costs associated with closure, developed to an intended accuracy of ±30%, and
- Development of a multi-disciplinary information resource.

Closure knowledge base: description of operations

The first step in the closure planning process is to develop an understanding of the issues that may be relevant to closure. The following sections provide a summary of the current knowledge base for the site in relation to the following aspects:

- Project Summary
- Description of operations;
- Legal obligations relevant to closure;
- Environmental issues relevant to closure; and
- Social issues relevant to closure.

4 Project summary

4.1 Location

Yandicoogina is located in the Shire of East Pilbara, approximately 90km northwest of Newman (Figure 2) and is sufficiently remote that mining is operated on a 100% fly-in fly-out (FIFO) basis.

The mine is one of several operations within a localised area along a Channel Iron Deposit (CID) in the lower reaches of the Marillana Creek catchment. The first of these to be developed (commencing 1991) was the BHPBIO Yandi mine located approximately 12 km east of the RTIO Yandicoogina mine. In addition, two junior iron ore mining companies are currently seeking to establish operations within the orebody: Iron Ore Holdings hold a pending mining lease for an area approximately 5km to the north-east and Brockman Iron Pty Ltd hold a pending mining lease for an area approximately 20 km to the north.

Other major mines in the area include the BHPBIO Mining Area C (MAC) mine approximately 32 km to the south-east and the RTIO Hancock Joint Venture Hope Downs 1 mine approximately 22 km to the south. Ore bodies at these locations are geologically distinct to Yandicoogina, and are located upstream. Yandicoogina closure is therefore not expected to impact these areas.

Locations of current and proposed mining areas are shown in Figure 3.

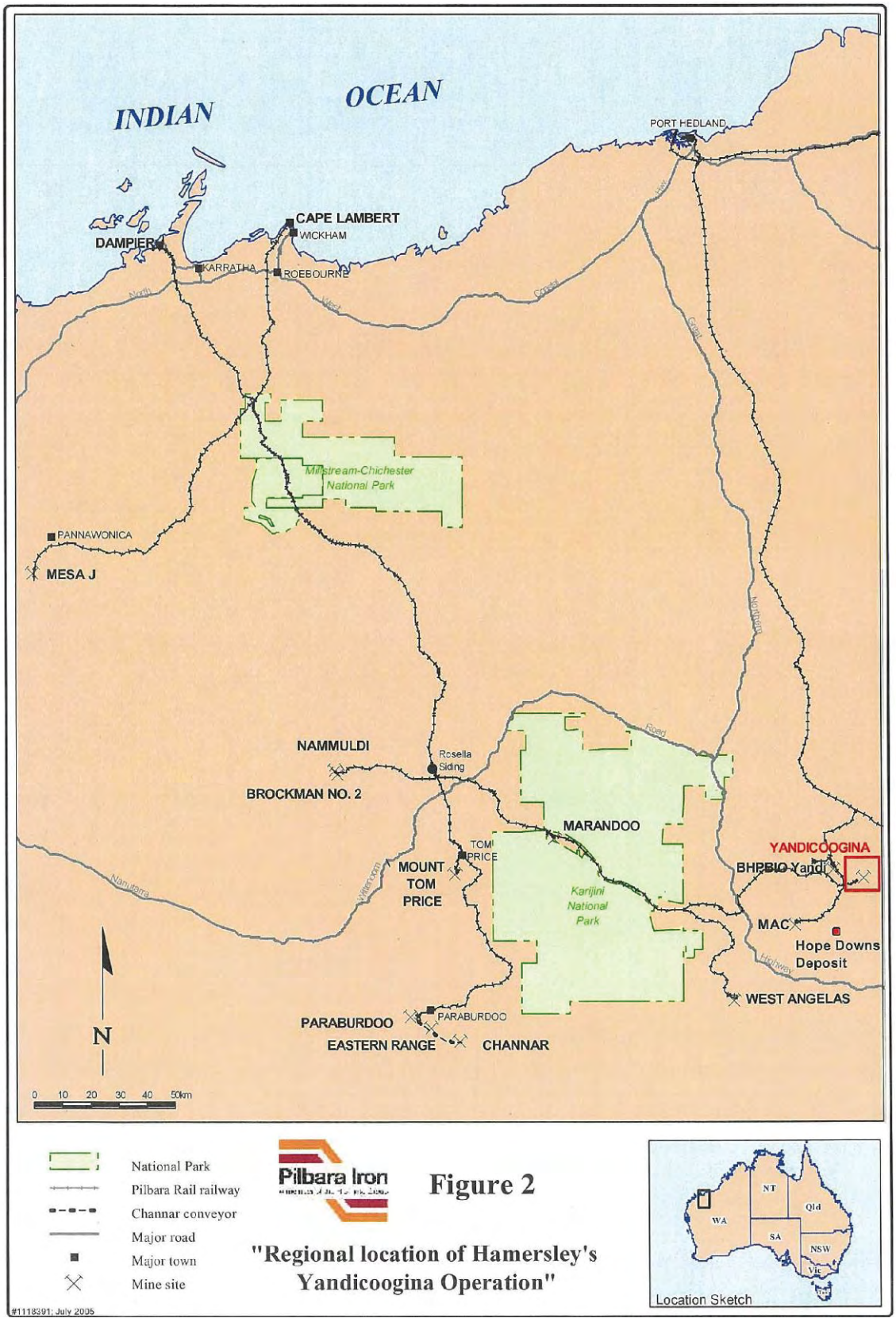


Figure 2 Regional location of Yandicoogina

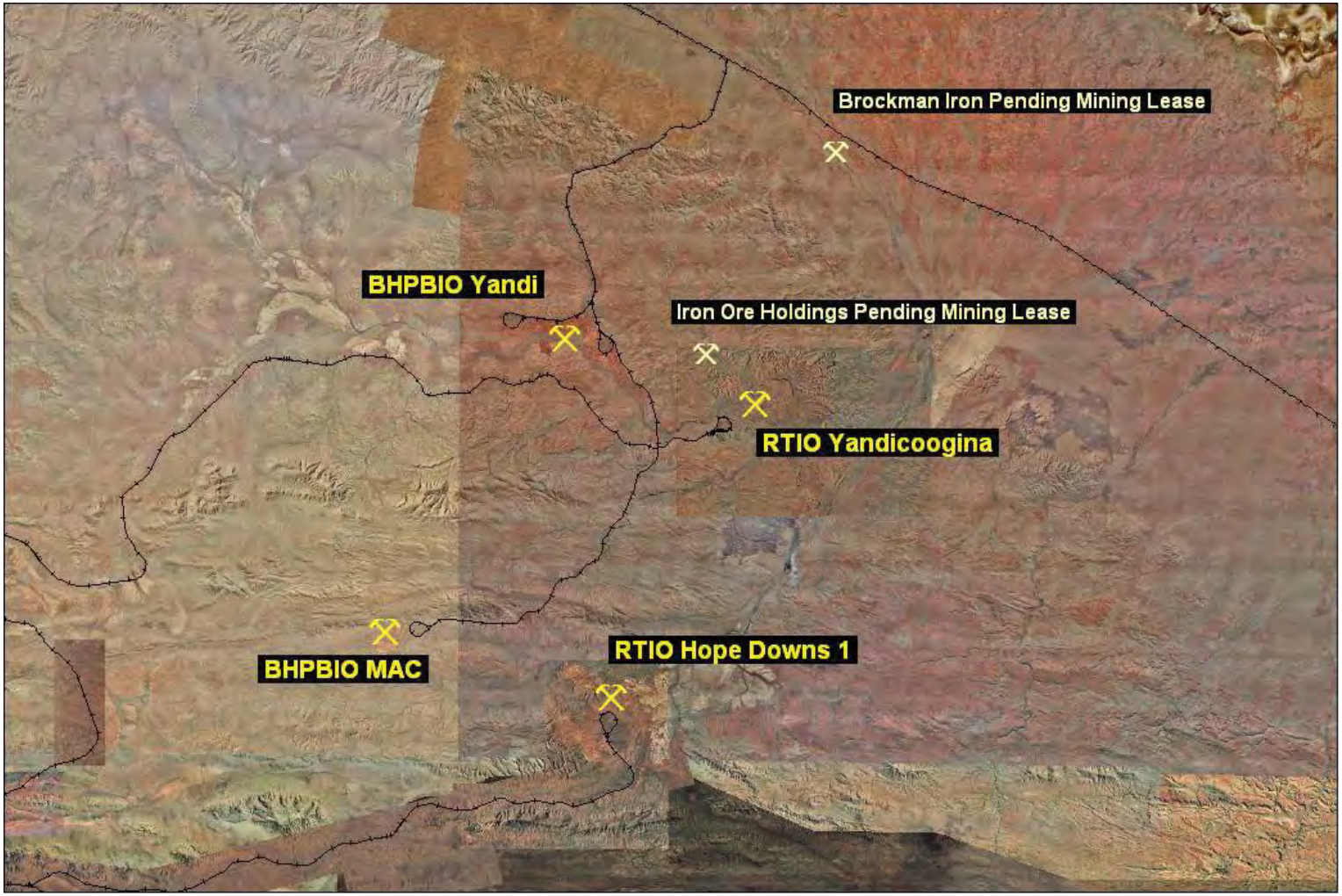


Figure 3 Local current and proposed mining areas

4.2 Adjacent mine sites

4.2.1 BHP Billiton Yandi (Marillana Creek) mine

BHP Billiton Iron Ore (BHPBIO) operates its Yandi (also known as Marillana Creek) mine on leases immediately west of RTIO. The BHPBIO mine commenced operation in 1991 under the terms of the *Iron Ore (Marillana Creek) Agreement Act 1991*.

4.2.2 Iron Ore Holdings proposed Phil's Creek mine

Iron Ore Holdings (IOH) holds tenure to the immediate north of RTIO on which it proposes to operate a small (~1.5 Mt/a) iron ore mining operation. It was agreed that the ore will be transported to Yandicoogina where it will be purchased by RTIO. It will be stockpiled as a separate product and loaded on the RTIO rail network to Cape Lambert port.

Several items of infrastructure have been proposed to manage ore transfer, including a haul road, dump hopper, conveyor and stacker. The current proposal is for IOH to pay for the infrastructure, but there may be some subsequent closure liability for RTIO. Any such liabilities have not been considered in this closure study, but may require inclusion in subsequent studies for the site following finalisation of arrangements between the parties.

4.2.3 Brockman Iron's proposed Marillana Iron Ore project

Brockman Iron also has an iron ore mining project under development to the immediate north known as "the Marillana Iron Ore project".

5 Description of operations

5.1 Deposits

RTIO Yandicoogina mine deposits are situated on a shallow alluvial orebody that snakes over a distance of approximately 90 km from Snooker and Meander mining operations in the west to Billiard in the east, as shown in

Junction Central (JC) was the first RTIO deposit to be developed, followed by Junction South East (JSE). These remain the only deposits approved for mining, however approvals are being sought under the EP Act to allow development of the Junction South West (JSW) and Oxbow deposits.

As depicted in Figure 3, BHPBIO holds mining leases between the RTIO Snooker and Meander deposits, and between the RTIO Meander and Oxbow deposits. BHPBIO operates its Yandi (also known as Marillana Creek) mine on these deposits.

5.2 Current mine layout

The current site layouts for Junction Central and Junction South East mines are indicated in Figure 5 and Figure 6 respectively.

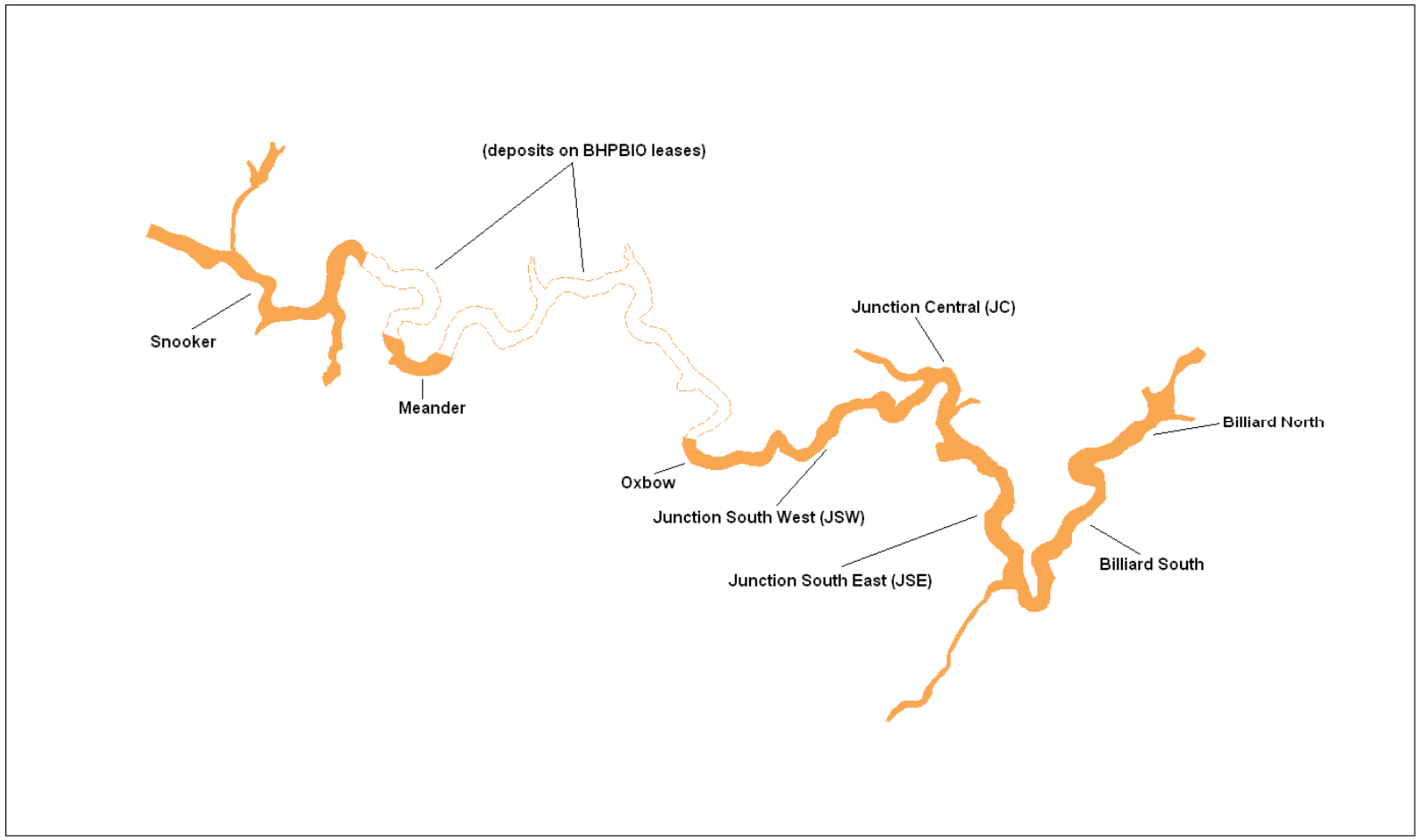


Figure 4 Local current and proposed mining areas

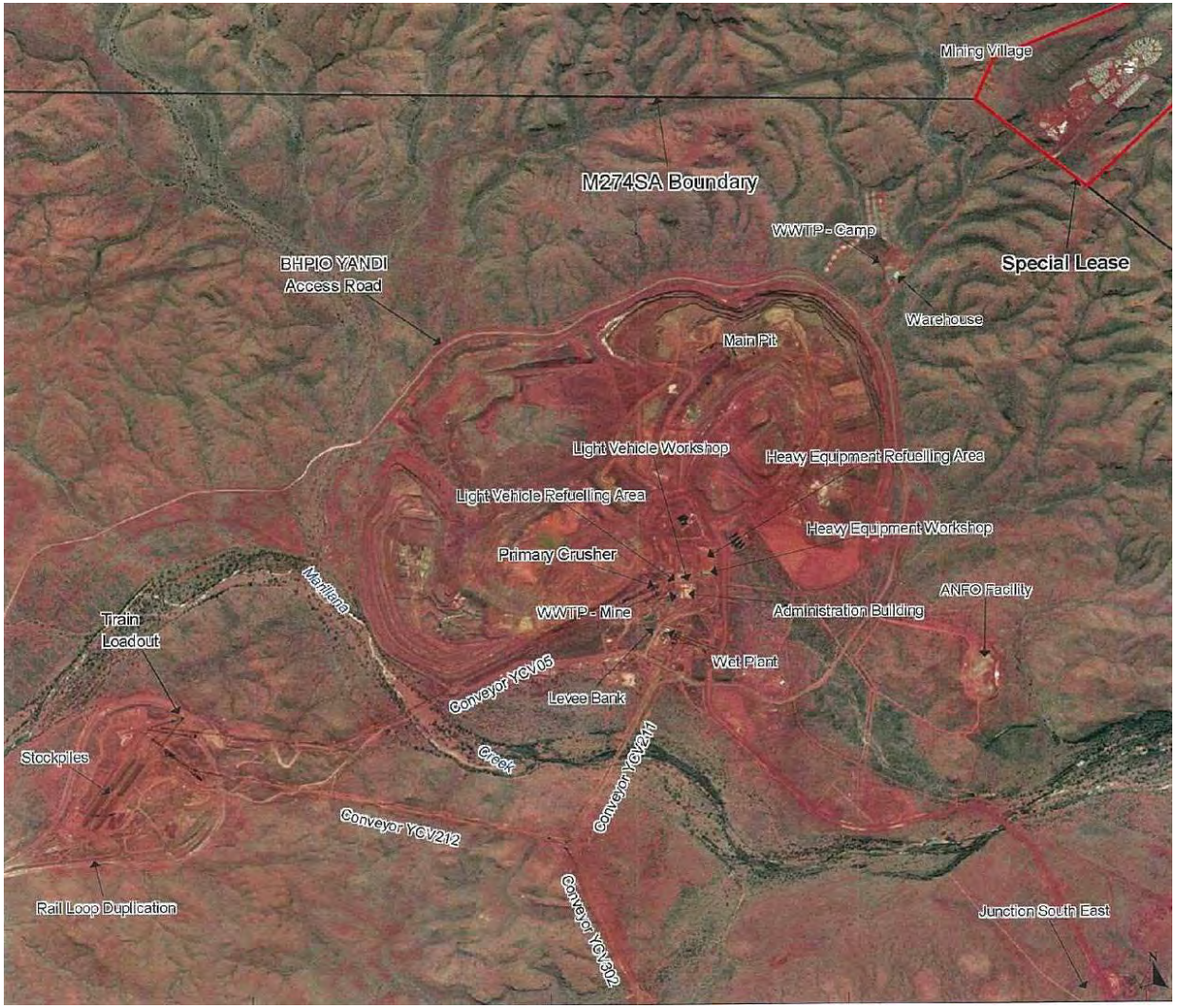


Figure 5 Current Junction Central mine layout

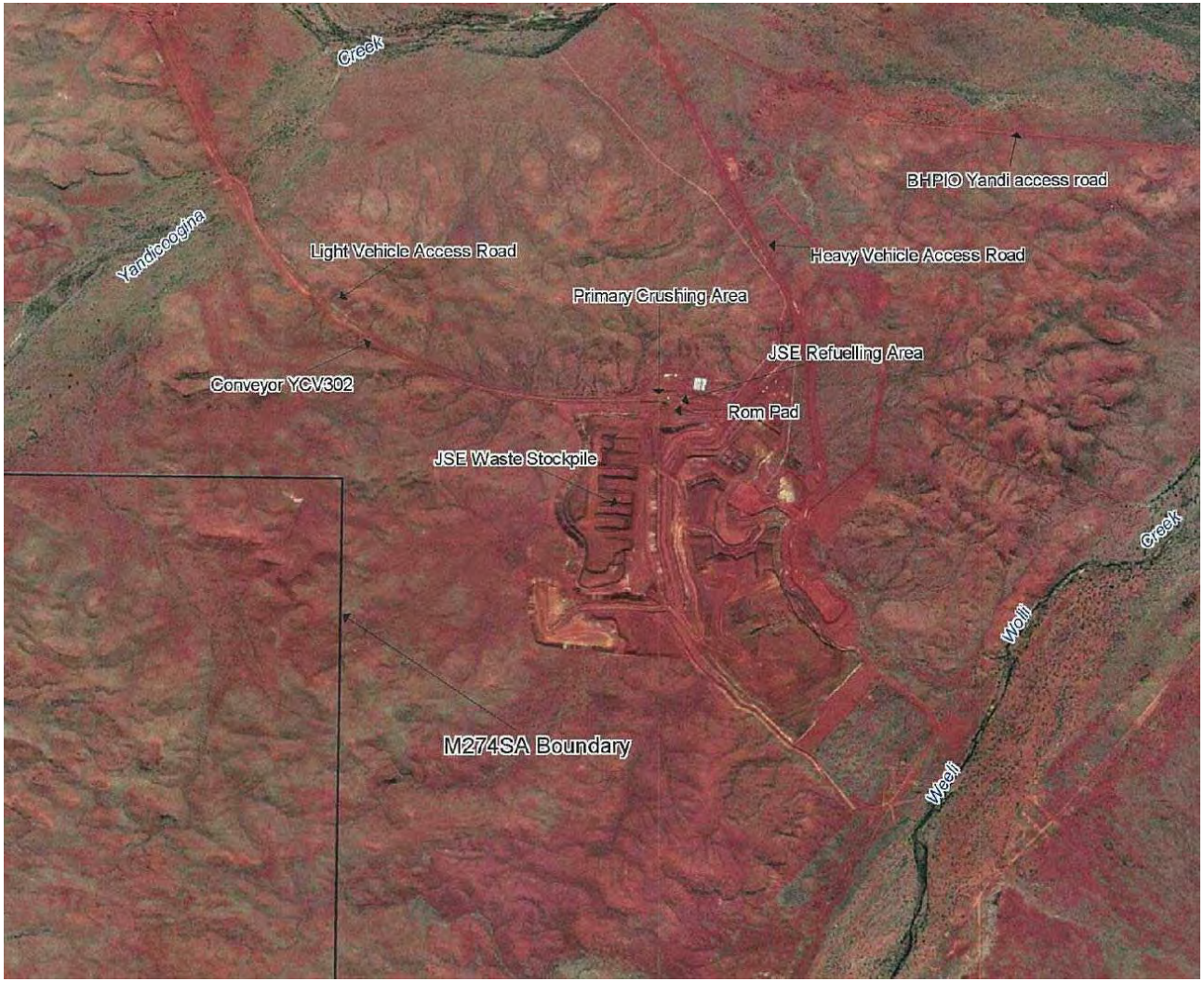


Figure 6 Current Junction South East mine layout

6 Leases applicable to Yandicoogina

All current RTIO mining areas at Yandicoogina, along with several future deposits, overlay Pastoral Lease L3114 984, operated as Marillana Station by BHPBIO.

Mining is enabled by the *Iron Ore (Yandicoogina) Agreement Act 1996*, which has the effect of excising a portion of the pastoral lease for RTIO mining purposes. Special leases have been issued following negotiation with BHPBIO for infrastructure locations (e.g. Yandicoogina camp).

Upon cessation of the State Agreement and special leases, tenure for the excised areas would revert to Pastoral Lease L3114 984. Proposed final land uses will therefore require negotiation with BHPBIO.

Several future Yandicoogina mining areas have alternative underlying tenure. The Oxbow deposit, for which RTIO is currently seeking Government approval, overlays vacant crown land. Snooker and Meander deposits (to the west of existing mining areas, and which are not included in the scope of this present study) overlay the Juna Downs pastoral lease managed by RTIO.

The location of Marillana and Juna Downs stations are shown in Figure 7, and current RTIO lease areas in relation to Marillana Station are shown in Figure 8.

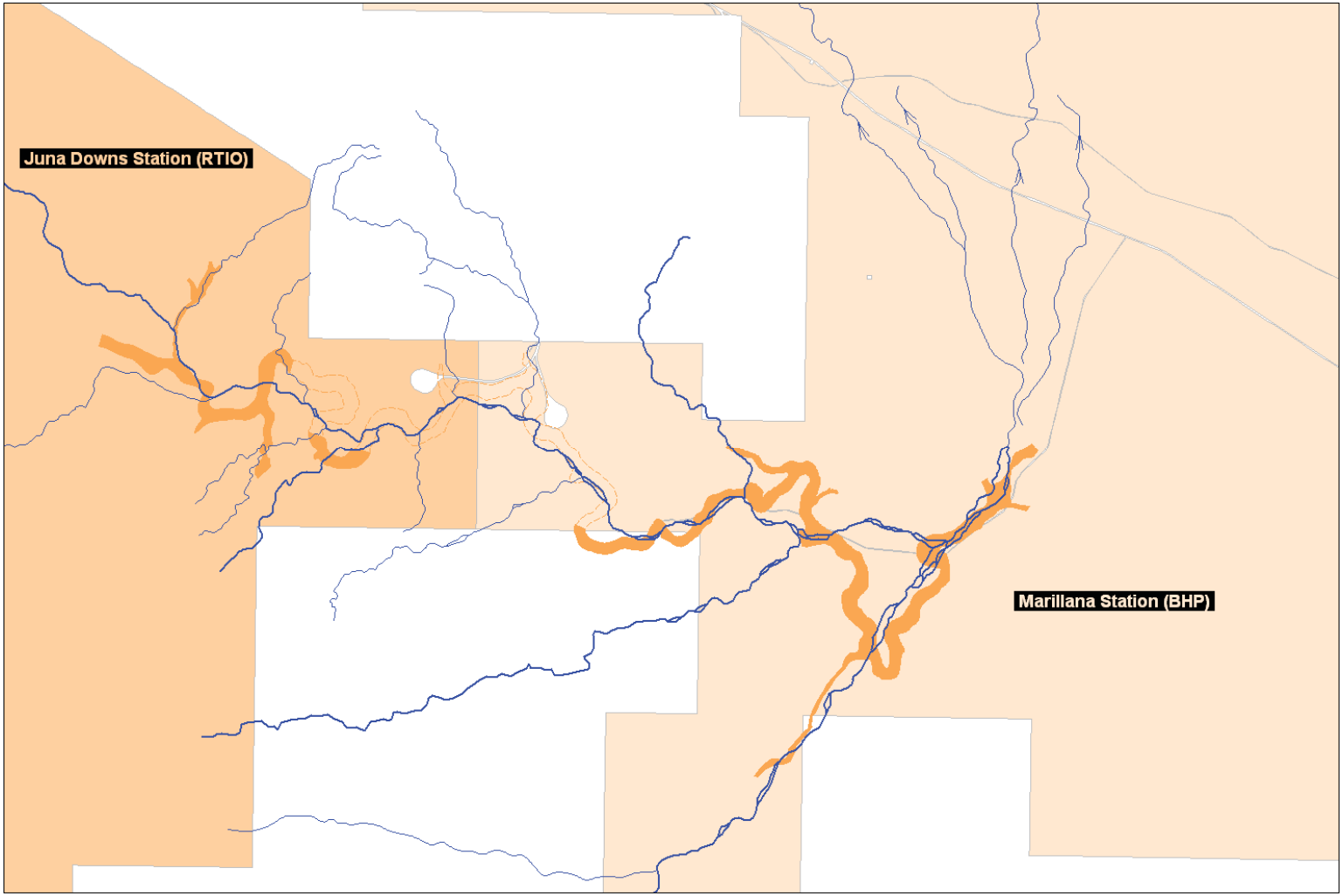


Figure 7 Pastoral leases around Yandicoogina mining area

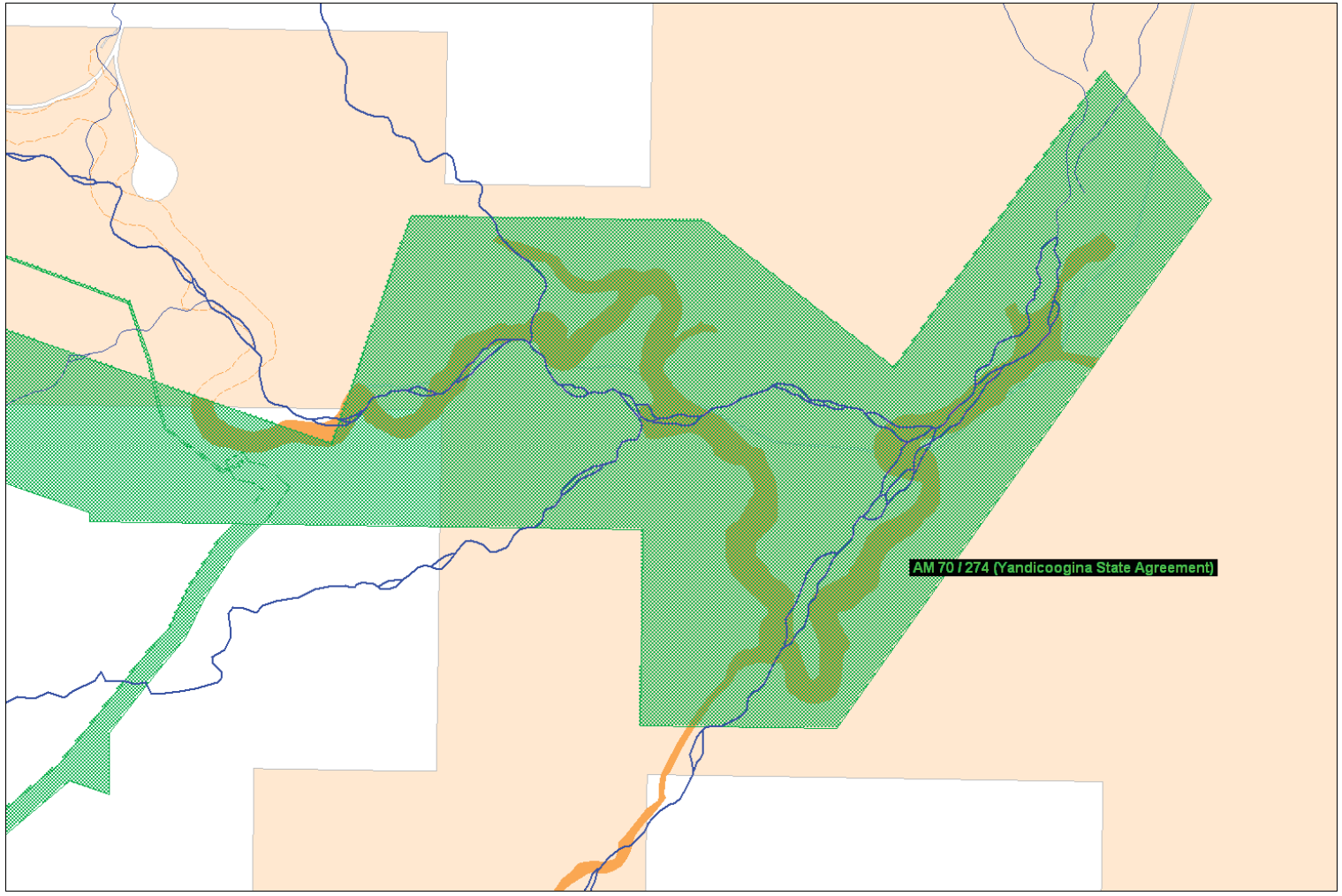


Figure 8 Yandicoogina State Agreement area (overlaying BHPBIO Marillana Station lease)

Closure obligations and commitments

This section provides a review of the legal and other obligations.

A number of general legislative obligations apply to all sites at all times. Whilst these may be important to consider during closure, this section concentrates on obligations that are specific to closure of this site. A review of generic RTIO closure obligations was conducted by Freehills in 2008[3].

This section is structured as follows:

- Table 1 contains a summary of key legal closure obligations relevant to the project;
- A description of State Agreements and Ministerial Statements is provided, as these are important for understanding the legal framework relevant to the site;
- Specific obligations relating to decommissioning, rehabilitation and Indigenous communities are discussed; and
- Rio Tinto corporate closure planning standards are summarised.

7 Legislative framework

7.1 State agreement legislation

A State Agreement is an Act of the Western Australian Parliament to regulate mining activities that are of economic or strategic importance to the State. All of Rio Tinto's Western Australian iron ore mines are subject to State Agreement[4].

State Agreements override other State legislation that might otherwise apply. However, in practice the extent to which this occurs is generally minimal due to the manner in which the Agreements are structured. For example, environmental approvals and licences issued under the *Environmental Protection Act 1986* (EP Act) are still required for all RTIO mines.

Yandicoogina is subject to the *Iron Ore (Yandicoogina) State Agreement Act 1996.*

[3] Freehills, Generic Closure Obligations, draft report for discussion, 16 July 2008, RTIO-CR-00168434

[4] Note that whilst all RTIO mine sites are covered by State Agreements, some ancillary areas (e.g. camps, infrastructure services, etc) may be located outside the Agreement boundary.

7.2 Ministerial statements

Ministerial Statements are the end result of the environmental process outlined in Part IV of the EP Act.

Part IV of the EP Act outlines the process whereby approval is given to significant projects by the Minister for the Environment, under advice from the Environmental Protection Authority (EPA). The approval process is a public one, with several opportunities for a public right to appeal its nature and content.

Part IV approvals have explicit and/or implicit precedence over other approvals. For example, S41 of the EP Act prohibits decision-making authorities from making decisions until the Ministerial approval process is complete. Section 55(4) of the EP Act requires that subsequent environmental approvals and licences must be consistent with the Part IV approval. Whilst there are no such formal restrictions on other types of approvals (e.g. planning approvals, heritage approvals), it is rare for them to be inconsistent.

The EPA expects closure plans to be submitted with approvals documentation to facilitate the incorporation of closure issues into its environmental impact assessment[5].

Yandicoogina is subject to three current Ministerial Statements:

- Statement 417 came into effect in 1996, and relates to the Junction Central deposit,
- Statement 523 came into effect in 1999, relates to Junction Central mine expansions, and effectively replaces Statement 417, and,
- Statement 695 came into effect in 2005, and relates to the Junction South East deposit.

Amendments to Statements 523 and 695, relating to proposed increases to approved dewatering volumes, were formally approved in July 2009 and March 2009 respectively.

RTIO is currently seeking environmental approval for mining operations at the Junction South West and Oxbow deposits and these will be subject to an additional Ministerial Statement. However, RTIO will be seeking to have its various Yandicoogina Ministerial Statements consolidated in the future.

7.3 Mining proposals

Mining proposals are issued under the *Mining Act 1978*. This is the primary legislation under which mine closure is regulated in Western Australia and the DMP is the responsible agency.

Whilst RTIO submits proposals under this legislation for all projects, formal approval is only required for operational areas that are not covered under State Agreement legislation. Some mining areas (e.g. waste dumps, fines dams) and ancillary infrastructure (e.g. mining camps) may fall into this category. The content of mining proposals generally mirrors that in environmental approval documentation.

[5] This was not necessarily the case when previous Yandicoogina approvals were sought, but closure plans were required in this instance because the EPA determined that closure was a significant aspect to be considered for this particular project

The DMP requires mining companies to submit updates of closure plans every 3 years. However, this requirement is not applicable to RTIO because the Department of State Development (DSD), which administers State Agreements, does not require closure plans to be submitted.

7.4 Specific legal obligations

7.4.1 Decommissioning

A general principle enshrined in the State Agreements within which RTIO sites operate is that infrastructure reverts to the State upon closure unless otherwise agreed. With respect to Yandicoogina this is stated in S39 of the *Iron Ore (Yandicoogina) Agreement Act 1996*.

7.4.2 Rehabilitation

A separate report has been prepared to detail legal obligations and commitments relating to Yandicoogina rehabilitation, and is summarised here.

A closure plan was submitted to the Government in 1999 to satisfy the requirements of Ministerial Statement 523. The plan was revised and resubmitted in 2003, and accepted by the Department of Environment in March 2005. These plans make several specific commitments regarding rehabilitation processes and outcomes, as summarised in Table 1.

The agreed minimum rehabilitation criteria (as outlined in the 2003 plan) were:

- Water quality in the Weeli Wolli braided area should remain suitable for stock watering,
- The extent and intensity of the impact of drawdown on creek and phreatophytic vegetation should be limited to within 1- to 2 km of the pit, and
- Salinity in in-pit water should be less than 15,000 mg/L.

RTIO considers that the previously agreed objectives and criteria should be revised to reflect current understanding of Yandicoogina environmental and social values. RTIO has proposed new objectives for discussion (Section 18).

A number of potential rehabilitation options were identified and assessed in the 1999 closure plan. The preferred option involved backfilling to an average height of 490 mRL and localised backfilling up to 515 mRL. This strategy was submitted to Government and agreed upon.

In light of new knowledge accumulated since 2003, RTIO no longer considers this closure scenario to be technically or environmentally viable and has proposed a revised final landform configuration for discussion (Section 8.2).

An additional commitment was made in the 2003 plan to construct three in-pit waste fines storage compounds with specified locations, dimensions and heights, which were to be surrounded by coarser waste rock. The purpose of this commitment was to ensure a continued groundwater flow path. The fines cells have subsequently been constructed in accordance with an amended design approved by regulatory agencies in July 2010.

Table 1 Summary of key current legal obligations relevant to (project) closure

Issue	Obligations
Decommissioning	Infrastructure reverts to the State upon closure unless otherwise agreed. Negotiation should therefore occur prior to decommissioning.
Rehabilitation	• At JC, backfill voids to an average height of 490 mRL, with the floor level raised to a level of up to 515 mRL in some areas. • At JSE, backfill voids to at least 490 mRL. • At JC, at least 85% of overburden to be returned in-pit. • At JSE, overburden to be used as fill during backfill of voids. • Three in-pit fines cells to be constructed in JC, of specific dimensions, locations and heights. • With respect to JSE, 'Backfill Hill' is the nominated backfill source (additional to overburden), subject to environment and heritage backfill being acceptable. Otherwise an alternative backfill source to be sought. Additional backfill will also be required for JC. • Progressive rehabilitation must be undertaken. • The following slope stability targets set (at JC, but also JSE by implication): o Slopes <5° having slope length <170m o Slopes 5-10% having slope length <120m o Slopes 10-20% having slope length <80m o Landforms able to withstand 20% annual exceedence probability. • Drainage designed to accommodate a 5% annual exceedence probability (JC, but also JSE by implication). • The following erosion targets set (at JC, but also JSE by implication): o Total erosion <50 t/ha/yr after 1 wet season o Total erosion <40 t/ha/yr after 5 years o No maintenance required after 5 years. • The following revegetation targets set (at JC, but also JSE by implication): o Plant density >10% of control sites after 1 wet season o Plant density >66% of control sites after 5 years o Weed species less than in control areas after 5 years. • Abandonment bunds to be placed 10m outside unstable area to dimensions 2m high and 5m wide, with vegetation planted where possible to lessen visual impact (at JC, but also JSE by implication). Surface water to be diverted away from pits to prevent flooding, and protect integrity of walls and bunds (at JC, but also JSE by implication).
Cultural heritage	No specific legal requirements or obligations at closure.

7.5 Indigenous communities

RTIO signed the first Industrial Land Use Agreements (ILUA) in Australia in relation to the Yandicoogina mine in March 1997. The Yandi ILUA has been signed with the Gumula Aboriginal Corporation the representative body for the native title claimant groups within the area (the Bunjima, Nyiyaparli and Innawonga Traditional Owners). The original native title claim WC96/18 under which the ILUA was signed has now been superseded by three separate claims Innawonga Bunjima WC96_061, Nyiyarparli WC05_006 and Martu Idja Banyjima WC98_062.

The Agreement provides a framework for protecting important heritage values in the Yandicoogina locality, and delivering social and economic benefits to the Bunjima, Nyiyapali and Innawonga people.

The ILUA does not contain any specific legal obligations in relation to closure and rehabilitation, but does provide some context for discussion of relevant issues.

7.6 Corporate closure planning requirements

All Rio Tinto businesses have an internal corporate requirement to undertake closure planning in accordance with the Rio Tinto Closure Standard[6].

Compliance with the Closure Standard requires RTIO to:

- Commence planning for closure at project inception to enable closure considerations to be incorporated into project design,
- Develop a closure provision, to a specified accuracy that narrows as the site moves closer to closure,
- Conduct a closure study for each site on a five-yearly basis for approved operations, taking into account developments that may influence closure scope, strategies or implementation, and,
- Develop a final decommissioning plan five years prior to scheduled closure.

[6] Rio Tinto Closure Standard, RTIO-HSE-0016299

Closure data

This section outlines the current understanding of technical and environmental aspects that may be relevant to the development of closure strategies for the site.

8 Climate

8.1 Weather station

RTIO has maintained a meteorological monitoring station at Yandicoogina since 1998. The Bureau of Meteorology (BOM) has maintained a station at Newman, approximately 90 km SSE of Yandicoogina since 1965[7].

Statistics quoted in this section are based on analysis of:

- RTIO Yandicoogina climate data collected from 2000-2006; and
- BOM Newman climate data collected from 1971-2006.

8.2 Rainfall

The annual average rainfall in Newman is 310 mm, well below the estimated annual pan evaporation rate of 3,600 mm per year[8]. Yandicoogina data suggests a higher annual rainfall of 492 mm at the mine site, but this is based on a smaller data set[9].

The majority of rain falls in the three months from January to March, which each average more than 100 mm/month. The period between May and November is practically dry, with averages of less than 20 mm/month.

Monthly rainfall averages for the period 2000 to 2011 (June) are presented in Figure 9. High inter-annual variability in summer rainfall is indicated by the large standard deviations for rainfall in the December – March period.

Rainfall data at Yandicoogina is recorded on 15 minute intervals and therefore provides a reasonable indication of intensity.

The most sustained intense rainfall event recorded at Yandicoogina between 2000 and 2006 occurred over a three day period from 25–27 January 2003, with a total of 313 mm. The peak 24 h rainfall was 246 mm, which fell during the January 2003 event. A plot of cumulative rainfall over time for this event is provided in Figure 10.

[7] The current BOM station is located at Newman Aero and has been operating since 1971. The BOM has also previously maintained stations at Newman Town (approximately 80km SSE of Yandicoogina) from 1965-2001 and Sand Hill (40km east of Yandicoogina) from 1971-1984.

[8] Rio Tinto Iron Ore Yandicoogina Annual Environment Report 2007.

[9] Recent climate records suggest increasing rainfall in the northwest generally. This may be the reason for the differential between the two averages, as the Yandicoogina data has been collected more recently.

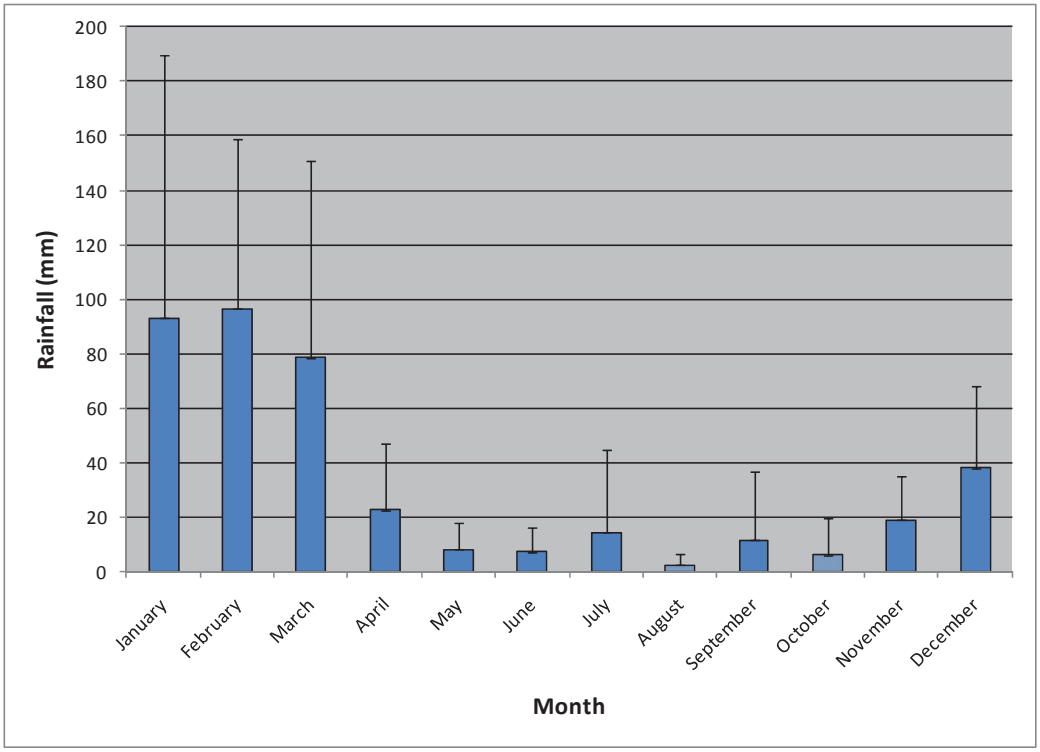


Figure 9 Average monthly rainfall at theYandicoogina monitoring station (Jan 2000 to June 2011; standard deviation indicated by vertical bars)

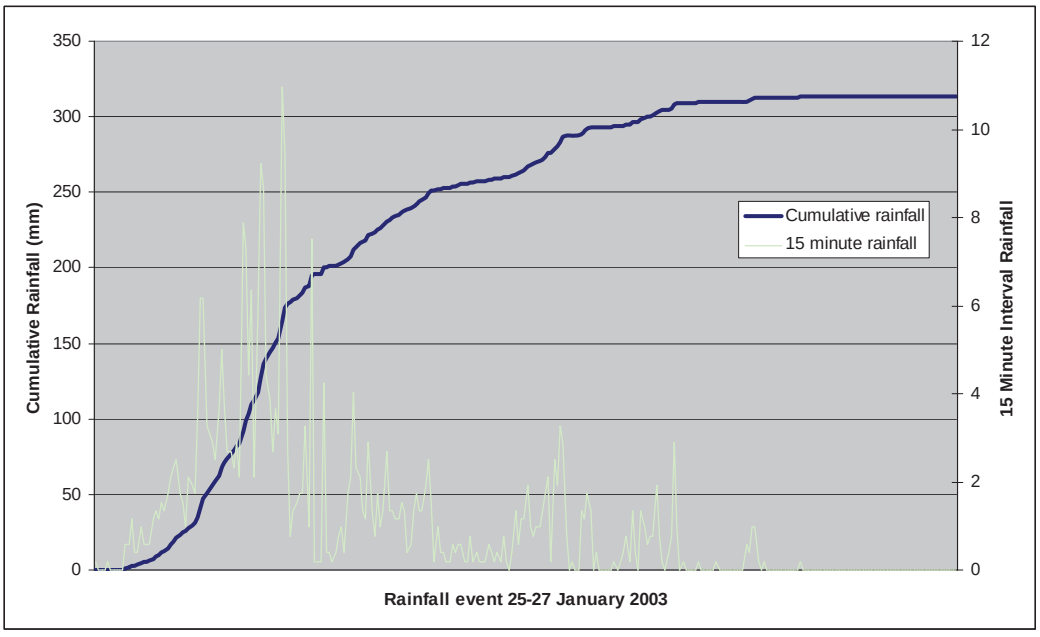


Figure 10 Yandicoogina rainfall event 25-27 January 2003 – cumulative rainfall plot

There were two events from 2000–2006 when rainfall exceeded 20 mm for a 15 minute period (25 January 2006 [Figure 11] and 7 March 2004 [Figure 12]). Several rainfall events exceeded 10 mm. It is unusual for such intensity to be sustained, with only three examples of multiple 15 minute intervals of >10 mm rainfall in any one day (7 March 2004, 20 March 2005 and 11 February 2005).

Synthetic rainfall data has been generated for the site. A 1-in-100 year event of 24–72 hours duration is predicted to be in the range of 200–370 mm[10], which correlates with the January 2003 event.

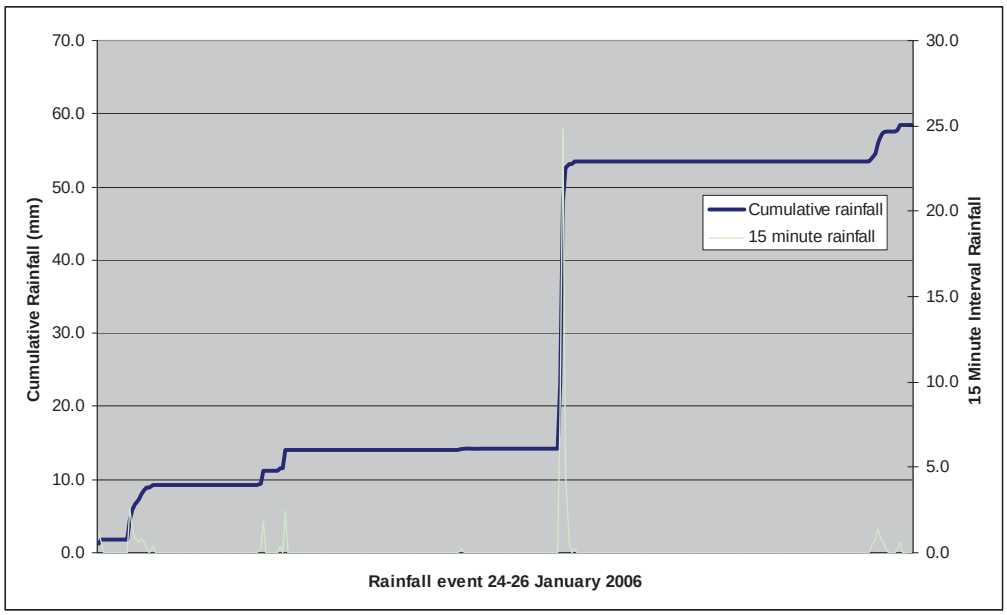


Figure 11 Yandicoogina rainfall event 24–26 January 2006 – 15 minute interval rainfall figures

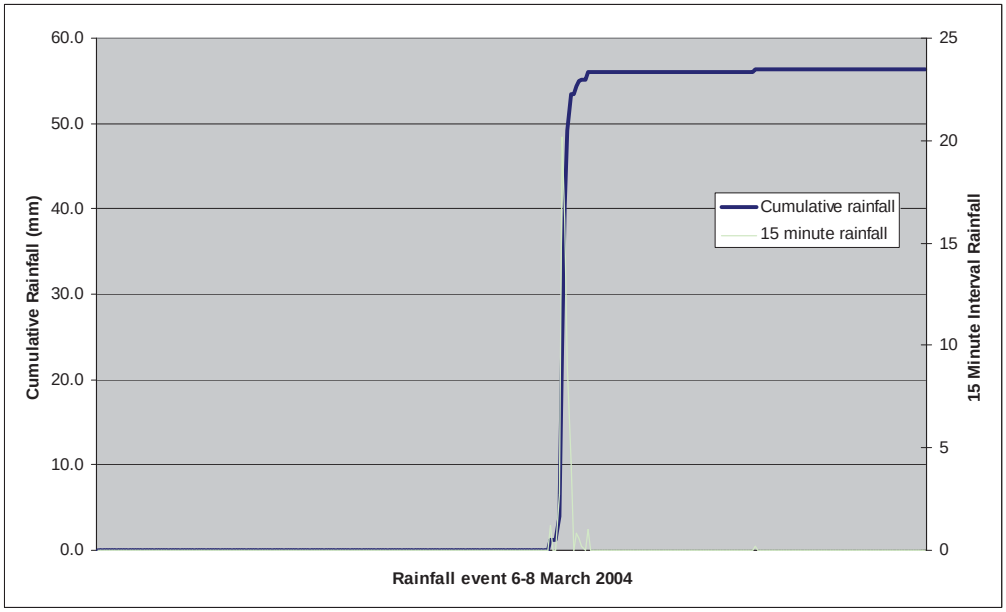


Figure 12 Yandicoogina rainfall event 7 March 2004, 15 minute interval rainfall figures

[10] RTIO Resource Development, Marillana Creek Regional Flow Balance – Pre and Post-Mining Comparison, February 2010, RTIO-PDE-0072519.

8.3 Temperature

Daytime temperatures at Yandicoogina frequently exceed 40°C between October and March, with monthly average temperatures ranging between 16.0°C in June and 31.9°C in December. This is broadly similar to observations at Newman. Yandicoogina temperature data are shown in Figure 13.

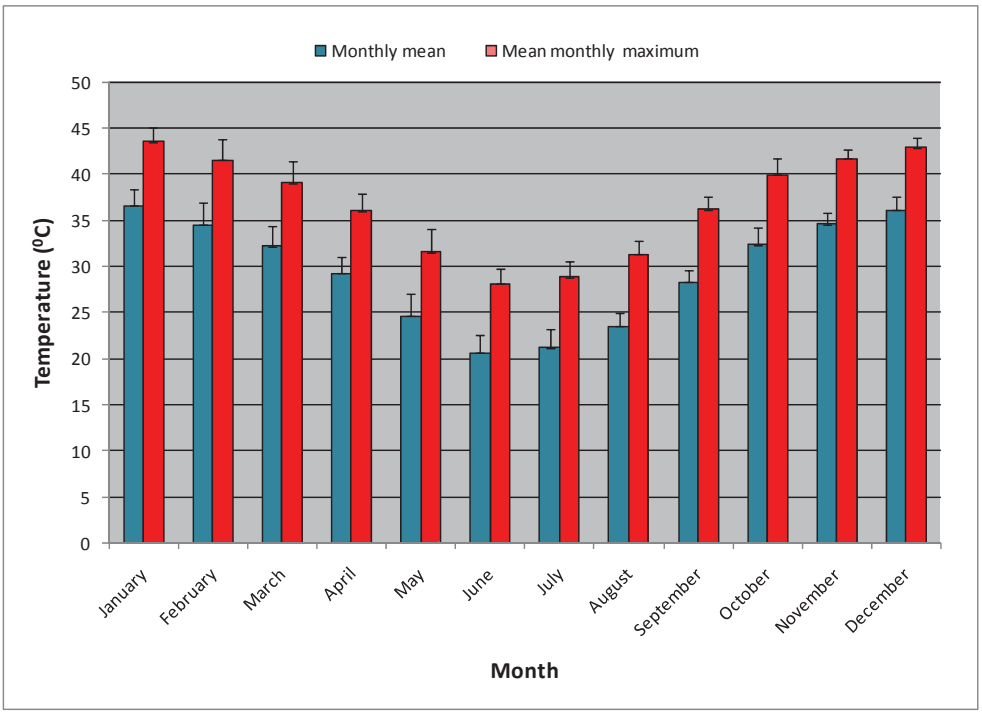


Figure 13 Monthly average temperature at the Yandicoogina monitoring station (Jan 2000 to June 2011; standard deviation indicated by vertical bars)

9 Climate change projections

A study by CSIRO Marine and Atmospheric Research[11] used a number of models to make climate change projections for the whole of Australia. Modelling was undertaken for various greenhouse gas scenarios, and the findings below are based on mid-range global warming scenarios. With respect to the Pilbara, the study found:

- An average temperature increase of between 1°C and 1.5°C between 1990 and 2030
- An average temperature increase of between 3°C and 4°C between 1990 and 2070
- A reduction of up to 5% rainfall during the months of December to February, and a reduction of up to 5% annual rainfall, by 2030 (relative to 1990)
- A reduction of up to 5% rainfall during the months of December to February, and a reduction of up to 10% annual rainfall, by 2070 (relative to 1990).

Note that there is a high degree of uncertainty regarding predictive climate modelling for north-western Australia and research is currently being undertaken by the Indian Ocean Climate Institute (IOCI) to validate modelling assumptions.

[11] Suppiah *et al.* 2007, 'Australian climate change projections derived from simulations performed for the IPCC 4th Assessment Report', *Aust Met Mag*, 131-152.

Opinion on rainfall projections for the Pilbara currently range from significant annual rainfall decreases of 30–40% and a reduction in the number of cyclonic events (but increasing event intensity)[12] to significant rainfall increases and an increase in cyclonic events.

At this stage, until the effectiveness of climate change models is verified, closure impacts modelling needs to take both potential outcome extremes into account.

10 Natural landscape

The dominant landscape features of the Yandicoogina area are the ephemeral watercourses that drain to the northeast to Fortescue Marsh. The creek lines follow a surface gradient sloping downwards from west to east (~520 mRL at Oxbow to ~480 mRL near the Marillana Creek and Weeli Wolli Creek confluence). A row of small hills rising 800 to 900 mRL extend to the northwest from JC, with a line of slightly higher hills (900 to 1,000 mRL) running in an east-west direction to the south of the current mining operations. An area less than one km south of the CID at JSW/Oxbow rises to over 600 mRL. The topography of the locality is provided in Figure 14.

The surface topography has been shaped by alluvial processes with the existing streams winding between low lying mesas and hills. Three major landforms can be distinguished:

- Low stony hills: these areas generally consist of hills, ridges and breakaways supporting a scattered overstorey of small trees (*Eucalyptus* and *Acacia* species) over moderately dense Spinifex (*Triodia* species) hummock grassland,

- Valleys: these areas consist of low stony plains in valleys supporting scattered overstorey of small trees (*Eucalyptus* and *Acacia* species) over sparse mixed shrubs and Spinifex (*Triodia* species). Alluvial flats are dominated by *Acacia* shrub lands with a moderately rich understorey of shrubs, herbs and tussock grasses, and,

- Drainage lines: these areas vary from small gullies in upper hills to more major creek lines. Minor drainage lines differ very little from the vegetation type surrounding them and are usually species poor. Major creek lines support *Eucalyptus* dominated woodlands and open forest over a mixed understorey of shrubs and grasses.

The project area includes areas within the Boolgeeda, McKay, Newman, Robe and River land systems (Table 2). The River land system includes the major drainage lines (Marillana, Yandicoogina and Weeli Wolli creeks).

[12] Rio Tinto Climate Change Adaption Project: *Climate Change Impacts in the Pannawonica – Yandicoogina Region of the Pilbara*, Environmental Modelling and Prediction P/L Australia, January 2009. Unpublished report produced exclusively for Rio Tinto internal use.

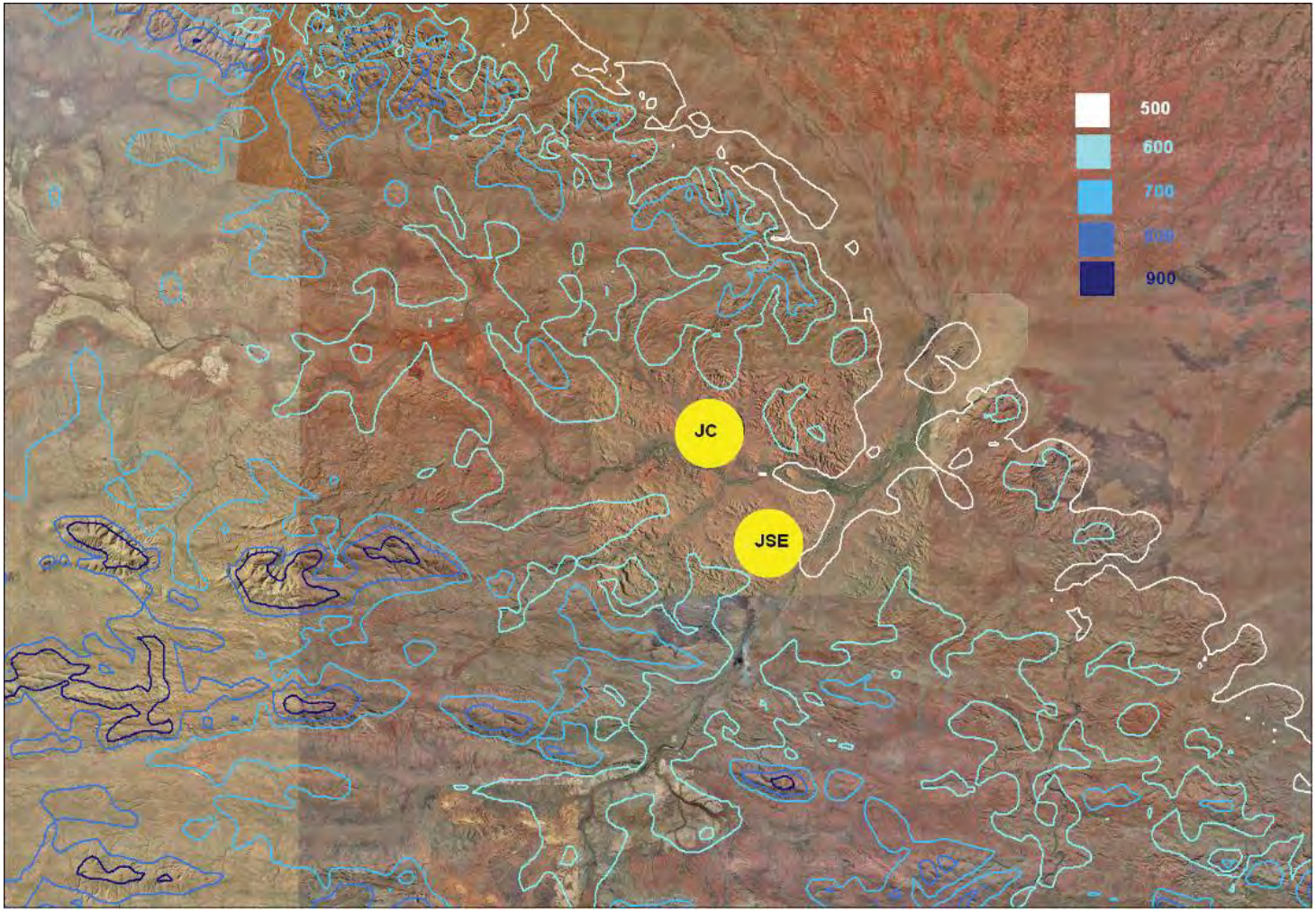


Figure 14 Topography in theYandicoogina locality

Table 2 Land systems occurring in the Yandicoogina locality

Land System	Description
Bolgeeda	Stony lower slopes and plains derived from quaternary colluvium and situated below the surrounding hill systems. Major soil types include red loamy earths and red shallow loams. The vegetation is characterised by hard and soft spinifex grasslands and scattered mulga (*Acacia aneura*) shrublands. This land system is extensive in the western half of the Oxbow area and in the JSW-A area.
McKay	Hills, ridges, plateaux remnants and breakaways of meta-sedimentary and sedimentary rocks. Major soil types include stony soils and red shallow loams. The vegetation is characterised by hard spinifex grasslands with isolated trees and shrubs. This land system dominates the low hills north and south east of the project area.
Newman	Rugged jaspilite plateaux, ridges and mountains of varied geological origin. Major soil types include stony soils and red shallow loams. The vegetation is characterised by hard spinifex grasslands with isolated trees and shrubs. This land system is prevalent to the south of the project area.
River	Major river channels and active flood plains formed from quaternary alluvium. Major soil types include red sands, loams and clays of varying depth. The vegetation is characterised by a mixture of hummock grasslands, shrublands and woodlands; including riverine fringing vegetation. This land system comprises much of the Marillana, Yandicoogina and Weeli Wolli creek systems.
Robe	Low mesas and buttes derived from tertiary pisolitic limonite and laterite. Major soil types include stony soils, shallow gravels and loams. The vegetation is characterised by hard and soft spinifex grasslands with isolated trees and shrubs. This land system is common across the project area, adjacent to the Marillana creek system.

11 Site geology and material characteristics

Key reports providing baseline geology data for Yandicoogina are listed in Table 3.

Table 3 Key geological material characteristics reports

Title	FDMS Ref
Yandi Geology: Stratigraphy, Lithogogy, Chemistry, Alterations and Modelling Parameters, March 2004, Valente & Etheridge	RTIO-PDE-0012215
Iron Ore Mineral Waste Review, August 2009, Lindars, Roseby & Terussi	RTIO-HSE-0072426
Yandicoogina Mineral Waste Risk Assessment: Acid Rock Drainage Potential, June 2007, Lundy-Stern & Green	RTIO-PDE-0033672
Impact of Mining and Mine Closure on Water Quality and the Nature of the Shallow Aquifer, Yandi Iron Ore Mine, December 2002, S Gardiner, Curtin University of Technology (School of Geology) Master of Science thesis	GDSR 4746

11.1 General geological description

The Yandicoogina ore body is a paleochannel[13] known as a Channel Iron Deposit (CID), which broadly runs under Marillana and Weeli Creeks. Present-day creek lines deviate from the CID in several areas, and mining is currently restricted to these sections.

Site geology consists of three main layers, as explained by Gardiner[14]:

- Basement rocks (including the Weeli Wolli formation, which is assumed to provide a hydraulic barrier as discussed in Section 17.1) and altered basement rocks;
- The CID, which is up to 70m thick, and consists of pisolite (iron oxide spheroids) that have formed in the paleochannel; and,
- Overburden material, including deposits of low iron concentration (weathered channel horizon), clays and alluvium.

Clay minerals typically occur in voids, fractures and other structures in the CID. Kaolinite is the dominant clay type.

The overburden is a mixture of lateritic pisolite, poorly sorted angular to sub-rounded BIF, chert and dolomite gravels in a sandy matrix. Discontinuous kaolin clay bands and pods are common in the overburden and occur less frequently in the CID.

Mineral waste generated at the site consists largely of overburden material and CID fines.

12 Material characteristics

12.1 Potential geochemical hazards

Potential geochemical hazards in Pilbara iron ore deposits include:

- Acid and metalliferous drainage (AMD)
- Fibrous materials (e.g. asbestos)
- Spontaneously combustible materials, typically characterised by high sulphur content

The risk of AMD related issues at Yandicoogina is low, based on an assessment made by RTIO in 2007 (refer to Section 11.3).

Fibrous material risks are negligible in the CID downstream of the BHPBIO operations.

Spontaneously combustible materials have not been recorded in the Yandicoogina lithologies.

---

[13] Paleochannels are remnants of ancient streams cut into old rocks and filled with sediments from younger rocks; i.e. they reflect historical drainage lines.

[14] S Gardiner, *Impact of Mining and Mine Closure on Water Quality and the Nature of the Shallow Aquifer, Yandi Iron Ore Mine*, December 2002, Curtin University of Technology (School of Geology) Master of Science thesis, GDSR 4746

12.2 Material characterisation

The engineering properties of Yandicoogina mineral waste materials (for example sodicity and erodibility) have not been fully characterised. Ongoing studies are planned as a component of the closure planning process.

RTIO has previously undertaken erodibility research on Tom Price, Paraburdoo and West Angelas ore types, and has a project currently underway to extend monitoring to other sites and generic waste types. The findings of this research will inform landform design and configuration assessments at Yandicoogina scheduled to commence in 2011 (Section 21).

12.3 Mineral Waste Risk Assessment – Acid and Metalliferous (AMD) Drainage Potential

An assessment of the potential risks (of Acid and Metalliferous Drainage (AMD) at past, current and possible future deposits at the Yandicoogina (Yandi) Mine Site was completed in 2007[15]. This included the Yandi Junction Central (YJUN), Yandi Junction South East (YJSE), Yandi Junction South West (YJSW) and Yandi Billiard (YBIL) deposits.

The assessment included an analysis of:

- Background information;
- Relevant aspects of the surrounding environment; and
- Geochemistry of the main lithologies including sulfur distribution and chemical enrichment

In overall terms the potential AMD risk was assessed as low across the YJUN, YJSE and YBIL deposits, and low-nil at the YJSW deposit; based on geochemical interpretation and analytical testing of drill hole samples. The 99th percentile total sulfur concentration of all processed ore and waste at YJUN is less than 0.02% and the overall ARD risk is low to nil.

Additional geochemical validation sampling is planned as new deposits are developed. This will involve a combination of static and kinetic tests as dictated by sample test results.

[15] RTIO, Yandicoogina Mineral Waste Risk Assessment - Acid Rock Drainage Potential, 2007, RTIO-PDE-0033672

13 Hydrology

13.1 Completed studies

Key reports providing baseline water data for Yandicoogina are listed in Table 4.

Table 4 Key water reports for the Yandicoogina operations

Title	FDMS Ref
Marillana Creek Catchment Hydrology and Local Catchment Impacts, Yandicoogina +52 Mtpa Expansion Prefeasibility Junction South West (Stage 1) and Oxbow Deposits, January 2008, Beckett	RTIO-PDE-0047262
Yandicoogina Surface Water Management Report, April 2010, RTIO Resource Development	RTIO-PDE-0072516
Marillana Creek Regional Flow Balance – Pre and Post-Mining Comparison, February 2010, RTIO Resource Development	RTIO-PDE-0072519
Baseline Hydrology Assessment for Marillana Creek Discharge, May 2010, RTIO Resource Development	RTIO-PDE-0074001
Yandicoogina Water Balance; Pre and Post Mining Hydraulics and Hydrochemistry, April 2010, Kirkpatrick & Dogramaci	RTIO-PDE-0073467
Yandicoogina Hydrogeological Field Program Report – Bore Installation and Test Pumping 2008/9, August 2010, Kirkpatrick & Dogramaci	RTIO-PDE-0071209
Ecological Water Requirements in Dynamic Environments – Research Collaboration 1995-present, November 2009, Grierson (Powerpoint presentation)	RTIO-HSE-0077573
Yandicoogina Operations Groundwater Operating Strategy, November 2009, RTIO Technical Services	RTIO-HSE-0057642

13.2 Baseline water systems

There have been various hydrogeological investigations throughout the Yandicoogina lease since 1978. These studies emphasize that conceptually the Channel Iron Deposit (CID) is incised into the basement Weeli Wolli Formation and overlain by a thin veneer of alluvials. Higher permeability is related to secondary porosity in the CID and alluvium underlying Marillana and Weeli Wolli Creek beds. The surrounding basement is considered impermeable except in localised areas resulting from fractures. Recharge occurs in the creek systems from high intensity rainfall events where creeks cross the palaeochannel.

Pre-mining hydrogeology

A substantial and fundamental shift in the understanding of Yandicoogina hydrogeology occurred in 2008, following testwork aimed at enabling better correlation between modelling predictions and field observations.

Prior to this testing, it was thought that the Yandicoogina Channel Iron Deposit (CID) ore body was a through-flow aquifer with relatively high transmissivity, and bounded by the impermeable Weeli Wolli formation bedrock (Figure 15). It is now known that a layer of alluvium (which was previously thought to be restricted to surface layers) and weathered bedrock sits between the CID and the Weeli Wolli formation (Figure 16)[16].

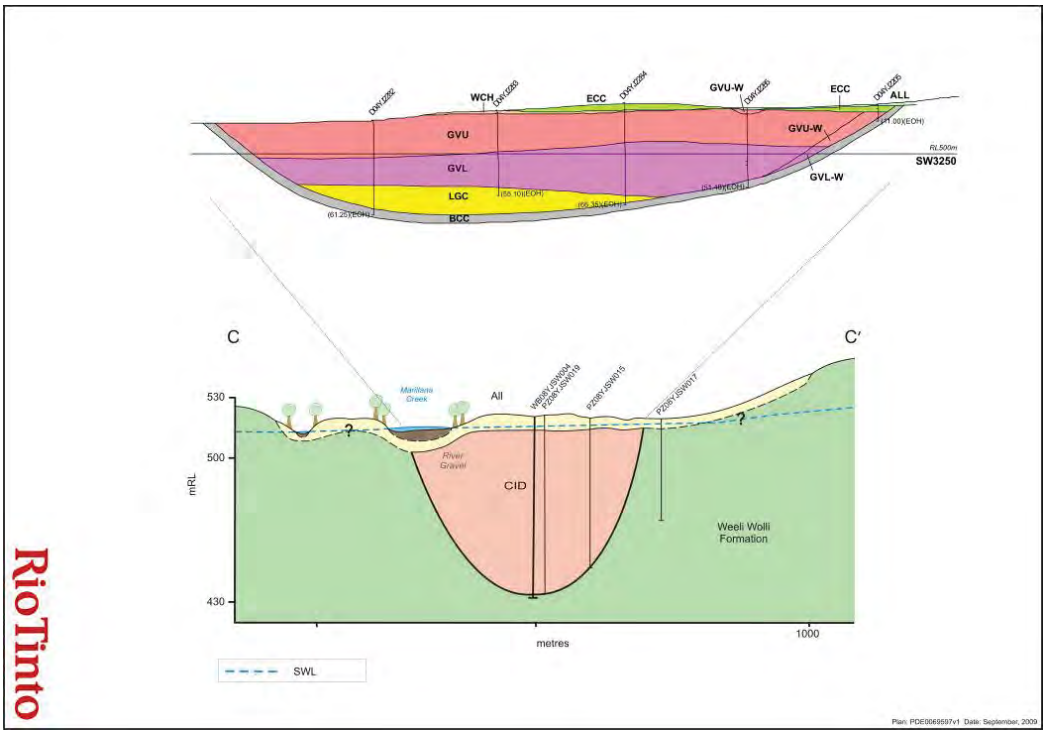


Figure 15 Outdated conceptual hydrogeological model (prior to 2008)

Figure 15 is a pre-2008 conceptual cross section at bore WB08YJSW001. Figure 16 is a current conceptual cross section at bore WB08YJSW004. Both bores are located in the Junction South West area. There is a stronger alignment between the CID and Marillana Creek routes in this section, and Marillana Creek is therefore shown intersecting the CID. Current mining areas (JC and JSE) would show Marillana Creek outside the CID footprint itself, but within the alluvial layer.

[16] RTIO, *Yandicoogina Hydrogeological Field Program Report – Bore Installation and Test Pumping 2008/9*, RTIO-PDE-0071209

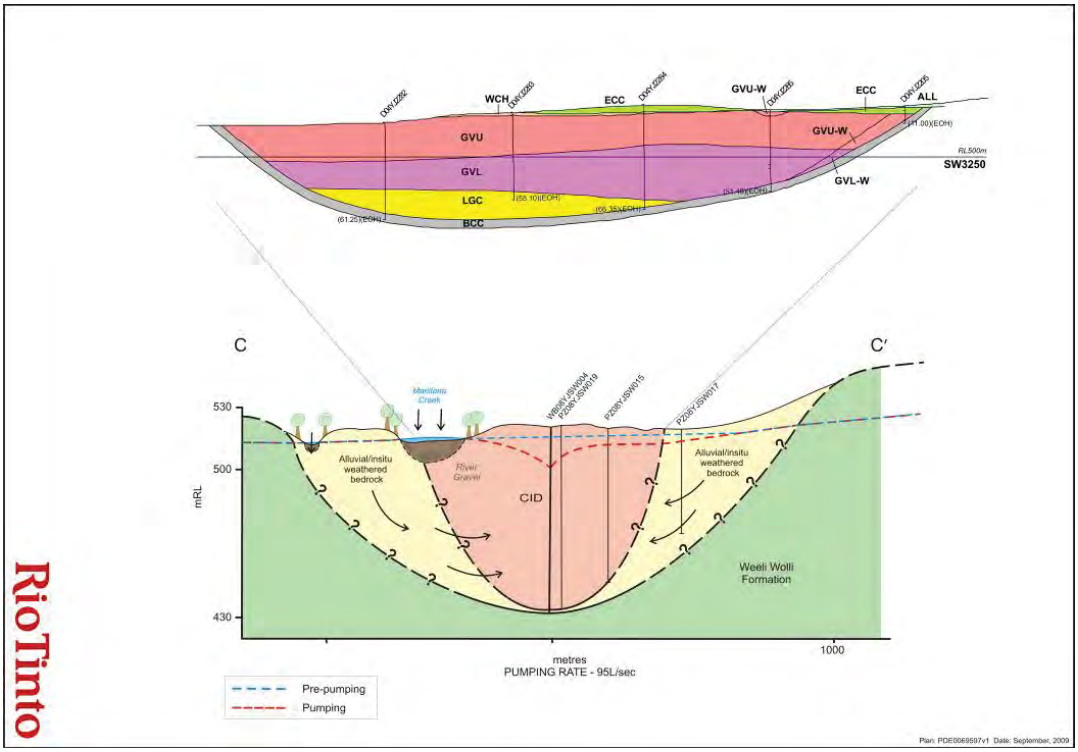


Figure 16 Current Yandicoogina conceptual hydrogeological model

The natural depth to groundwater varies from 3 m to 20 m below the surface[17] and flows generally towards Weeli Wolli Creek to the east. The alluvial/weathered bedrock layer is important because it means that rocks surrounding the ore deposit have a much higher hydraulic transmissivity and storage capacity than previously thought. It also provides a more obvious hydraulic connection between the CID and Marillana Creek, even in those areas where the two follow different routes.

Early closure strategies previously agreed with Government were intended to achieve water-related closure objectives, but were based on old hydrogeological models. It is unclear whether these objectives would have been achieved in practice given the revised hydrogeological model[18].

In order to calculate the regional pre-mining water balance and map the associated groundwater level distribution, the historical water level data was collated along the Yandicoogina palaeochannel from Oxbow deposit to Billiard north (Figure 17). In 1999, four additional shallow exploration holes were drilled along the full extent of the resource adjacent to Weeli Wolli Creek, these water levels where used in conjunction with 1974 levels to contour the conceptual pre mining groundwater level in the CID across the greater Yandicoogina length (Figure 17).

[17] RTIO pits are to a depth in the order of 60m, mining is therefore predominantly below water table.

[18] This question has not been addressed as part of this closure study because it is somewhat redundant. New closure objectives are proposed, and new closure strategies developed. The previously agreed objectives do not necessarily reflect the environmental and social values that are currently considered important to the Yandicoogina area, and the previously agreed strategies are no longer considered to be viable.

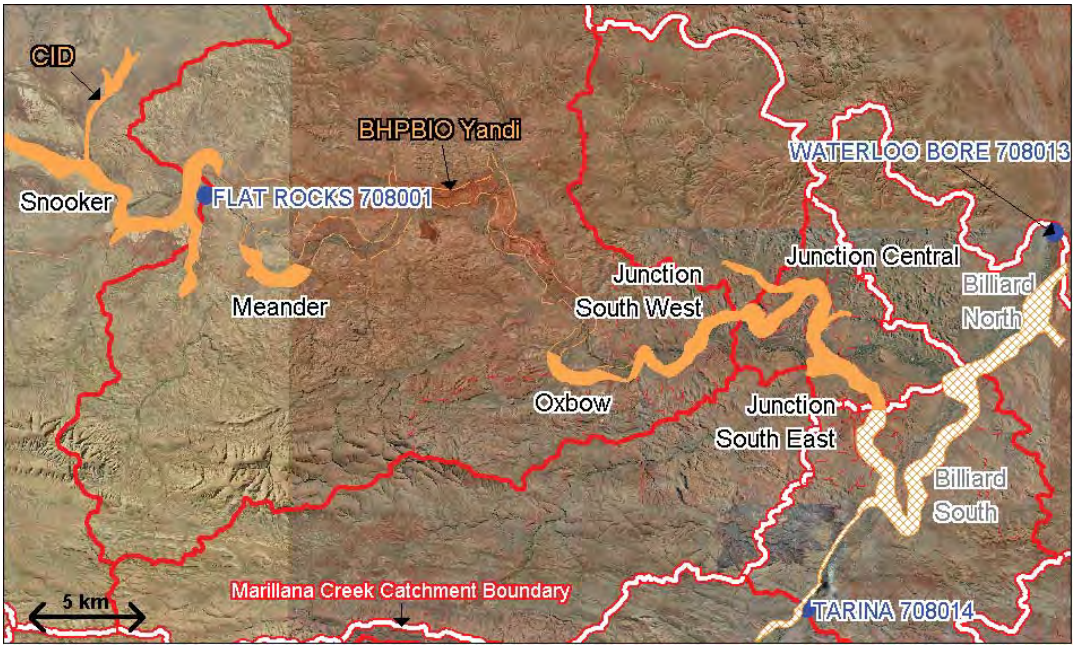


Figure 17 Gauging stations in the Yandicoogina locality

Based on this data, a conceptual pre-mining CID groundwater level contour map was created along the channel and the gradient was calculated based on the groundwater level elevations from measured resource drill holes detailed previously. The contour map indicates a water level gradient of 0.002 (2 m decrease every kilometre along 42 km strike of the palaeochannel). This resembles the natural surface elevation gradient with a drop of 98 m along 40 km distance starting from west of Oxbow to Billiard north.

The water levels in shallow monitoring bores drilled to the depth of approximately 50 m below ground level along the Weeli Wolli Creek (YW-P20, YW-P23, YW-P6 and YW-P4) range from 460 to 467 mRL. Monitoring bore YM119 has the longest continuous record at Billiard from May 1991 to 2009. The water level in 1991 was 465 mRL to present day levels at 476 mRL.

13.3 Groundwater chemistry

Total dissolved ions (TDS) in groundwater from the CID and alluvium range from 100 mg/L to 1,290 mg/L. The alluvium groundwater contains higher TDS compared to the CID aquifer. The groundwater from both aquifers are dominated by bicarbonate (HCO3-) anions, sodium (Na) constitutes a higher portion of the major cations followed by calcium (Ca) and magnesium (Mg).

Chloride (Cl) concentration ranges from 15 mg/L for the relatively fresh groundwater in the CID to a maximum of 280 mg/L in the alluvium. The average Cl concentration in the CID is 30% lower than that in the alluvium at ~120 mg/L. The relatively higher concentration of Cl in the shallow alluvium aquifer is due to direct evaporation from groundwater expressions and evapotranspiration by native vegetation along Marillana Creek.

13.4 Pre-mining surface hydrology

There are no permanent surface water features within the study area. Surface water is ephemeral, driven by rainfall events in the annual wet season. A dominant feature of the region is Fortescue Marsh, which is fed episodically by several major ephemeral creeks, including Weeli Wolli Creek. Marillana Creek, which is associated with Yandicoogina ore deposits, is a tributary of Weeli Wolli Creek, and itself has several significant tributaries including Yandicoogina Creek and Phils Creek.

An upstream gauging station (Flat Rocks, Figure 17) provides baseline hydrological data[19]. Waterloo Bore and Tarina gauging stations are located downstream of Hope Downs and Yandicoogina discharges, and are useful for assessing mining impacts.

The Flat Rocks gauging station rating curve is presented in Figure 18. There were seven rainfall events (five cyclones and two other events) between 1971 and 2003 which produced flows greater than 100 m^3/s, with the highest flow during the period recorded at 839 m^3/s. This equates to a water level of approximately 4 m.[20]

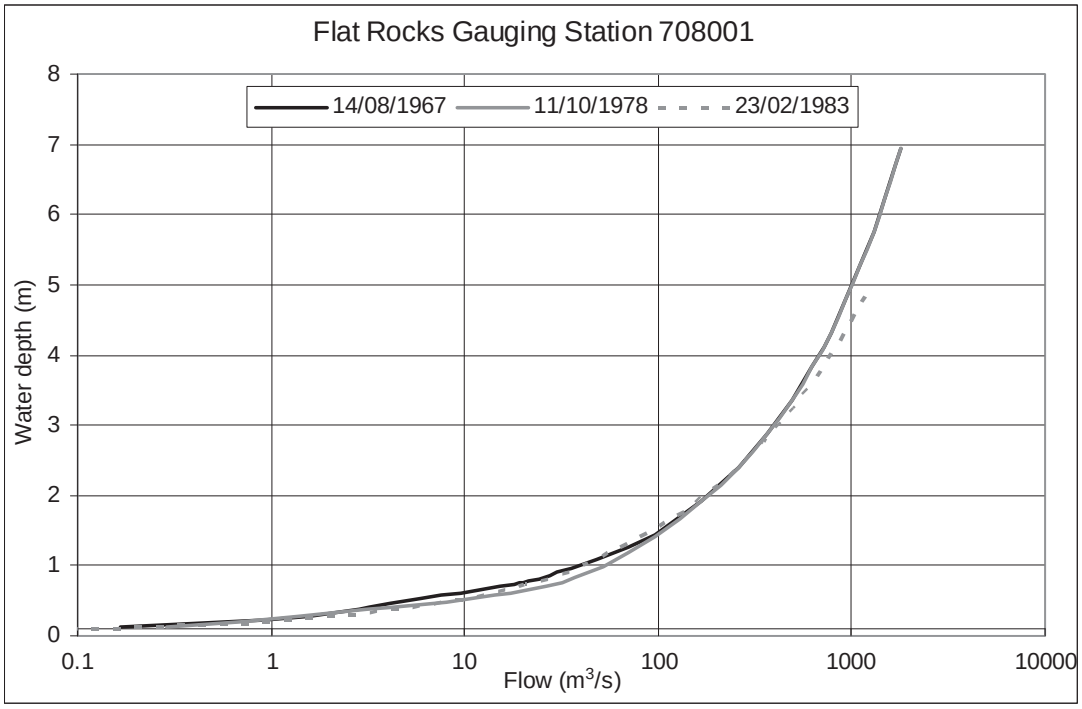


Figure 18 Flat Rocks Gauging Station rating curve

[19] RTIO, Marillana Creek Catchment Hydrology and Local Catchment Impacts, Yandicoogina +52 Mtpa Expansion Prefeasibility Junction South West (Stage 1) and Oxbow Deposits, January 2008, RTIO-PDE-0047262

[20] RTIO, Marillana Creek Catchment Hydrology and Local Catchment Impacts, Yandicoogina +52 Mtpa Expansion Prefeasibility Junction South West (Stage 1) and Oxbow Deposits, January 2008, RTIO-PDE-0047262

13.5 Ground and surface water interactions

As observed, there are no naturally occurring permanent surface water features present in the study area. All creeks are ephemeral and flow only occasionally after rainfall events, and groundwater is recharged via such events. The high connectivity between ephemeral creek systems and the CID aquifer has been demonstrated through recent geochemical research[21].

The volume of water captured in the Marillana catchment is massive, and a single rainfall event can lead to a significant degree of groundwater rebound. This is shown in Figure 19, which shows groundwater levels at Bore YM117 (located at the south-east corner of Junction Central near Marillana Creek). The groundwater level consistently recharges 5 to 8 m in this bore after a large rainfall event, and up to 18 months of pumping is required to reduce groundwater to pre-event levels.

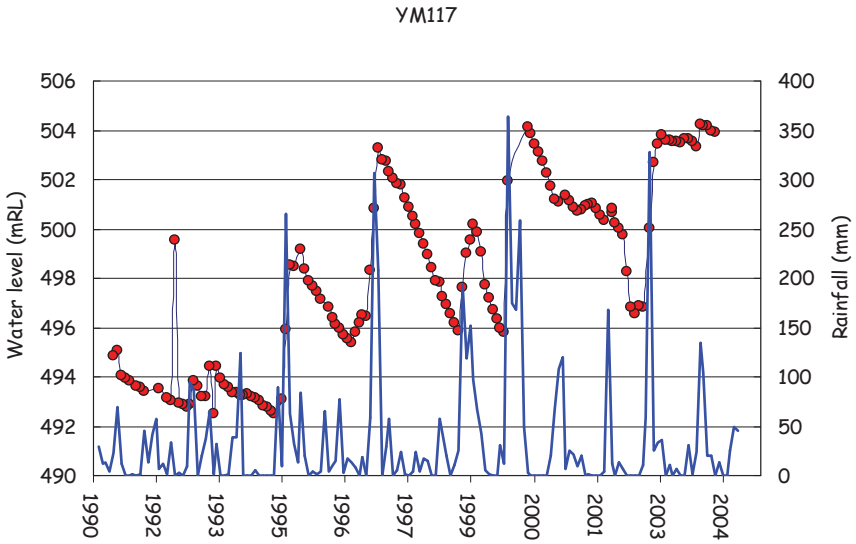


Figure 19 Relationship between rainfall and groundwater levels at Bore YM117

13.6 Environmental and social values

13.6.1 Environmental values of water

A substantial amount of research has been undertaken on riparian vegetation in and adjacent to the Yandicoogina mining area. Much of the focus of this research has focussed on the effects of dewatering and surface discharge on three key creek line species, *Eucalyptus victrix* (Coolibah), *Eucalyptus camaldulensis* (River Red Gum) and *Melaleuca argentea* (Silver Cadjeput).

In general terms, Eucalypt species begin to exhibit stress when soil water content goes above or below an optimal level. By contrast, *Melaleuca argentea* only becomes increasingly stressed as soil water content decreases (Figure 20).[22]

[21] RTIO, Yandicoogina Water Balance, Pre and Post Mining Hydraulics and Hydrochemistry, April 2010, RTIO-PDE-0073467

[22] Grierson P, Ecological Water Requirements in Dynamic Environments – Research Collaboration 1995-present, Powerpoint presentation, November 2009, RTIO-HSE-0077573

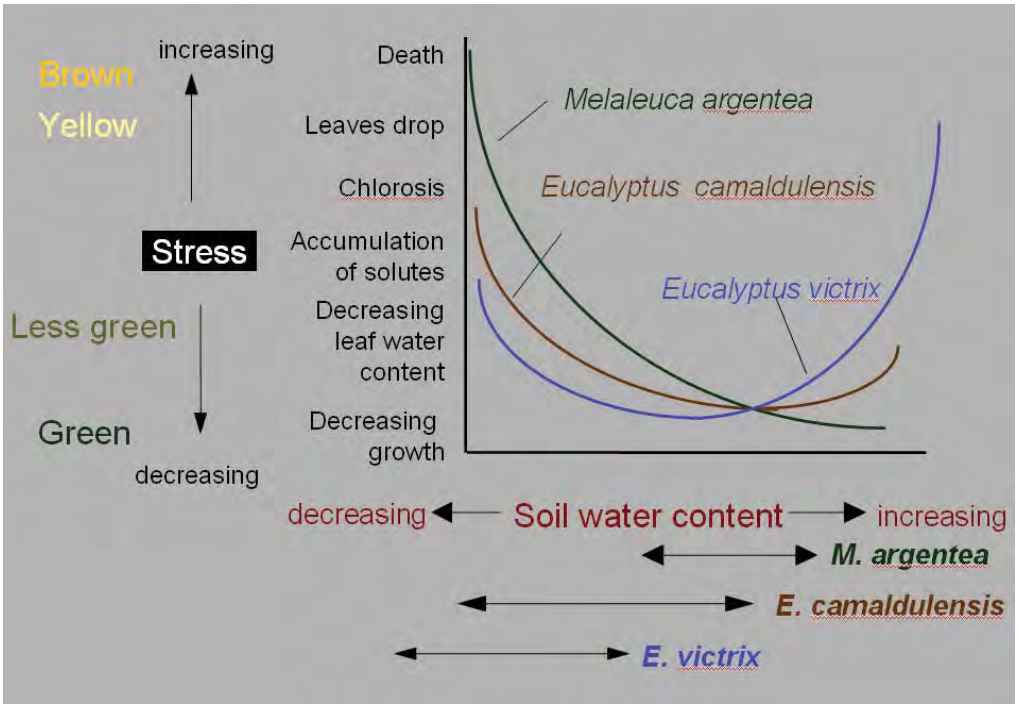


Figure 20 Soil water content response of selected riparian trees in the Yandicoogina area (Grierson 2009)

The Eucalypt species have been shown to be relatively resilient to water table fluctuations, because they are able to extract water variably through deep tap roots or shallow lateral roots depending on relative availability. Conversely, *Melaleuca argentea* is far more reliant on its shallow roots. Generally however, most riparian species show a relatively plastic response to soil moisture fluctuations.

Long term changes to the water regime may impact the range of individual riparian species along the creek lines, with some species favoured by increasing water levels, and others favoured by dryer conditions. Stygofauna are discussed further in Section 23.4.

13.6.2 Social values of water

Water has high significance for regional Indigenous communities[23]. Water is a highly valued resource in the Pilbara. The views represented by the Traditional Owners of the Yandicoogina area are consistent with those of other Indigenous people of the Pilbara and regions across Australia. A recently commissioned report by RTIO explains, '…*that in Indigenous belief systems water is perceived as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Waters sources are derived from the actions of mythic beings during the Dreaming and are the most important features in the Pilbara cultural landscape. Sustaining and protecting country, including the relationships Traditional Owners have with particular places, was found to be the primary obligation for people*'.[24]

[23] Rumley & Barber, We Used to Get Our Water Free – Identification and Protection of Aboriginal and Cultural Values of the Pilbara Region, April 2004, Study report prepared for the Water & Rivers Commission

[24] Barber & Jackson, Water and Indigenous People in the Pilbara: A Preliminary Study Funded by Rio Tinto Iron Ore, September 2010, CSIRO

Understanding water and drainage systems and their significance to the Traditional Owners should be an ongoing concern for the successful management of cultural heritage values within the Yandicoogina study area.

Past ethnographic consultation at the Yandi project has identified a number of culturally important creeks. The major named creeks in and around Yandicoogina, Marillana, Yandicoogina, Weeli Wolli and Phil's Creek have all been identified at one time or another as areas with high cultural value.

While no specific cultural or mythological information has to date been provided during any one heritage survey, linkages with creation beings and the sustaining influence of water on the environment and adjacent water systems is a recurring theme during discussions of the creeks and springs in the region.

Further investigation by RTIO on the cultural significance of water in its mining areas is being undertaken, and outcomes may influence future revisions of this closure study.

13.6.3 The effect of mining on water systems

Yandicoogina mining is conducted largely below water table, and dewatering is therefore required for ore access. Extracted water is discharged at the surface downstream of mining areas, and via a reinjection bore field located east of Weeli Wolli Creek. The program is inefficient due to leakage of discharged water back into mining areas being significantly greater than had been originally anticipated, combined with natural leakage from the Weeli Wolli Creek system and RTIO has been unable to lower the mining table sufficiently to access ore at the base of the orebody given current discharge licence limits.

The most significant consequence of dewatering has been the establishment of stretches of permanent water flows downstream of discharge points. RTIO modelling[25] indicates that the wetting front due to combined excess mine discharges (Yandicoogina, BHPBIO and Hope Downs 1 mine operations) could extend down Weeli Wolli Creek a maximum of approximately 17 km from the Marillana Creek confluence[26]. Such an outcome would avoid impacts at Fortescue Marsh, which is a further 23 km downstream.

Dewatering is expected to have minimal long term influence on regional water systems, as the volume of water entering the catchment during a single large rainfall event consistently leads to groundwater recharge of 5 to 8 m[27].

[25] RTIO, *Baseline Hydrology Assessment for Marillana Creek Discharge*, May 2010, RTIO-PDE-0074001

[26] This modelling result assumes a worst case combined discharge scenario of 110 GL/yr from RTIO mines at Yandicoogina and Hope Downs 1 and BHPBIO Yandi, with selected discharge outlets located downstream from current location. RTIO monitoring results appear to validate the model

[27] RTIO, *Yandicoogina Water Balance, Pre and Post Mining Hydraulics and Hydrochemistry*, April 2010, RTIO-PDE-0073467, also see Figure 19.

14 Biodiversity

14.1 Completed studies

Key reports providing baseline biodiversity data for Yandicoogina are listed in Table 5.

Table 5 Key baseline biodiversity reports at Yandicoogina

Title	FDMS Ref
Rio Tinto Iron Ore (Western Australia) Biodiversity Action Plan, September 2010, RT Technology & Innovation	RTIO-HSE-0067816
Rio Tinto Iron Ore – Yandicoogina Revegetation Reference Sites, July 2009, Mattiske Consulting Pty Ltd, component of a wider baseline vegetation study across RTIO Pilbara mine sites	RTIO-HSE-0098922
Yandi JSE Project – Conservation Significant Vegetation, Flora, Fauna and Fauna Habitat Assessment, October 2005, Biota Environmental Services Pty Ltd	RTIO-HSE-0059518
Yandi Expansion Areas Rare Flora Survey, February 2003, Biota Environmental Services Pty Ltd	RTIO-HSE-0014711
Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey, December 2004, Biota Environmental Services Pty Ltd	RTIO-HSE-0057590
Vegetation Mapping and Rare Flora Searches of Yandi Backfill Hill, September 2005, Biota Environmental Services Pty Ltd	RTIO-HSE-0014923
Yandicoogina Junction South East Project: Riparian Vegetation Management Plan, June 2006, prepared for Hamersley Iron by Strategen	RTIO-HSE-0016254
Yandicoogina Subterranean Fauna Assessment Phases I-V, December 2010, Biota Environmental Services	RTIO-HSE-0101408

14.2 Flora

14.2.1 Baseline vegetation communities

In its original assessment of Junction Central mining areas, the EPA assessed that creek vegetation is locally significant[28]. However, in its subsequent assessment of the Junction South East mining areas, the EPA noted that such vegetation is widespread[29]. There are no Commonwealth or State listed Threatened Ecological Communities at Yandicoogina[30] . Yandicoogina vegetation communities can be broadly classified into three groups, as described in Table 6.

[28] Environmental Protection Authority Bulletin 809, Yandicoogina Iron Ore Mine and Railway, April 1996 (p21)

[29] Environmental Protection Authority Bulletin 1195, Yandicoogina Junction Southeast Mine, Mining Lease 274SA, September 2005 (p10)

[30] The nearest listed community is the Priority Ecological Community at Weeli Wolli Springs, 10-20 km to the south. This is sufficiently distant and upstream that it should not be impacted by Yandicoogina activity.

Table 6 Yandicoogina baseline vegetation communities

Vegetation group and types	Description
Low stony hills - Vegetation type 1a to 1g	Low stony hills generally with a scattered overstorey of *Eucalyptus leucophloia* (Snappy Gum), *Corymbia hamersleyana* (Bloodwood), *Acacia inaequilatera* (Kanji) and/or Hakea *chordophylla* over moderately dense spinifex, predominantly *Triodia* aff. *basedowii*, with some *Triodia wiseana* on slopes.
Valleys (mosaic communities) – Vegetation type 2a to 2c	Undulating, low stony plains in valleys generally comprising of *Corymbia hamersleyana* (Bloodwood) over sparse mixed shrubs and various species of spinifex. Alluvial flats are dominated by *Acacia aneura* (Mulga) and other *Acacia* communities over moderately rich assemblages of shrubs, herbs and tussock grasses, as well as spinifex, *Triodia wiseana* and *T. pungens.*
Creeks – Vegetation type 3a to 3h	Drainage lines vary from small gullies in upper hills to more major creeklines in the Hamersley Ranges (Weeli Wolli, Yandicoogina and Marillana Creeks). Small, stony creeks in hills differ very little from the vegetation type surrounding them, and are usually species poor with occasional Eucalypts over *Triodia* aff. *basedowii* and *T. wiseana.* Lower in the landscape, they become more densely vegetated and species rich, including Eucalypt and Bloodwood species, shrubs, annual and perennial tussock grasses and herbs. Major creeklines comprise of woodlands and forests of *Eucalyptus camaldulensis* (Red River Gum), *E. victrix* (Coolibah) and other tree species over mixed shrublands, grasslands and herbs. Spinifex (usually *Triodia pungens* or *T. longiceps*) is comparatively sparse in drainage lines. Typical shrubs in drainage lines include *Acacia coriacea* subsp. *pendens* (major creeks only), *A. ancistrocarpa* (mainly in minor creeks), *A. bivenosa, A. pyrifolia, A. tumida* var. *pilbarensis, Gossypium robinsonii* and *Petalostylis labicheoides.* Major creeks sometimes have areas of apparent permanent or persistent water that support specialised water plants.

A study was undertaken in 2009 to collect suitable baseline data to enable subsequent rehabilitation success to be assessed[31]. Relevant data is summarised in Table 7. Note that the study did not consider creek line vegetation.

Creek line tree health has been monitored around Yandicoogina (Marillana and Weeli Wolli Creeks) since 2002, with the aim of measuring the impact of dewatering and discharges associated with mining. This research appears to indicate that climate is currently the most significant factor, and that there are significant year-to-year variations in crown cover and foliage cover due to climatic conditions[32].

Pilbara ecosystem research, including research into the relationship between water availability and riparian tree health, is currently being undertaken at Yandicoogina and other sites. The research is a collaborative partnership between RTIO and the University of Western Australia, and is supported by the Australian Research Council (ARC) funding.

[31] Mattiske Consulting Pty Ltd, Rio Tinto Iron Ore – *Yandicoogina Revegetation Reference Sites*, July 2009, RTIO-HSE-0098922

[32] Mark Adams, *Report on Monitoring of Tree Health at Paraburdoo and Yandi Mine Sites 2005/6*, June 2007, RTIO-HSE-0049593

Table 7 Yandicoogina control site vegetation statistics (2009)

	Lower slopes / flat	Midslopes	Upper slopes / hilltops
Bare ground (%)	20.8 ± 4.2 (std error)	10.8 ± 2.1 (std error)	12.1 ± 2.5 (std error)
Live plant density (plants/m^2)	Range 2.3 – 2.6	Range 2.6 – 6.0	Range 4.2 – 10.9
Foliage cover (%)	Range 27.3 – 31.9	Range 32.1 – 33.2	Range 18.7 – 29.0
Species richness (per m^2)	Range 0.7 – 1.1	Range 0.4 – 1.0	Range 0.5 – 0.85
Dominant plant types (average alive plants/m^2)	Perennial grasses (1.65) Shrubs (0.6) Perennial herbs (0.2)	Perennial grasses (3.5) Shrubs (0.2) Perennial herbs (0.04)	Perennial grasses (5.8) Sedge (2.0) Shrubs (0.1)
Dominant plant types (alive % foliage cover)	Perennial grasses (21.4) Shrubs (5.8) Trees (2.0)	Perennial grasses (26.6) Shrubs (4.5) Trees (1.5)	Perennial grasses (23.0) Shrubs (1.9) Trees (0.2) Sedge (0.1)

14.2.2 Rare and priority flora

Surveys for rare and priority flora have been undertaken across the length of the orebody and surrounding areas, as shown in Figure 21.

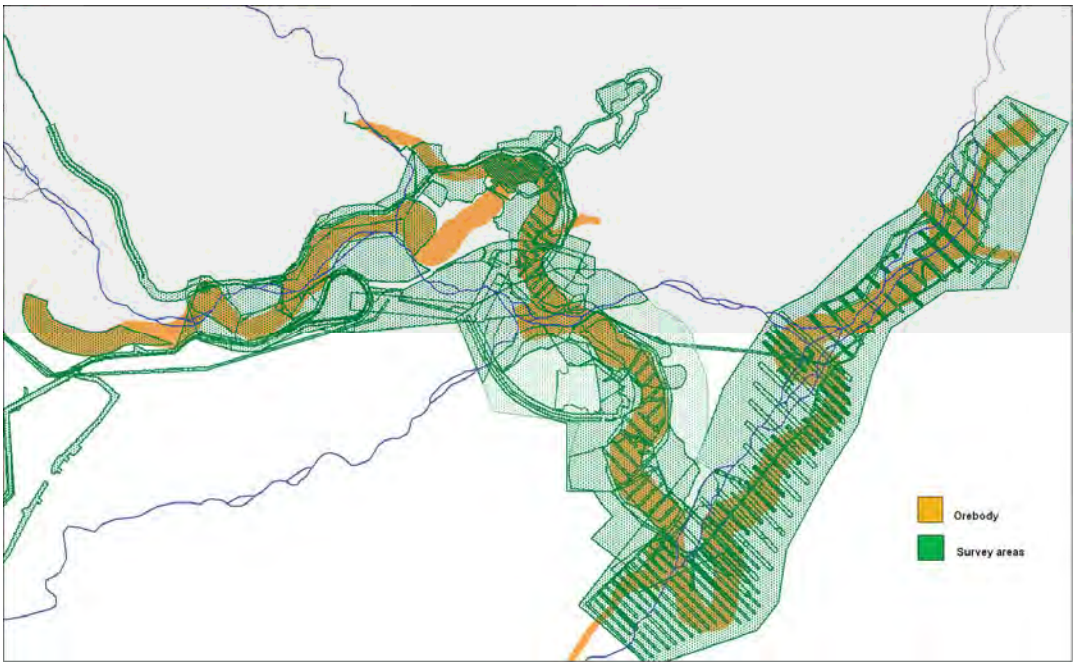


Figure 21 Yandicoogina flora survey areas

The following Declared Rare Flora (DRF) and Priority flora have been identified at the site[33]:

- *Lepidium catapycnon* (DRF [WA] & Vulnerable [Commonwealth]),
- *Rhodanthe frenchii* (Priority 2),
- *Sida* species Barlee Range (Priority 3),
- *Themeda* species Hamersley Station (Priority 3),
- *Rhychosia bungarensis* (Priority 3), and
- *Rostellularia adscendens* var. *latifolia* (Priority 3).

Neither Priority 2 nor Priority 3 listed species are currently assessed to be under immediate threat, but are listed because they are being considered for declaration as 'rare flora' and require further survey work. These species are not considered further in this study, but may require consideration in subsequent closure studies if their listing changes.

13.2.2.1 *Lepidium catapycnon* (Hamersley Lepidium)

Lepidiums are members of the mustard family, and other members of the genus are known as peppercresses, pepperweeds or pepperworts. The Hamersley Lepidium (*Lepidium catapycnon*) is a short lived perennial herb or shrub up to 40 cm high (Figure 22). It is listed as declared rare flora (DRF) by the Western Australian DEC, and by the Federal Government as Vulnerable. The species is known from 23 populations in the Pilbara[34]. It has been recorded at several Yandicoogina locations, as indicated on Figure 23. Although 'Backfill Hill' is likely to provide suitable habitat for the species, it has not been recorded there.

Figure 22 Lepidium catapycnon (Photo from the DEC Florabase website)

[33] Note that this list only captures species that have been observed in the study area: it does not include species that have been identified as having populations in the general area, and that have similar habitat requirements to those found in the study area. Note also that historic survey reports list other Priority species are being present in the study area: these were listed by the DEC as Priority species at the time of survey, but have subsequently been removed from the schedules.

[34] Department of Environment Water Heritage and Arts, Approved Conservation Advice for: Lepidium catapycnon (Hamersley Lepidium), December 2008
http://www.environment.gov.au/biodiversity/threatened/species/pubs/9397-conservation-advice.pdf

One of these locations (a hillside approximately 1 km west of the confluence of Marillana and Yandicoogina Creeks and adjacent to a bitumen JSE access road and conveyor) has a population of approximately 200 plants, one of the largest populations known. Approval to take this population was obtained from the Department of Conservation and Land Management in November 2005[35], as a precautionary measure prior to conveyor construction. Disturbance was avoided, and the permit has now expired. An exclusion zone has been established at this location.

Research has been undertaken into rehabilitation of the species[36]. It was found that the use of the growth hormone gibberellic acid enabled germination rates approaching 90% in the laboratory and concluded that good germination results are likely to be possible in the field.

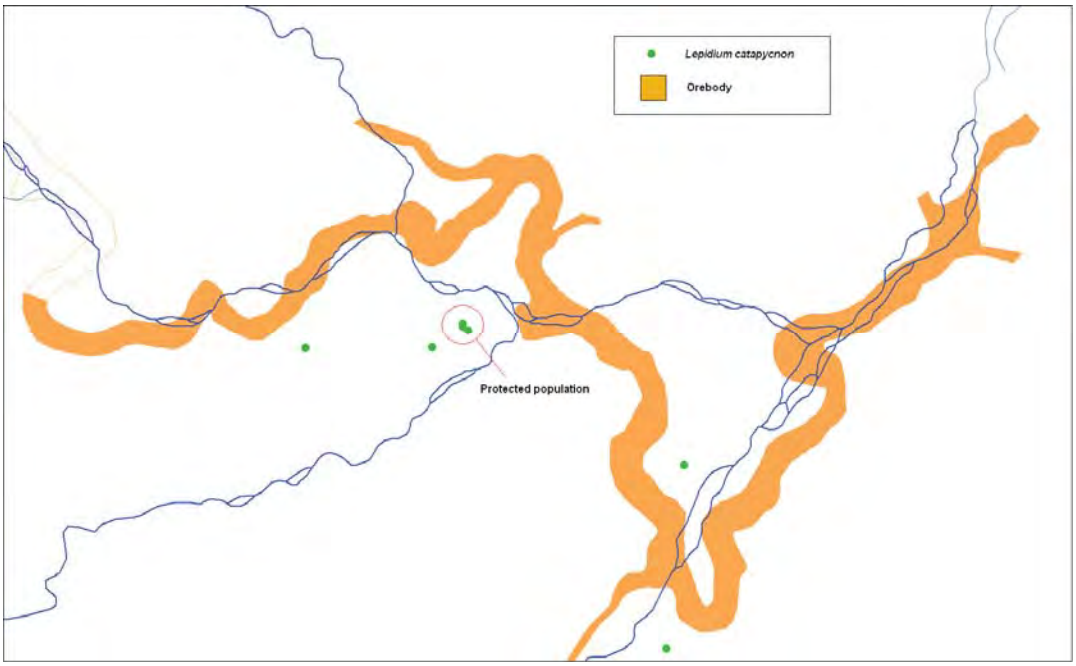


Figure 23 Recorded locations of Lepidium catapycnon in the Yandicoogina locality

14.3 Fauna

14.3.1 Fauna habitats

There are no restricted or otherwise significant habitats present in the Yandicoogina area that might be expected to support rare or restricted fauna[37] . Ephemeral water courses in the Pilbara have been identified as 'ecosystems at risk'[38], although they not included on Federal or State conservation lists.

[35] Permit to Take Declares Rare Flora Number 36-05/06, available at FDMS No RTIO-HSE-0059523

[36] Department of Conservation and Land Management (now DEC), The germination requirements of seeds of the rare Hamersley *Lepidium catapycnon* (Brassicaceae), February 2000, report to BHP Iron Ore Pty Ltd.

[37] Biota, *Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey*, December 2004, report prepared for Hamersley Iron Pty Ltd, RTIO-HSE-0057590

[38] Department of Conservation and Land Management 2003, *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*, Department of Conservation and Land Management, Perth

14.3.2 Rare and priority fauna

Seven rare or priority fauna have been identified as present, or likely to be present, at Yandicoogina[39]:

- Northern Quoll (*Dasyurus hallucatus*) (Declared Schedule 1 [rare or likely to become extinct], and also Federally listed as Endangered),
- Pilbara Olive Python (*Liasis olivaceus barroni*) (Declared Schedule 1 in Western Australia, and also Federally listed as Vulnerable),
- Peregrine Falcon (*Falco peregrinus*) (Declared Schedule 4 [otherwise protected fauna] in Western Australia),
- Australian Bustard (*Ardeotis australis*) (Priority 4 [WA]),
- Bush Stone-curlew (*Burhinus grallarius*) (Priority 4 [WA]),
- Star Finch (*Neochmia ruficauda subclarescens*) (Priority 4 [WA]), and,
- Western Pebble-mound Mouse (*Pseudomys chapman*) (Priority 4 [WA]).

The listing given to the Northern Quoll is the highest protection level in Western Australia and the second highest protection level nationally. The listing given to the Pilbara olive python is less severe, but still indicates a need for special consideration. Both species are discussed in further detail in this section.

The Peregrine Falcon is also a species considered to require special protection, although it is currently not considered rare or likely to become extinct. However, given that it has an extensive distribution that covers most of Australia it is not considered further in this report.

Priority 4 species are not considered to be currently threatened or in need of special protection, but could be if present circumstances change. They are also not considered further.

It should be noted that the Western Pebble-mound Mouse was identified in the 1996 Yandicoogina (Junction Central) approval as a species of concern[40]. The species was once considered to be rare, but its presence has been consistently noted in surveys across the Pilbara. Its range is no longer considered to be small or fragmented, and it was removed from the Threatened Species list in 1997.

13.3.2.1 Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll (Figure 24) is one of four species of quoll, a family of carnivorous marsupials. The Northern Quoll is the smallest of the four, growing to the size of a large kitten[41].

---

[39] Biota, *Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey*, December 2004, report prepared for Hamersley Iron Pty Ltd, RTIO-HSE-0057590

[40] Environmental Protection Authority Bulletin 809, Yandicoogina Iron Ore Mine and Railway, April 1996

[41] Department of Environment and Heritage, Quolls of Australia, undated Facts Sheet available at http://www.environment.gov.au/biodiversity/threatened/publications/pubs/quolls.pdf

Figure 24 The Northern Quoll[42]

The Northern Quoll distribution extends across northern Australia, from the Gascoyne region of Western Australia to the New South Wales border (Figure 25). Early fauna surveys at Yandicoogina failed to identify the species[43], however two specimens were observed in a building at the site in 2009. A targeted survey commenced in October 2009 to confirm its presence in the region[44]. The survey found no evidence of Northern Quoll in the area and it is thought that the individual specimens may have been driven out of their normal range due to an event such as bushfire.

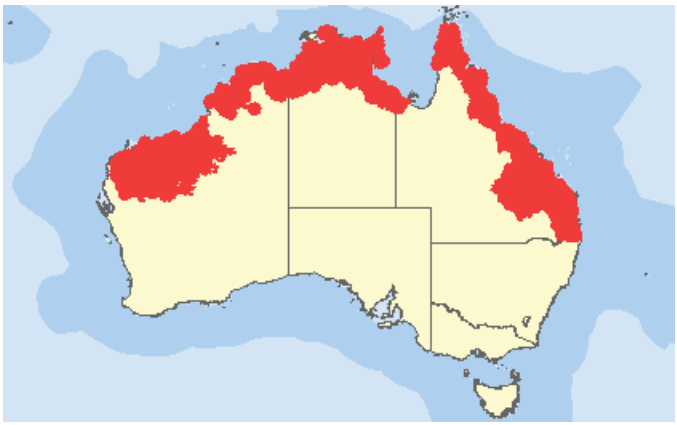


Figure 25 Northern Quoll distribution[45]

The Northern Quoll northern quoll is primarily carnivorous, with a diet that includes small vertebrates, reptiles, frogs and insects. Queensland and Northern Territory populations have been significantly reduced following introduction of the poisonous cane toad. Observed population declines in cane toad infested areas have been dramatic, and the species does not appear to have recovered or re-established in such areas[46].

---

[42] Photograph courtesy of Perth Zoological Gardens

[43] Biota, *Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey*, December 2004, report for Hamersley Iron Pty Ltd

[44] Biota, *Yandicoogina Targeted Northern Quoll Survey*, December 2009, RTIO-HSE-0086579

[45] Map from Department of Environment Heritage Water and the Arts website

[46] Department of Environment Heritage Water and the Arts, Northern Quoll Dasyurus hallucatus Listing Advice, approved 12 April 2005

Notwithstanding this, the Northern Quoll was already in decline prior to the introduction of cane toads, and has also been in decline in non-infested areas.

It should be noted that whilst cane toads have been considered responsible for rapid population declines, Northern Quolls are naturally vulnerable due to natural factors: breeding is on a strict annual cycle, with mating occurring over a confined period mid-year. Males generally live only for a single season, with a life expectancy of only 11–12 months. Approximately one half of females die before weaning their first litter, and one third survives for a second breeding season. Disruptions to a single breeding season (e.g. due to environmental factors) are therefore likely to have a substantial impact[47] .

Northern Quoll populations in the Pilbara region have substantially declined in the Pilbara, particularly in the past 20 years. Although the reason is unknown, altered fire regimes and the impact of cattle are considered likely factors[48]. Although predictions of future Cane Toad distribution indicate that it is unlikely to infest the Pilbara region in large numbers[4950], the species still warrants special protection in the area.

The Federal Government has identified priority actions associated with conservation of the Northern Quoll[51]. Actions that may be relevant to this closure study include:

- Minimise the impact of colonising cane toads on the species by:
    - investigating the use of physical barriers or other means, where feasible, to prevent the colonisation of key habitat areas
    - undertaking translocation and management of northern quoll populations in safe havens where necessary
- Identifying areas of critical habitat (e.g. island populations)
- Investigate the need to establish a captive breeding program for the species.

A species recovery plan has been prepared to manage priority actions[52]

---

[47] Oakwood M, *Reproduction and Demography of the Northern Quoll, Dasyurus hallucatus, in the Lowland Savanna of Northern Australia,* Australian Journal of Zoology, 2000, 48, p519. Note that this article presents the results of research undertaken at Kakadu National Park, and variations have been observed in populations living in different locations (e.g. rocky habitat vs lowland, coastal vs inland, tropical vs dry). Whilst this data is useful for understanding the species generally, there may be some differences observed in Yandicoogina populations

[48] Department of Environment Heritage Water and the Arts, *Northern Quoll (Dasyurus hallucatus*) *Listing Advice*, approved 12 April 2005

[49] Department of Environment Water Heritage and the Arts, *The Biological Effects, Including Lethal Toxic Ingestion, Caused by Cane Toads (*Bufo Marinus*)*, 12 April 2005, advice on amendments to Key Threatening Processes under the EPBC Act.

[50] Notwithstanding that the cane toad is not expected to populate the Pilbara in large numbers, the Yandicoogina area may provide good habitat due to the presence of surface water, particularly if wet seasons become more intense. Salinity increases generated as a result of mining activity is unlikely to restrict cane toad spread, as it is tolerant to such conditions.

[51] Department of Environment Heritage Water and the Arts, *Northern Quoll* Dasyurus hallucatus *Listing Advice*, approved 12 April 2005

[52] Hill & Ward, *National Recovery Plan for the Northern Quoll* Dasyurus hallucatus, 2010. Report prepared for the Northern Territory Department of Natural Resources, Environment, the Arts and Sport, and endorsed by the Australian Federal Government and Western Australian and Queensland State Governments.

13.3.2.2 Pilbara olive python (*Liasis olivaceus barroni*)

The Pilbara Olive Python Liasis olivaceus barroni is a subspecies of the more widespread olive python Liasis olivaceus olivaceus (Figure 26), the range of which extends from northern Western Australia, through Northern Territory and into western Queensland. By way of contrast, the Pilbara olive python is restricted to the Pilbara, as shown on Figure 27.

Figure 26 Olive python (Liasis olivaceus olivaceus)

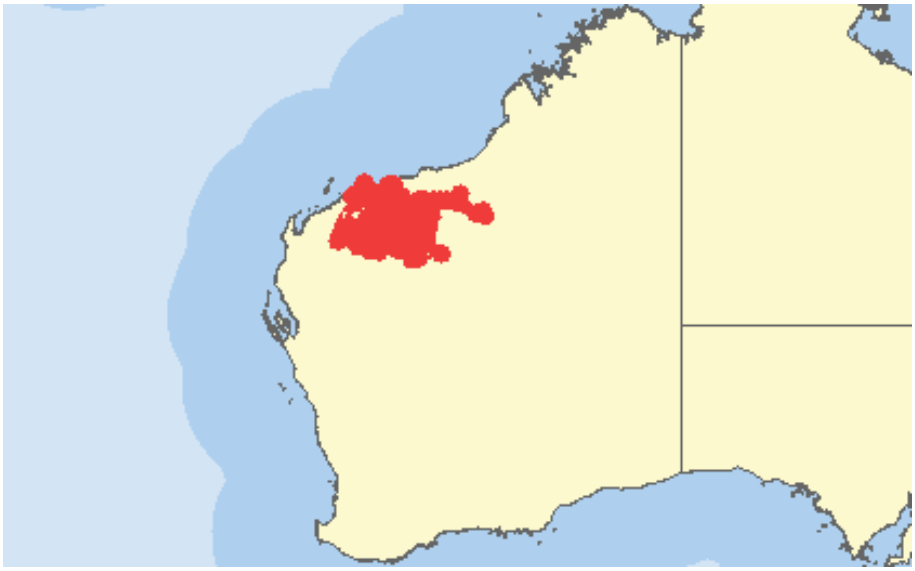


Figure 27 Pilbara Olive Python distribution[53]

The Pilbara Olive Python subsp. barroni differs from the subsp. olivaceus in that it grows larger (up to four metres, with an average length of 2.5 metres), and has a greater number of scales[54].

[53] Map from Department of the Environment Water Heritage and the Arts website

[54] Information obtained from Pilbara Pythons website http://www.pilbarapythons.com/olivepython.htm

The Pilbara Olive Python's regular habitat is characterised rocky habitats near water , particularly deep gorges and water holes. The presence of water is important, as it often ambushes prey from a submerged position[55]. The species is present in Karijini National Park gorges, and has been recorded in Marillana Creek near Yandicoogina, as well as at the Yandicoogina camp[56].

The Federal Government has identified direct predation by feral cats and foxes, and predation of its prey by the same species, as main threats to the Pilbara Olive Python[57]. A 2001 State biodiversity audit found that the species was relatively common within its range, and that its listing as Vulnerable is unjustified[58]. Notwithstanding this, the Department has indicated to RTIO that it is important to recognise the significance of the Pilbara Olive Python[59].

The Federal Government has identified priority actions associated with conservation of the Pilbara Olive Python[60]. Actions that may be relevant to this closure study include:

- Manage any changes to hydrology which may result in changes to the water table levels, increased run-off, sedimentation or pollution,
- Implement (plans) for the control and eradication of foxes and cats in the local region,
- Raise awareness of the Pilbara olive python within the local community,
- Identify populations of high conservation priority, and
- Investigate options for linking, enhancing or establishing additional populations.

14.4 Stygofauna and troglofauna

Stygofauna monitoring has been conducted regularly at Yandicoogina since 1998, with at least seven separate monitoring events. Species accumulation curves indicate that the number of new taxa to be recorded is likely to be low. Troglofauna monitoring was first conducted in 2009[61].

At least 46 taxa of stygofauna have been collected the Yandicoogina area, with most specimens collected from shallow alluvial layers close to the surface. Of these, 12 are known only from the project area. However, this is expected to be an artefact of limited sampling, rather than an indication that any of these species are locally endemic. Taxa known only from the project area are similar to species that have been collected more widely, and it is expected that a similar pattern would follow. There are no geological reasons to suspect a high degree of endemism.

---

[55] Department of Environment Water Heritage and the Arts, *Approved Conservation Advice for Liasis olivaceus barroni (Olive Python – Pilbara subspecies)*, approved July 2008

[56] Biota, *Yandi Expansion Desktop Fauna Assessment and Targeted Invertebrate Survey,* December 2004, report for Hamersley Iron Pty Ltd, RTIO-HSE-0057590

[57] Department of Environment Water Heritage and the Arts, *Approved Conservation Advice for Liasis olivaceus barroni (Olive Python – Pilbara subspecies)*, approved July 2008

[58] Department of Conservation and Land Management, *2002 Biodiversity Audit: Pilbara 3 (PIL3 – Hamersley Subregion*), October 2001

[59] Correspondence dated 28 October 2005, RTIO-HSE-0014992

[60] Department of Environment Water Heritage and the Arts, *Approved Conservation Advice for Liasis olivaceus barroni (Olive Python – Pilbara subspecies)*, approved July 2008

[61] Biota, *Yandicoogina Subterranean Fauna Assessment Phases I-V,* December 2010, RTIO-HSE-0101408

Yandicoogina does not provide ideal troglofauna habitat due to frequent inundation during periods of heavy rainfall. Three potentially troglobitic species have been collected, none of which are endemic to the area.

14.5 Biodiversity values

RTIO has undertaken an assessment of biodiversity values based on studies and assessments conducted to date, including those referenced in Table 8.

A Biodiversity Action Plan (BAP) has been developed to cover all RTIO sites, including Yandicoogina. The relevance of identified values to Yandicoogina closure is indicated in Table 8.

Table 8 Relevance of key Yandicoogina biodiversity values identified in the RTIO BAP to closure

Biodiversity value identified in RTIO BAP	Comments
Fortescue Marsh	Fortescue Marsh has been nominated for RAMSAR listing, and is a primary focus for regulators. The marshes are downstream of Yandicoogina, but sufficiently distant that impacts are not expected. Closure strategies should be assessed to predict impacts to Fortescue Marsh.
Weeli Wolli Springs Community	Weeli Wolli Springs, and the associated ecological community, are located sufficiently upstream that Yandicoogina closure is not expected to have the potential for impact. Not considered further in this closure study.
Northern quoll	Endangered mammal previously sighted at Yandicoogina, although subsequent targeted surveys indicate that the sighted specimens may have been visitors to the area. Management of this species should be considered in the development of closure strategies. The creation of suitable habitat may have the potential for positive regional biodiversity impacts.
Pilbara olive python	Vulnerable reptile previously sighted at Yandicoogina. Management of this species should be considered in the development of closure strategies. The creation of suitable habitat may have the potential for positive regional biodiversity impacts.
Stygofauna	Several previously unrecorded species have been collected, but there is no evidence that mining activities may result in species loss. Closure strategies should be assessed to predict impacts to stygofauna populations.
Acacia subtiliformis	Priority 3 species (i.e. assessed as not currently under direct threat). Not considered further in this closure study.
Lepidium catapycnon	Declared Rare Flora with significant populations present. Management of this species should be considered in the development of closure strategies.

15 Contaminated sites

A preliminary contaminated sites investigation was conducted by RTIO personnel at Yandicoogina in May 2007[62] in order to determine whether the site should be reported to the Government under the *Contaminated Sites Act 2003*. The investigation included a review of the findings of a 2001 contaminated sites investigation undertaken by consultants SKM[63]. The investigation concluded that the site should be reported as a suspected contaminated site, with further investigation to be undertaken to assess the extent of contamination. The Government has not yet responded to the report.

A Preliminary Site Investigation (PSI) has been undertaken, and a Sampling and Analysis Plan (SAP) prepared, by consultants URS in 2010[64]. The following areas were identified as being 'potentially high risk', with a further 19 areas identified as 'moderate risk':

- Light and heavy vehicle wash bays
- Heavy vehicle refuelling
- Lube bay and above-ground storage tanks, and,
- Surface water culvert.

The SAP outlines the process for assessing contamination in high and moderate risk areas.

[62] Pilbara Iron, *Phase 1 Contaminated Sites Audit Yandicoogina – May 2007*, May 2007, FDMS RTIO-HSE-0029639

[63] Sinclair Knight Merz, *Stage 2 Phase 2 Contaminated Sites Study,* report prepared for Hamersley Iron Pty Ltd, August 2001

[64] URS, *Rio Tinto Iron Ore Preliminary Site Investigation and Sampling and Analysis Plan: Yandicoogina,* July 2010, RTIO-HSE-0094696

Closure knowledge base (4): social aspects

This section outlines the current understanding of social aspects that may be relevant to the development of closure strategies.

16 Heritage values

Extensive archaeological and ethnographic surveys have been undertaken within the Yandicoogina locality, principally in association with mining activities in the area[65]. These reports help to inform the heritage values of the Yandicoogina area. It is important to note that these studies are primarily project specific; as such the Traditional Owner response identifying areas of archaeological and ethnographic significance do not often encompass areas beyond these project zones. The representative Traditional Owners participating in surveys will offer cultural information on a need to know basis. Additional surveys and consultation will be required across the life of the mine.

Key information contained in this Section is available in open reports upon request[66]. The information contained within these reports is confidential to Rio Tinto Iron Ore (RTIO) and the representative bodies, management committees and members of the Gumala Aboriginal Corporation (GAC), Martu Idja Banyjima, Innawonga Banjima and Nyiyaparli claim groups and must not be disclosed to any other person or organisation without the written permission of the all of these groups with the following exceptions: State and Commonwealth agencies (e.g. The Department of Indigenous Affairs, the Department of Environment and Conservation, the Department of Industry and Resources, the Department of Environment and Water Resources) for the purposes of demonstrating compliance with various State and Commonwealth regulatory and other requirements.

Caution should be exercised to ensure that cultural sensitivity is preserved.

17 Stakeholder Consultation

17.1 Profile of local community

17.1.1 Regional towns

Yandicoogina is a remote mine site that operates on a 100% FIFO (Fly-in, Fly-out) worker basis. The nearest town is Newman, which is ostensibly linked to BHPBIO operations in the area (particularly the Mt Newman mine which is located on the outskirts of the town). The RTIO Yandicoogina mine has negligible interaction with Newman or any other local towns.

Service providers are largely flown directly to the site, although it is possible that local service providers may be utilised from time to time. For the purposes of this study, it is assumed that Yandicoogina closure will not impact on local service providers.

[65] Davis, Yit & Burke, *Yandicoogina Cultural Heritage Management Plan DRAFT*, 2009, RTIO Internal document.
[66] RTIO Heritage Sites Register and RTIO Heritage Reports Register. Note: this is in contrast to a closed report, which contains information that is sufficiently sensitive to require restricted access.

The small town of Nullagine, located 130 km northeast of Yandicoogina, has a high proportion of Aboriginal residents, and is subject to a specific work program aimed at improving employment opportunities. Further information is provided in Section 17.1.3.

17.1.2 Workforce

As of August 2009, there were 557 personnel (employees and Category 1 contractors) on site. This is anticipated to increase to around 600 by 2011 based on projections arising from the current mine plan.

All personnel are employed on a FIFO basis, with the majority based in Perth. Fifty six personnel (46 employees and 10 Category 1 contractors) commute from Busselton, a regional town with a population of 24,000; with the potential for greater numbers in the future. A further 10 trainees fly in from Nullagine, as outlined below.

The total number of Indigenous personnel currently employed at Yandicoogina is 27, with a further six Category 1 contractors. This is in addition to the 10 Indigenous trainees involved in the Nullagine workforce program.

17.1.3 The Nullagine workforce program

RTIO operates programs to facilitate Indigenous employment at its Pilbara operations. One such program involves a 12-week Work Start pre-employment program in Nullagine, a small community of around 200 people, located approximate 130 km northeast of Yandicoogina. The first graduates commenced work at Yandicoogina in 2008.

Nullagine was formerly a major regional gold mining centre with a peak population of approximately 3,000 prior to World War I. Population declined dramatically with the collapse of the Pilbara gold mining industry. The most recent census (2006) listed the population at 217, 109 of whom were Indigenous. Most of these speak Aboriginal languages (primarily Martu Wangka) as a first language. Unemployment in the town is around 30%.

Two of the ten current trainees are Bunjima people, and therefore have some connection with the Yandicoogina area. This number is likely to increase as the program develops. Similar workforce programs have been proposed for other towns in the Pilbara.

17.2 Relevant Aboriginal groups

According to early anthropological studies, the Yandicoogina mining area is located at the confluence of territories of three Aboriginal language groups: Bunjima (Pandjima, Panyjima)[67], Nyiyaparli (Naibali, Nyiyaparli) and Palyku (Bailgu). The current representation of Traditional Owner boundaries is reflected in the Native Title Claim boundaries[68]. According to these claims (which are still to be determined by the Native Title Tribunal), the Yandicoogina mine is located on the traditional country of the Martidja Banyjima (MIB), Innawonga Banyjima (IB), and Nyiyaparli peoples. Native Title claim areas are shown in Figure 28.

[67] Multiple spellings apply to many Aboriginal groups in accordance with variations to how they are anglicised. The first name mentioned is in current use, with common alternatives provided in brackets. Note that the primary names used in this closure study report differ from those used by McDonald (AHIS report ID 20435).

[68] National Native Title Tribunal Register of Native Title Claims and Determinations

In the past, these groups lived a hunter-gatherer-fisher lifestyle throughout the central Pilbara. Evidence suggests they often lived together, intermarried, and met for ceremonies.

Anthropologists have discussed the MIB, IB and, Nyiyaparli groups as belonging to a "central Pilbara culture block," sharing an understanding of cultural norms, laws, and customs[69]. Relationships between these groups are organised through the 'skin system,' which crosses language boundaries and dictates much of the social structure for Central Pilbara Aboriginal society.

The geographical boundaries of the MIB, IB and Nyiyaparli, Aboriginal groups cannot be distinguished by linguistics alone, and any attempt to define group boundaries through linguistic groupings is potentially problematic (i.e. Tindale 1974). Research in the Central Pilbara demonstrates that Indigenous identification with traditional lands or 'country' is more attributed to broader kin groups than to language groups[70]. Boundaries are also dynamic and will have changed over time.

Yandicoogina mine is nominally considered to be on Bunjima territory (Bunjima and MIB), with Nyiyaparli land commencing to the east of Weeli Wolli Creek. However, these boundaries are fluid, and the area is considered to straddle the country of both groups[71].

The Paylku people identified by Tindale (1974) are more generally identified with the Fortescue Marsh area to the north of Yandicoogina than with Yandicoogina itself, although there is some evidence of historic connection. They are closely related to the Nyiyaparli people and have mixed freely with them. The Paylku people (as a separate group to Nyiyaparli) have not been prominent in Yandicoogina agreement negotiations.

Aside from Bunjima and Nyiyaparli, a third group was heavily involved in development of the Yandicoogina Land Use Agreement: the Innawonga (more commonly associated with the Paraburdoo area). Bunjima, Nyiyaparli and Innowonga people are closely inter-related and share a common language (Bunjima)[72].

The three groups are represented by the Gumala Aboriginal Corporation, which was established during Yandicoogina negotiations.

---

[69] Day, B.. *Report on the ethnographic survey at possible burial site P02175, Yandi Village Walk trail and Billiards Drilling Project at Weeli Wooli Creek, Yandicoogina.* 2004. A report for Hamersley Iron Pty Ltd and Gumala Aboriginal Corporation.

[70] Clarke, C & Smith, M.. *Yandicoogina Prospect WA: A Survey for Aboriginal Sites (Final Report) – A Survey of Temporary Reserves 5259, 5603-4, 6685 and 6696 for CSR*. 1982, A report for CSR.

[71] Elizabeth McDonald, *Report of Archaeological Site Inspections and Ethnographic Consultation, 2003/2004 Yandicoogina Evaluation Drilling Program and Mine Expansion Yandicoogina, Pilbara, Western Australia (AHIS report ID 20435)*

[72] Clive Senior, *The Yandi Story (1998)*, internal RTIO report not available for external distribution

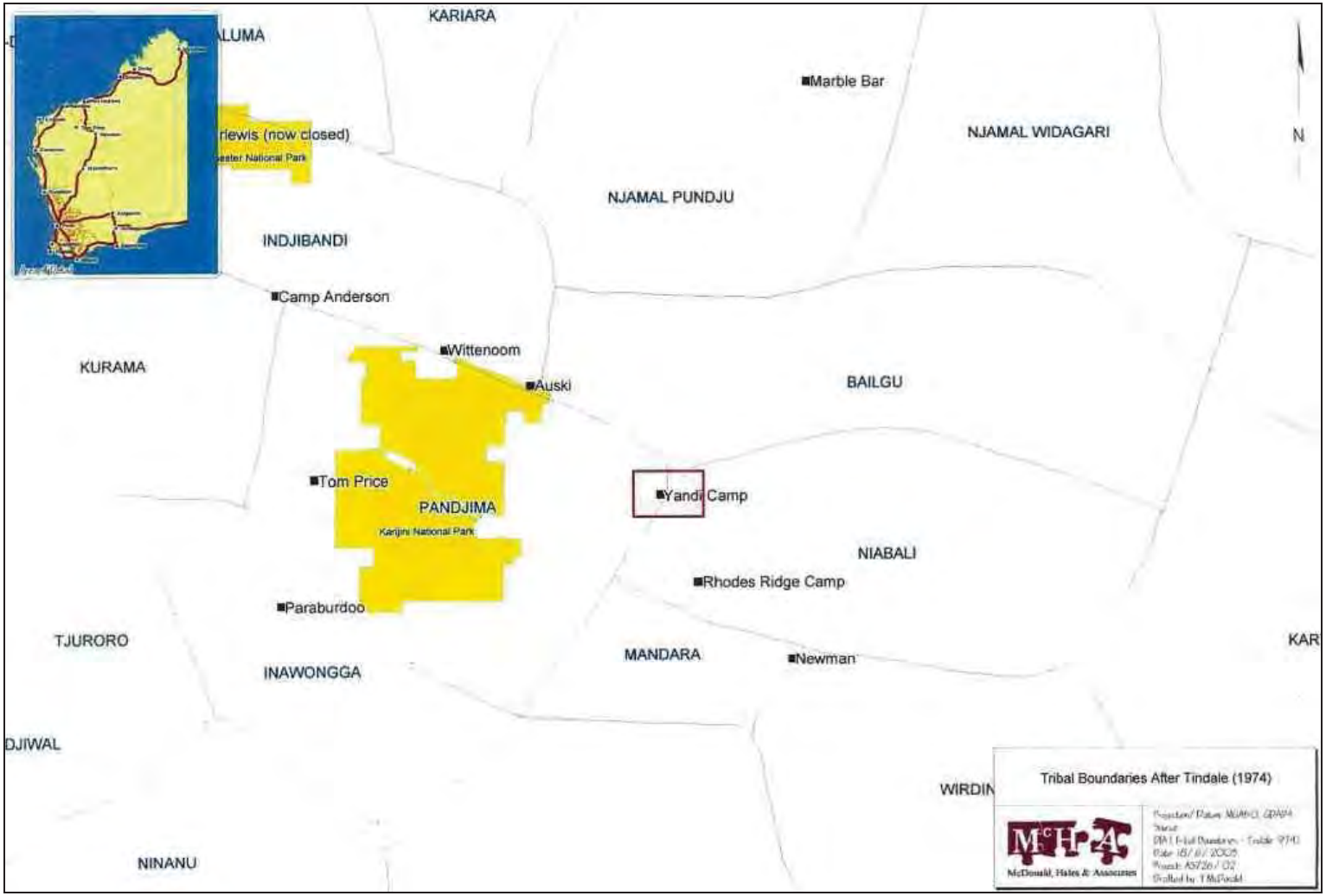


Figure 28 Native Title Claim Groups within the Yandicoogina Mine area (Tindale, 1974)

17.3 Ethnographic values

A number of ethnographic sites have also been identified in the Yandicoogina locality, most significantly in connection with Marillana Creek and Weeli-Wolli Creek. The creek systems are recognised to have important associations with camping, ceremonies and cultural activities[73]. A heritage exclusion zone is currently in force around Weeli-Wolli Creek, Marillana Creek and Phil's Creek. RTIO is required to consult with Traditional Owners and seek their approval prior to any disturbance within this exclusion zone. It should also be noted that any long-term alteration to the regional water regime is likely to be of high cultural significance.

Early consultation conducted as part of this study did not raise any specific ethnographic issues with respect to Yandicoogina closure. To date, consultation regarding closure has been at a broad options level and as such the main concerns raised by the Traditional Owners related to changes to the cultural landscape as a whole, rather than any site-specific concerns.

17.4 Archaeological sites

Numerous Aboriginal archaeological sites have been recorded: including artefact scatters, quarries, rock shelters, engraving sites and scarred trees. These sites range from low to high archaeological and cultural significance[74].

17.5 Non-Indigenous cultural heritage values

There are no known significant non-Indigenous cultural heritage values associated with the site.

17.6 Communication register

Table 9 documents communications undertaken to date that may be relevant to the development or implementation of closure strategies for the site.

[73] For example, see Chapter 6 of the 2008 Federal Native Title Report, *Indigenous Peoples and Water*, at http://www.hreoc.gov.au/social_Justice/nt_report/ntreport08/index.html. RTIO is currently undertaking a study to provide a better understanding of the cultural significance of water with respect to its operations in the Pilbara.
[74] Davis, Yit & Burke, *Yandicoogina Cultural Heritage Management Plan DRAFT,* 2009, RTIO Internal document.

Table 9 Communication register

Title of communication	Date(s)	Stakeholders	Outcomes
Junction Central environmental approvals	1996	EPA public process. Public submissions from: Conservation Council Dept Aboriginal Affairs Dept Conservation & Land Management Dept Minerals & Energy Dept Resources Development	The main closure concerns identified by stakeholders were: • Salinity of any remaining pit voids; and • Aquifer rebound, and vegetation stress caused by depressed groundwater levels. A commitment was made to develop a decommissioning plan at least 2 years prior to closure: the EPA considered this to be insufficient, and imposed a condition requiring the plan to be developed within 5 years of commissioning.
Agreement on key environmental criteria	1998	Department of Environment Water & Rivers Commission	Closure performance criteria agreed as part of the 1998 closure planning process. Agreed criteria were: • Maintain beneficial use (stock watering) water quality in Weeli Wolli braided area; • Limit extent and intensity of impact of drawdown on creek and phreatophytic vegetation to within 1 to 2 km of the pit; and • Limit the potential for saline development of in-pit water to less than 15,000mg/L. These criteria were re-affirmed in the 2003 closure plan update and approved by the DEC in 2005.
Junction South East environmental approvals	2005	EPA public process. Consultation was undertaken in preparation of Environmental Protection Statement with: Environmental Protection Authority • Dept Environment Dept Conservation & Land Management Conservation Council • Wildflower Society • Gumula Aboriginal Corporation BHP Billiton Iron Ore Hope Downs Management Services One public submission was received on a non-closure related topic during the public appeal period.	Closure related issues raised by stakeholders related to the following issues: • Salinisation of mine void lakes • Surveys and rehabilitation plans for 'Backfill Hill' prior to mining for backfill material • Mechanisms for development of completion criteria • Undertaking closure planning as a component of operational mine planning • Minimisation of the time between mining and rehabilitation The final proposal approved by the EPA included the following closure strategy (developed after stakeholder consultation, and not questioned during the public appeal period): *"Use out of pit waste dumps and ROM pad, plus additional mined fill, to backfill the final pit void to at least 490mRL. Rehabilitation of backfilled material to commence once final landforms are constructed and stable."* A commitment was made to revise the 2003 Closure Plan to include JSE within 12 months of commissioning: a closure plan was submitted in 2008, but it was not accepted by Government.

Title of communication	Date(s)	Stakeholders	Outcomes
Discussions with Government (2010 closure study)	2010	Office of the Environmental Protection Authority Department Environment & Conservation Department of Water Department of Mines & Petroleum	Several meetings were held with Government agencies in conjunction with consultation undertaken for the concurrent Junction South West expansion proposal, including a one day workshop 28 May 2010 where closure objectives and options were discussed. Departmental officers agreed that it may be appropriate to review existing objectives, but indicated that such decisions would need to be made by the OEPA. Efforts to engage discussion with the OEPA during the course of the study were unsuccessful. A formal letter was sent to the OEPA on 18 June 2010[75], with no response. DMP officers suggested that an objective be included that relates to erosion management. Departmental officers agreed that the existing closure strategy (partial backfill) is likely to be inappropriate, but indicated that formal endorsement of alternative strategies would need to be made by the OEPA. Departmental officers did not endorse any particular alternative closure strategy on the basis that further information is required to enable reasonable assessment. However; there was some qualified support for the 'channel' and 'pit void' options.

[75] Correspondence to Office of the Environmental Protection Authority dated 18 June 2010, RTIO-CR-0022848

Title of communication	Date(s)	Stakeholders	Outcomes
Discussions with Traditional Owners (2010 closure study)	2010	Gumula Aboriginal Corporation	The following discussions have been held to discuss issues arising from the 2010 closure study: • Half day workshop 24 March 2010 to discuss ethnographic values relevant to closure, to introduce closure options, and obtain feedback on options[76]; and • Attendance at the Gumala elders meeting 20 August 2010 to discuss issues specific to the 'channel final landform configuration' (the preferred landform scenario presented in this study report). Concerns were initially raised that the final landform would be different to the pre-mining landscape. No specific ethnographic values that may affect closure planning were identified in the discussions. It was clear at this stage that the Traditional Owners did not wish to provide definitive answers regarding the project, as the options discussed were at a broader strategic level. With respect to the channel configuration, the following issues were identified: • Any standing water should be of suitable quality to maintain a functional ecosystem; • The channel should be constructed in such a manner that enables egress to people or animals that enter; • Heritage surveys conducted to date are not sufficient to identify impacts. Surveys of additionally impacted areas would be required; • Consideration should be given to maintaining access from one side of the channel to the other; and Further discussions will be required with Traditional Owners when more specific closure plan details have been established.

[76] Workshop outcomes are documented in memo RTIO-CR-0024696. The summary of outcomes was also forwarded to Gumala Aboriginal Corporation on 26 March 2010

18 Yandicoogina closure objectives

A consolidated list of Yandicoogina closure objectives is presented in Table 10. A detailed description of each objective follows.

Table 10 Yandicoogina closure objectives

No.	Objective
1	Working with Indigenous communities and other stakeholders to preserve, protect and manage the cultural heritage values of the area
2	Considering the implications of closure on local communities when developing and implementing closure strategies
3	Negotiating completion criteria with Government stakeholders, and working towards achieving those goals
4	Returning the area to landforms that are safe, stable and compatible with the surrounding environment
5	Working towards achieving environmental outcomes that are compatible with the surrounding environment
6	Working with employees and stakeholders to identify and manage ongoing employment and other opportunities
7	Achieve closure objectives in a cost effective manner
8	The water in any pit voids should be able to support natural ecosystems
9	Environmental values of Fortescue Marsh should not be compromised
10	Closure strategies should be complimentary to those employed at the BHPBIO Yandi mine
11	Final landforms should be designed and constructed so as to withstand erosive forces associated with floodwaters

18.1 Description of objectives that apply to all RTIO sites

RTIO has developed a general vision for closure of its sites. The closure vision contains seven closure objectives, as outlined below.

18.1.1 Cultural heritage values

Objective 1: Working with Indigenous communities and other stakeholders to preserve protect and manage the cultural heritage values of the area

RTIO recognises the strong links that Traditional Owners have with their land, and respects Native Title claims and determinations.

Mining activity in the Pilbara often occurs in areas which are significant to Indigenous communities. Where this is the case, it is often not possible to avoid cultural heritage impacts during operation. When developing closure strategies, consideration needs to be given to developing landforms that are consistent with long-held cultural heritage values, to restoration of sites that may have been disturbed during operation, and to ensuring that the final land use

enables ongoing heritage protection. This is a process that requires the involvement of Traditional Owners.

18.1.2 Impacts to local communities

Objective 2: Considering the implications of closure on local communities when developing and implementing closure strategies

Communities in mining areas of the Pilbara are heavily dependent upon the mining industry. Closure of sites with residential populations, or that employ local services, will have profound impacts on the local community.

Whilst such impacts are likely to be inevitable, effective closure planning requires that they be recognised and strategies developed to mitigate them. Strategies are also required to assist the community to effectively prepare for change.

18.1.3 Completion criteria

Objective 3: Negotiating completion criteria with Government stakeholders, and working towards achieving those goals

RTIO has a long term objective of relinquishing its sites to the Government. However, this can not happen without achieving agreement on the criteria to be met in relation to land rehabilitation.

18.1.4 Safe, stable and compatible landforms

Objective 4: Returning the area to landforms that are safe, stable and compatible with the surrounding environment

Landforms would ideally be reinstated to pre-mining states. However; this will generally not be practically or economically viable, and assessment is required to identify alternative landforms that are acceptable. Landform stability and compatibility with the surrounding environment are two critical considerations in final landform design.

18.1.5 Appropriate environmental outcomes

Objective 5: Working towards achieving environmental outcomes that are compatible with the surrounding environment

The environmental outcomes to be achieved upon closure will depend on the preferred land use option for the site. This objective is intrinsically linked to working towards the achievement of agreed relinquishment criteria, which are likely to focus predominantly on rehabilitation objectives, and that will be developed to support the agreed end land use.

It is acknowledged that the act of mining will generally lead to localised loss of habitat. Rigorous pre-mining assessment of impacts and effective stewardship during operations will minimise the extent and significance of such losses, and ensure that regional biodiversity is not compromised.

Upon closure, it may not be possible to reinstate local habitat to its pre-mining state. Indeed, such a result may not be compatible with the agreed end land use (e.g. the land may be converted for pastoral activities).

RTIO aims to achieve positive regional biodiversity outcomes. This does not necessarily mean that rehabilitation will lead to local ecosystems that are improved beyond pre-mining states, although opportunities to do this need to be actively pursued where practicable. However; where local ecosystems can not be restored to an acceptable degree then regional offsets and other conservation actions should be considered.

18.1.6 Workforce management

Objective 6: Working with employees and key stakeholders to identify and manage ongoing employment and other opportunities

Closure of any site has implications for site personnel, and for contractors that provide services to the site. In many cases, site closure will force personnel and their families to relocate.

Direct transfer to other sites will be a viable option for many employees. However, not all employees will be able to transfer to comparable positions at other mines. Other options, such as career changes within the company, redundancy or retirement may be applicable. The company needs to discuss available options with its employees to enable the most appropriate opportunities to be progressed.

Strategies are also required to facilitate a smooth transition for employees affected by closure. This includes provision of training opportunities as the site approaches closure, and relocation assistance for those so affected.

Special focus needs to be given to local Indigenous employees and service providers, as relocation opportunities may be more limited.

Rio Tinto generally has no legal obligations to non-employee service providers upon closure of the site. However, the implications of closure on such providers will be considered where appropriate.

18.1.7 Cost effective closure implementation

Objective 7: Achieving closure objectives in a cost effective manner

Cost effectiveness is an important consideration in the assessment of closure options. Whilst the best possible environmental and social outcomes are desirable objectives for closure, this may be restricted by economic viability. Less expensive options may still deliver acceptable (but not necessarily the best) environmental and social outcomes.

A sustainable development approach is taken in the Rio Tinto closure planning process, whereby the social, environmental and economic implications of closure options are considered, and those which achieve the best overall outcomes are selected.

18.2 Description of Yandicoogina specific objectives

Several additional objectives have been drafted to take into account specific environmental and social values associated with the Yandicoogina area.

18.2.1 Pit water quality

Objective 8: The water in any pit voids should be able to support natural ecosystems

Traditional Owners have suggested during consultation that pit lakes have the potential to improve the local landscape, but only if the water is of a suitable quality to support natural ecosystems. RTIO intends to adopt this concept as a key closure objective for Yandicoogina.

There is no permanent surface water present in the study area, so the creation of pit lakes will represent a departure from the natural environment.

The nearest permanent water is located at Weeli Wolli Springs to the south and Fortescue Marshes to the north. These water bodies present dramatic differences in water quality, with the former being fresh and the latter ranging from sub-potable to hypersaline (depending on the length of time since last rainfall). Both water bodies are capable of supporting a variety of fauna, including fish, tortoises and frogs[77]. The area is therefore capable of sustaining natural ecosystems in and around water bodies of varying salinity. Notwithstanding this, a fresh water body is likely to be seen as having greater environmental value than a saline one.

Elevated salinity levels could be expected to develop within any pit lakes that feature in the Yandicoogina final landform due to an evaporation rate that exceeds rainfall. This does not necessarily preclude the ability of the lake to support a natural ecosystem, but it may limit biodiversity outcomes.

It may be possible to design pit lakes at Yandicoogina so as to limit the extent to which salinity increases (e.g. by promoting surface and groundwater flushing). Opportunities to achieve this should be implemented where appropriate.

This objective requires RTIO to undertake modelling to predict post-closure water levels and quality, and institute measures to maximise the biodiversity outcomes possible within those constraints.

18.2.2 Fortescue Marsh

Objective 9: Environmental values of Fortescue Marsh should not be compromised

Fortescue Marsh has been identified by stakeholders as a wetland area of great significance, and listing under the Ramsar Convention on Wetlands has been proposed.

Current monitoring and modelling data indicate that Fortescue Marsh is sufficiently downstream that it is not impacted by current or proposed mining operations. RTIO considers the likelihood of impacts associated with Yandicoogina closure to be low. Nevertheless, this objective requires RTIO to undertake assessments to confirm that this is the case.

---

[77] FMG, Fortescue Marshes Management Plan, October 2006, available at http://www.fmgl.com.au/IRM/Company/ShowPage.aspx?CPID=1524

18.2.3 Compatibility with BHPBIO Yandi closure strategies

Objective 10: Closure strategies should be complimentary to those employed at the BHPBIO Yandi mine

The RTIO Yandicoogina and BHPBIO Yandi operations are adjacent to one another, and the closure outcomes at one site will affect those at the other. It is therefore important that consideration be given to both sites when planning for closure.

RTIO Yandicoogina operations are undertaken on BHPBIO pastoral tenure. Communication is therefore required to ensure that the closure objectives and outcomes planned by RTIO are compatible with long term BHPBIO aspirations for its pastoral lease.

18.2.4 Erosion management

Objective 11: Final landforms should be designed and constructed so as to withstand erosive forces associated with floodwaters

This objective can be seen as an extension of Object 4, which relates to the creation of stable landforms. However; the management of floodwater erosive forces has been identified as a significant issue for Yandicoogina due to its local topography, and one that presents challenges unlikely to be relevant at most other sites.

Identification and Management of Closure Issues

This plan outlines how RTIO intends to achieve the conceptual final landform configuration, and how the design will be further developed in subsequent closure studies.

19 Process for selecting a final landform configuration

Consideration of final landform design is important at an early stage of project development, as it may influence critical operational design and implementation decisions. The process of developing a final landform design involves:

- Identifying closure objectives (Section 17) that may be relevant to final landform design
- Developing potential landform design options that are consistent with the RTIO closure vision, and are likely to achieve relevant closure objectives
- Sustainability assessment of potential options to arrive at a preferred final landform design
- Stakeholder consultation to confirm that the preferred final landform design is likely to be acceptable
- Modelling the effects of the preferred landform design on environmental systems.

20 Final landform configuration

Preliminary studies have been undertaken to assess the viability of implementing the 'channel option', which was the preferred configuration arising from the sustainability assessment[78].

The current long term mine plan assumes that the ore body is mined from several discrete pits from Oxbow in the west to Billiard North in the east (Figure 29). The pits are separated where the orebody runs underneath or adjacent to ephemeral creek lines.

[78] SKM, *Rio Tinto Iron Ore Yandicoogina Operation: Final Landform Channel Option*, September 2010, RTIO-CR-0025223

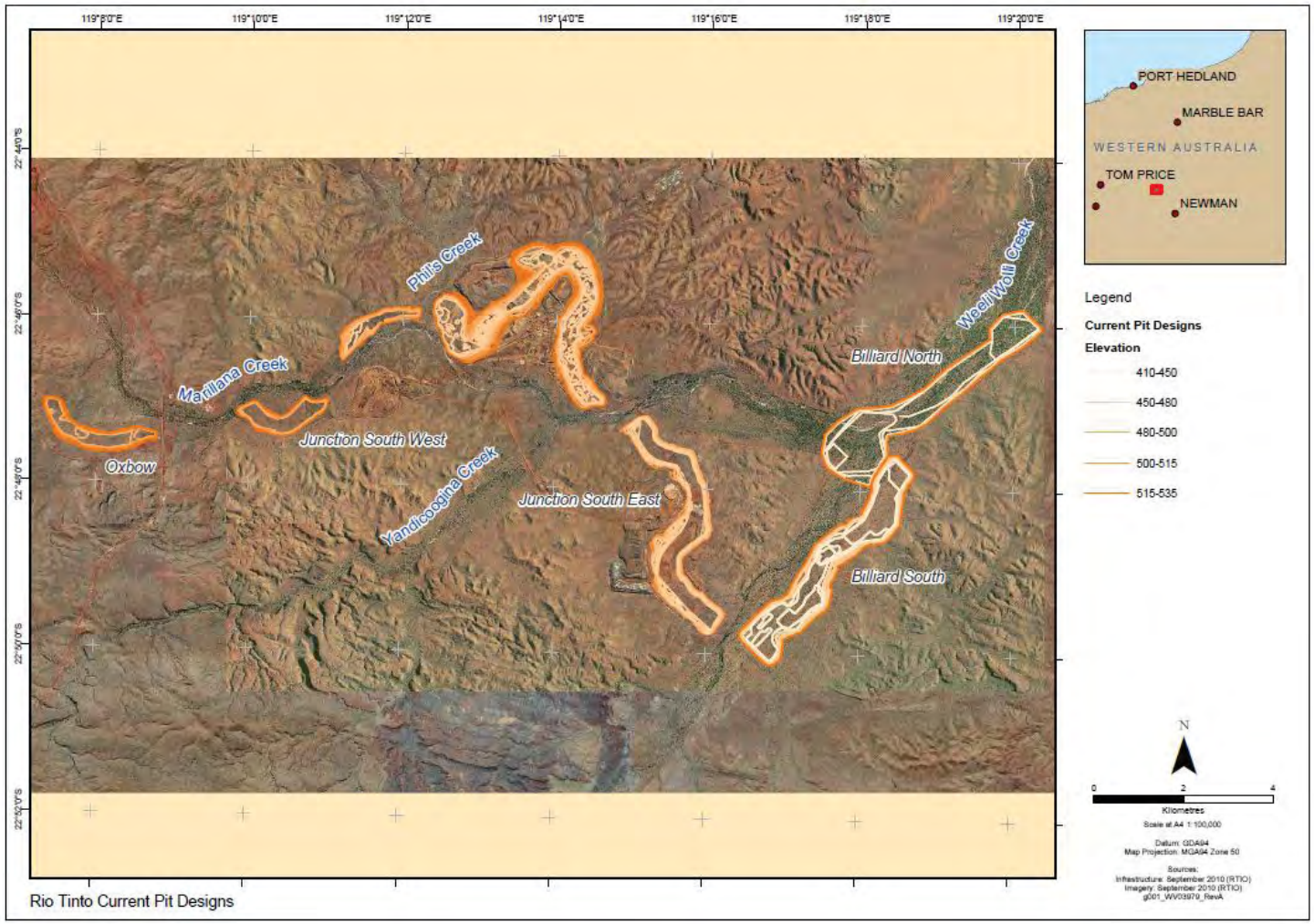


Figure 29 Long term mine plan showing proposed pit outlines

The final landform configuration would involve:

- Diversion of creek lines to enable excavation of material from between the current pit shells, to form a single continuous 'channel' pit (Figure 30)
- Backfill of the western end of the channel to above water table using mining waste material, with retention of the eastern half below water table. This would lead to a permanent pit lake forming in the eastern half of the channel (Figure 31),
- Local landscaping of channel walls with mining waste material to achieve a nominal maximum slope of 15 degrees (Figure 32),
- Construction of engineering solutions, at points where surface water flows would be directed to enter and exit the channel pit lake (i.e. Marillana Creek, Phil's Creek, Yandicoogina Creek and Weeli Wolli Creek, and smaller tributaries as required). The purposes of these structures would be to mitigate erosion during pit lake filling and initial discharge and over a long-term (Figure 33),
- Construction of levees to prevent water from entering the channel at uncontrolled locations, and,
- Rehabilitation of banks to assist in erosion control, and to promote biodiversity enhancement,
- Habitat establishment such as revegetation and placement of woody debris along channel pit lake margins[79].

It should be noted that the landform configuration has been designed on the basis that there will be no external waste dumps present after closure, waste material that is stored in external waste dumps during the mine's operational phase will be used to backfill and landscape the channel in accordance with the final landform design.

[79] Van Etten, E.J.B. (in review) Riparian vegetation considerations for pit lakes, In, Pit lakes: Design and Management, McCullough, C. D. (ed) Australian Centre for Geomechanics, Perth, Australia.

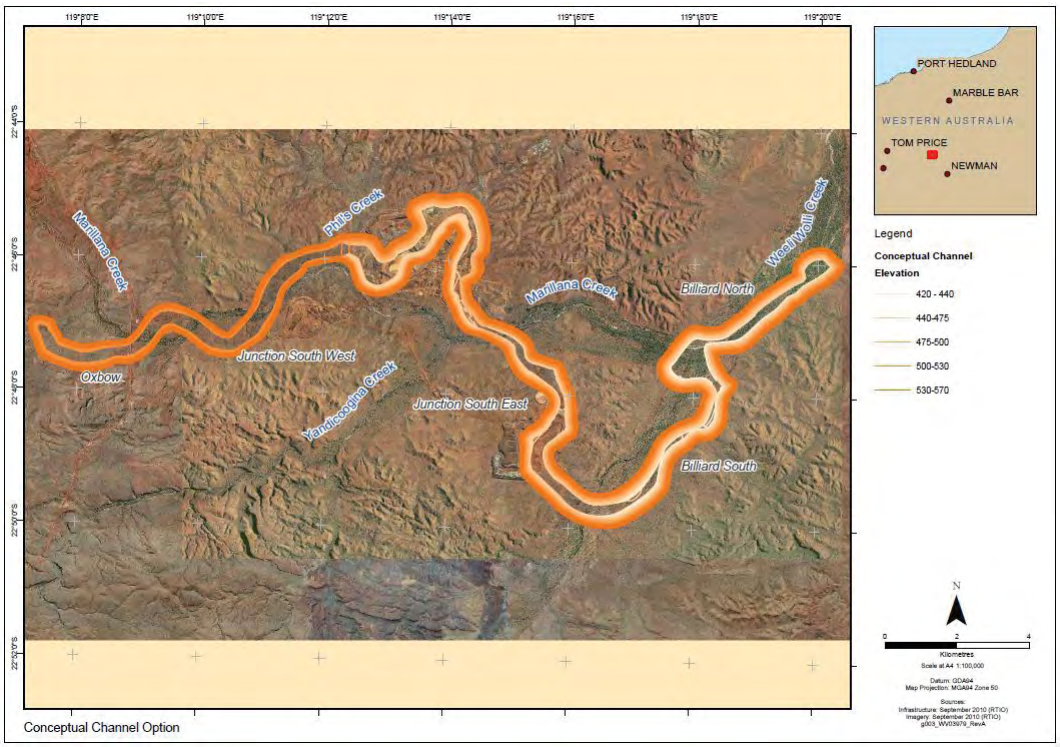


Figure 30 Final landform configuration (top view)

Figure 31 Final landform configuration (top view showing pit lake)

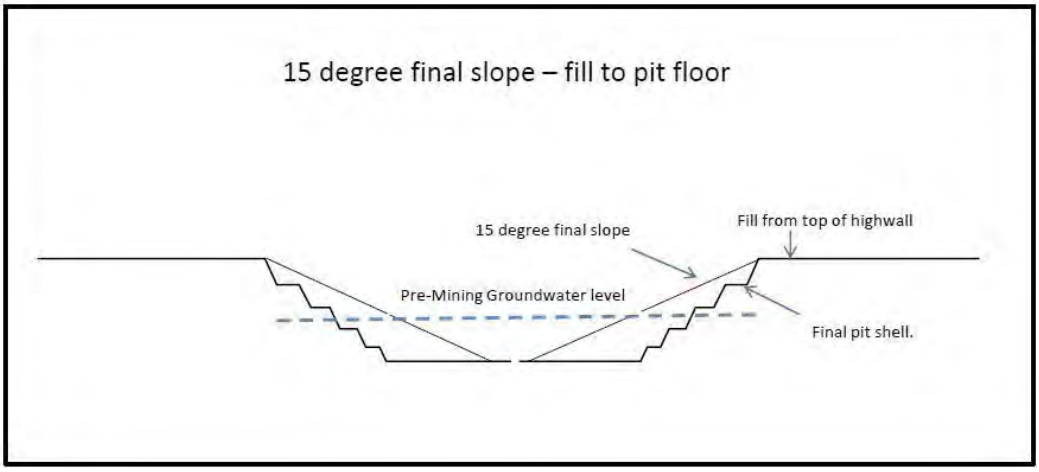


Figure 32 Final landform cross-section

Figure 33 Example of a rock chute structure used to control water ingress into the channel

21 Proposed additional final landform studies

The proposed final landform configuration has been successfully applied in similar rehabilitation projects both within Australia and overseas; particularly in Germany with lignite coal mining examples. Whilst it has the potential to deliver a number of benefits, including the potential to become a closure model for similar sites, further studies are required to confirm viability, and to ensure that any potential negative impacts can be effectively managed. Further studies required include:

- RTIO is implementing a review of relevant Australian and international examples of similar landform configuration, both current and in development; for example those from the Canadian Oil Sands region. This review is anticipated to include site visits, literature review and discussion with international/domestic planners and closure experts. The review will provide guidance for the design of pit lakes to international best practice and is scheduled to be completed by the end of 2011
- Confirmation that the mine plan and schedule can be amended to enable delivery of the final landform configuration without compromising ongoing production volumes and grades
- Development of a staged creek diversion program that would be required to enable excavation of material between pits
- Creek line drilling to determine the ore quality in currently unmined areas, to enable an assessment of whether closure costs can be offset by the sale of this material
- Development of a pit lake closure water model(s) to predict:
    - Long-term pit water quality
    - The period of time required for water recovery to equilibrium levels
    - The frequency and extent to which pit lake water within the channel is likely to flush downstream
    - The extent to which the pit lake may become a groundwater sink, and have a depressive effect on local groundwater levels.
- Development of a downstream Creek water model(s) to predict:
    - Channel pit lake diversion water quality and hydrology
    - The period of time required for channel pit lake water levels to reach equilibrium levels
    - Initial channel pit lake discharge water quality and hydrology.
- Further hydrological and engineering assessment to better determine the extent of structures required to control erosion on channel pit lake inlets and outlets

- Studies to evaluate ecological limitations of the channel pit lake design (e.g. to determine if the channel pit lake will represent a migration barrier to Creek aquatic biota, and if so how this can be managed[80])
- Studies to identify a suitable restoration target aquatic ecosystem, for example from regionally relevant water bodies[81]
- Studies to determine ways to restore the channel pit lake as a regionally representative water body
- Identification of habitat restoration priorities, including consideration of the habitat requirements of keystone flora and fauna species[82]
- Heritage surveys across the full length of the Yandicoogina projects area, including currently undisturbed and un-surveyed areas along creek lines, to identify cultural heritage implications
- Consultation with BHPBIO and other operators near the Weeli Wolli Creek to ascertain compatibility with closure strategies at other mines and to best manage any identified cumulative effects.

These further studies are proposed to commence in 2011 to address current knowledge gaps, and closure strategies will be further developed and refined according to study outcomes.

22 General rehabilitation management strategies

The following documents outline generic approved rehabilitation strategies for RTIO businesses:

- Landform Design Guidelines[83]: Outlines waste dump design principles,
- SCARD Management Plan[84]: Describes the process for determining whether acid rock drainage is likely to be an issue for a site, and the process for managing this during operation and closure, and,
- Rehabilitation Handbook[85]: Provides guidelines on topsoil management, rehabilitation targets, revegetation and monitoring.

[80] Lund, M.A. and McCullough, C.D. (in review) Restoring pit lakes: factoring in the biology, In, Pit lake Mine Closure and Management, McCullough, C. D. (ed) Australian Centre for Geomechanics, Perth, Australia.
[81] McCullough, C.D., Van Etten, E.J.B. and Lund, M.A. (in review) *Setting restoration goals for restoring pit lakes as aquatic ecosystems: a case study from south west Australia*, in Heavy Minerals 2012, Perth, Australia, 4-5 October.
[82] McCullough, C.D. and Van Etten, E.J.B. (submitted) *Ecological engineering of a novel lake district: new approaches for new landscapes.*
[83] RTIO, *Pilbara Iron Landform Design Guidelines*, RTIO-HSE-0015708
[84] RTIO, *RTIO(WA) Spontaneous Combustion and ARD (SCARD) Management Plan for Operations,* RTIO-HSE-0010872
[85] RTIO, *Rehabilitation Handbook,* RTIO-HSE-0011608

22.1 Progressive rehabilitation

RTIO aims to undertake progressive rehabilitation of waste dumps and pits when mining activity in those areas is scheduled to cease in order to:

- Comply with Government's expectations for progressive rehabilitation
- Build internal expertise in relation to rehabilitation of Pilbara landforms
- Validate assumptions made when developing closure strategies
- Effect a measure of dust control, as the footprint of disturbed land is reduced
- Lessen the task at the point of closure.

22.1.1 Progressive rehabilitation schedule

The availability of land for rehabilitation is linked to the mine plan, which is dynamic throughout the life the mine. Mine plans for Yandicoogina specifically have been in a state of flux during 2010 due to:

- Previous mine plans proving unviable due to incorrect hydrogeological models (that have since been rectified), and
- Incorporation of improved data for the Junction South West and Oxbow deposits.

The most significant change to the mine plan in 2010 (with respect to closure planning) is that in-pit dumping of waste in Junction South East has not been able to occur, and new approvals have been sought for the construction of external dumps. These will be temporary structures, and rehabilitation is therefore not planned. However, progressive rehabilitation that was originally planned to occur within the pits is no longer possible.

Further significant changes to the mine plan may occur in 2011 following outcomes of studies proposed to further investigate the channel final landform. An indicative progressive rehabilitation schedule will be drafted as part of these investigations.

22.1.2 Table of actions arising from Final Landform Plan

Actions arising from this Final Landform Plan are identified in Table 11.

Table 11 Actions arising from Final Landform Plan

Ref	Action	Recommended Commencement
YA1	Confirm that the mine plan and schedule can be accommodated to enable delivery of the channel configuration without compromising ongoing production schedule and grades (or develop an appropriate alternative final landform configuration)	2011
YA2	Develop a staged creek diversion program to enable excavation of material between pits (if the channel configuration remains the preferred option)	2011
YA3	Undertake drilling to determine ore quality in currently un-mined areas	2011
YA4	Develop a closure water model to predict impacts of the channel configuration	2011
YA5	Undertake detailed hydrological and engineering assessment to determine the extent of structures required to control erosion	2011
YA6	Undertake heritage surveys across the length of the Yandicoogina mining operation, including currently undisturbed and un-surveyed areas along creek lines, to identify cultural heritage implications of the channel configuration	2011
YA7	Consult with BHPBIO to ascertain compatibility of closure strategies with the BHPBIO Yandi mine	2011
YA8	Confirm the channel configuration as the preferred closure option, or develop an alternative option if required	Completion of YA1 to YA7
YA9	Develop a progressive rehabilitation schedule	Completion of YA8

Biodiversity management plan

Rio Tinto considers management of biodiversity impacts to be a critical component of its commitment to sustainable development.

This plan outlines how RTIO intends to achieve positive biodiversity outcomes upon closure of the Yandicoogina mine.

23 Management of specific biodiversity values

This section outlines management measures for each of the biodiversity values identified in the RTIO Biodiversity Action Plan that may be relevant to Yandicoogina closure. These are:

- Fortescue Marsh;
- Northern Quoll;
- Pilbara Olive Python;
- Stygofauna; and
- Hamersley Lepidium.

23.1 Fortescue Marsh

RTIO considers that Fortescue Marsh is sufficiently distant that it will not be impacted either by current mining operations, or by operations of the proposed JSW and Oxbow deposits. Modelling undertaken by RTIO supports this conclusion (Section 12). The potential for implementation of the channel configuration to impact Fortescue Marsh is expected to remain low.

There is potential for water collecting within the channel to develop compromised water quality, particularly with respect to elevated turbidity and salinity levels, and for this water to reach the marshes during episodic flushing events. However, the volume of flushed water would be expected to be small in relation to the volume of storm water that would be concurrently discharged, and the potential for environmental impact is therefore likely to be low.

Consequently, no measures are proposed to manage potential impacts to Fortescue Marsh resulting from closure implementation. However, this will be reassessed following completion of proposed final landform studies and during feasibility assessments for future mining areas (e.g. Billiard South and North).

23.2 Northern Quoll

An extended history of fauna surveys since the mid 1990's has demonstrated that the Northern Quoll is uncommon in the Yandicoogina locality.

The Northern Quoll has a high conservation status, and Pilbara populations are particularly important due to the absence of cane toads which have caused severe declines elsewhere.

Yandicoogina closure therefore presents an opportunity to generate positive biodiversity outcomes if suitable Northern Quoll habitat can be established. The channel configuration may provide an opportunity to construct suitable Northern Quoll habitat. Furthermore, it may be possible to enhance habitat potential at a relatively low implementation cost. RTIO proposes to research Northern Quoll habit requirements in order to take full advantage of any such potential.

23.3 Pilbara olive python

Given that Pilbara Olive Python has a lower conservation status than the Northern Quoll, research into the habitat requirements of the latter will be given a higher priority.

The Pilbara Olive Python is known from the central Pilbara region. The species has been listed as Vulnerable, but is now known to have a wide distribution and the Western Australian State Government has indicated that the listing may be unjustified[86]. Notwithstanding this, the channel final landform configuration incorporates the presence of standing water, which is known to be a preferred python habitat feature. Implementation may therefore provide ready opportunities to create suitable habitat, but further investigations are required to maximise this potential.

23.4 Stygofauna

Stygofauna are present at Yandicoogina, predominantly within shallow alluvial layers. The majority of species collected to date are also known from locations outside of the area, and it is expected that other species also have wider distributions. Notwithstanding this, implementation of the channel final landform configuration has the potential to impact on local stygofauna populations through mechanisms such as:

- Reduction in void spaces caused when backfilling and landscaping the channel
- Reduction in void spaces caused by silt and sediment runoff (e.g. bank erosion)
- Hydrological changes
- Reduction of water quality.

An assessment of the stygofauna impacts associated with implementation of the channel final landform configuration should be undertaken, and opportunities identified to minimise such impacts.

23.5 Hamersley Lepidium

Lepidium catapycnon is a hillside species that is unlikely to be significantly affected by implementation of the preferred final landform configuration. The species is not considered further in this management plan.

[86] Department of Conservation and Land Management, *2002 Biodiversity Audit: Pilbara 3 (PIL3 – Hamersley Subregion*), October 2001

24 Revegetation plans

24.1 General rehabilitation methods

RTIO rehabilitation methods are prescribed in a Rehabilitation Handbook[87], which is a component of the company's Environmental Management System[88]. Rehabilitation will be managed in accordance with this document.

Yandicoogina closure will involve rehabilitation of riparian environments. RTIO does not have experience in rehabilitation projects of this type in the Pilbara region, and recognises that additional research is necessary to provide a suitable knowledge base prior to implementation.

24.2 Topsoil management

Effective topsoil management is a critical factor in the success of subsequent revegetation of the site. A topsoil management procedure is contained within the RTIO environmental management system (IEMS)[89], and should be implemented throughout the life of the mine to facilitate the best possible rehabilitation outcomes.

24.3 Topsoil inventory

RTIO undertakes regular reconciliations of topsoil volumes available at all sites. The most recent reconciliation was undertaken in 2010, and results are summarised in Table 12. As indicated in Table 12, there is a substantial deficit of topsoil available for effective rehabilitation.

Table 12 Soil stockpile volumes and deficit (as of 2010)

Material Type	Area (ha)	Volume (m^3)
Stockpiled soil volumes[90]	-	1,529,121
Disturbance area requiring soil application[91]	1406	-
Volumes required at site for effective revegetation[92]	-	2,812,000
Current soil deficit		1,282,879

[87] RTIO, *Rehabilitation Handbook,* October 2009, RTIO-HSE-0011608

[88] The RTIO Environmental Management System (IEMS) applies to all RTIO sites in the Pilbara. Each site, including Yandicoogina, holds ISO14001 certification with respect to its application of IEMS.

[89] RTIO, *IEMS Procedure – Soil Resource Management,* RTIO-HSE-0011596

[90] Volume refers to stockpiles of topsoil, subsoil and topsoil/subsoil mixtures

[91] The disturbance area requiring soil application is assumed to be the total disturbance footprint minus pit footprints

[92] This volume is based on multiplication of the disturbed surface area in m^2 and an optimal topsoil respread depth of 200mm

24.3.1 Management of the soil deficit

The current topsoil deficit could be managed by:

- Collecting more than the minimum quantity of soil mandated in standard RTIO procedures in locations where soil is present at a greater thickness;
- Maintaining the recommended topsoil volume in selected high priority domains, and applying no topsoil to others; or
- Reducing the thickness of soil re-spread across the site.

There may be some opportunities to make up a portion of the current deficit through collection of additional soil when new areas are mined. This is particularly relevant to Yandicoogina because alluvial soils could be expected to occur at greater depth than other locations in the Pilbara. Notwithstanding this, the extent to which additional stockpiles can be created will be severely limited by restricted land availability within the RTIO lease. It is therefore likely that a significant topsoil deficit will remain.

RTIO generally favours the preferential use of topsoil in priority domains over reducing the thickness of soil re-spread across the site. However, this rule may not apply to recreation of the unique landforms proposed at Yandicoogina. Further research is required to:

- Define a topsoil application strategy for the landform, including application depths to various areas such as creek lines, creek banks and areas outside of the creek areas,
- Determine alternative growth media that may be applicable at this operation,
- Ascertain the best methods for restoration of Pilbara creek line habitat, and,
- Investigate how to balance the requirement to apply topsoil on channel banks to enable vegetation establishment (which will assist long term landform stability) with short-term erosion management goals.

The Biodiversity Management Plan will be amended to address soil deficit management when research outcomes have been determined.

24.4 Seed management

24.4.1 Seed collection and storage

RTIO collects seeds on an annual basis from across the Pilbara, with emphasis on ensuring that there are appropriate local seeds of local provenance available for rehabilitation of each of its sites.

Implementation of the channel final landform configuration would result in the loss of some existing riparian vegetation. Seeds will be collected prior to disturbance to facilitate re-establishment of riparian communities upon closure.

Seeds are stored in a purpose-built facility at the RTIO Dampier port facility.

24.4.2 Seed mixes to be used in Yandicoogina rehabilitation

Due to the period of time until closure, specific seed mixes for Yandicoogina closure have not yet been developed, however the following principles will apply:

- Seeds of local provenance will be used preferentially,
- Specific seed mixes will be selected to provide a range of species appropriate for the domains being rehabilitated,
- Consideration will be given to developing seed mixes that will provide rapid cover for channel banks to mitigate against erosion risks, and,
- Consideration will be given to incorporating species that have cultural significance to Traditional Owners (e.g. bush tucker and medicinal plants).

25 Plans to achieve biodiversity objectives

The following site closure objectives are relevant to biodiversity management:

- Achieve environmental outcomes that are compatible with the surrounding environment,
- Water quality should be able to support natural ecosystems, and,
- Environmental values of Fortescue Marsh should not be compromised.

25.1 Baseline surveys

RTIO has undertaken surveys to ascertain vegetation composition in reference sites across the Pilbara. Similar faunal studies are planned to commence in 2011 to supplement campaign surveys previously conducted. The outcome will be a more complete indication of ecosystem values in RTIO operational areas. RTIO intends to conduct regular surveys at established reference sites throughout the life of its mines.

These surveys will generate a body of knowledge that will provide a basis for determining whether closure has been implemented in a manner that achieves the objective of achieving compatible environmental outcomes. Criteria for measuring success are likely to focus on comparisons between rehabilitated areas and reference sites with respect to parameters such as native and introduced species distribution, density and richness.

25.2 Water quality should support natural ecosystems

The proposed channel final landform configuration would involve retention of a long pit lake ‘channel’ that is expected to contain permanent water. Elevated salinity and turbidity levels could be expected, but these reductions in water quality are likely to be mitigated by seasonal flushing during periods of heavy rainfall. Toxic contaminants, such as heavy metals, are not expected to be a significant issue due to the low AMD potential associated with Yandicoogina geology (refer to Section 11.3).

Hydrological modelling is required to predict water rebound levels (i.e. depth of water expected in the channel), and salinity. Once these predictions have been made, an assessment is required to confirm that water quality is suitable for sustenance of natural ecosystems. At least four aspects should be considered:

- The ability of pit lake water to sustain aquatic flora and fauna, and support other species;
- Impacts of the altered hydrological regime on groundwater dependent vegetation;
- Impacts of the altered hydrological regime on stygofauna; and
- Impacts of seasonal flushing of channel water downstream during periods of heavy rainfall.

25.3 Environmental values of Fortescue Marsh

Impacts to Fortescue Marsh are likely to be restricted to the impacts of seasonal flushing of channel water downstream during heavy periods of rainfall. This will be assessed following confirmation of closure hydrological models.

25.4 Table of actions arising from Biodiversity Management Plan

Actions arising from this Biodiversity Management Plan are identified in Table 13.

Table 13 Actions arising from Biodiversity Management Plan

Ref	Action	Recommended Commencement
YA10	Research Northern Quoll habitat requirements to enhance habitat potential in final landforms	2012
YA11	Research Pilbara olive python habitat requirements to enhance habitat potential in final landforms	2012
YA12	Assess impacts of closure implementation on stygofauna populations	Completion of YA4 (Table 11)
YA13	Undertake research to improve knowledge of rehabilitation of riparian environments, including the best methods for restoration of Pilbara creek line habitats	Completion of YA9 (Table 11)
YA14	Investigate how to balance the requirement to apply topsoil on channel banks to enable vegetation establishment with short-term erosion management goals	2011
YA15	Establish faunal reference sites, and commence monitoring faunal assemblages	2011
YA16	Investigate alternative growth media to partially address topsoil deficits	2011
YA17	Assess the ability of pit lake water to sustain aquatic flora and fauna, and support other species	Completion of YA4 (Table 11)
YA18	Assess the impacts of closure implementation on groundwater dependent vegetation	Completion of YA4 (Table 11)
YA19	Assess the impacts of seasonal flushing of channel water downstream (towards Fortescue Marsh) during periods of heavy rainfall	Completion of YA4 (Table 11)

Cultural heritage management plan

This plan outlines heritage management obligations to be met prior to successfully meeting RTIO's Yandicoogina closure plan objectives.

26 Objectives and targets for heritage management

Objectives for heritage management are identified in the closure vision for the site. Targets have been set to facilitate and measure achievement of these objectives. Objectives and targets are outlined in Table 14.

Table 14 Objectives and targets for cultural heritage management

Objective	Target
Work with Indigenous communities and other stakeholders to preserve protect and manage the cultural heritage of the area	Fully consult with Traditional Owners regarding proposed closure and post-closure activities.
	Consider all culturally significant sites in the final design and implementation of closure strategies.
	Reach agreement with Traditional Owners on mitigation and reparative measures for impacts made during construction and operation of the mine[93].
	Consider and implement measures to facilitate continued Traditional Owner access to the Yandicoogina mine area upon closure and relinquishment.
	Comply with internal RTIO Heritage Management framework: RTIO Aboriginal Heritage Policy (2001), RTIO Cultural Heritage Management Standard for Australian Business (2007), RTIO Cultural Heritage Management Systems Guidance for Australian Businesses (2005), RTIO Communities Policy (2003), Rio Tinto Communities Standard.
Negotiate relinquishment criteria with Government stakeholders	Ensure all statutory obligations and consent conditions are met and this information forwarded to the Department of Indigenous Affairs (DIA) prior mine closure.

26.1 Heritage management strategies

Broad strategies for heritage management in relation to closure objectives are outlined in Table 20. Strategies for the management of specific sites, if required, will be developed as the site approaches closure.

[93] Such impacts might include:

- Changes to ethnographic values caused by landscape alteration;
- Approved destruction or alteration of significant sites that fall within the mine footprint; and
- Approved salvage of artefacts.

Table 15 Heritage management strategies

Issue	Strategies
Stakeholder consultation	• Existing channels of communication with Traditional Owners, Government and other stakeholders will be employed to discuss and reach agreement on closure strategies. These may be modified as required to address any specific issues arising from closure and post-closure planning and implementation. • The outcomes of discussions regarding closure issues will be documented.
Management and mitigation of impacts to cultural heritage prior to closure	• Undertake sufficient heritage surveys (archaeological and ethnographic) to identify heritage sites and areas of significance within proposed project areas • Where possible avoid or minimise undertake mine design and activities to avoid heritage sites • Ensure all statutory requirements are met prior to any clearance of a heritage site (i.e. *Aboriginal Heritage Act 1974*) • During the Life of the Mine undertake consultation with the relevant Traditional Owners to identify potential impacts to cultural heritage sites, and agree on appropriate mitigation activities. • Agreed mitigation activities will be implemented.
Impacts of closure and post-closure activities	• Existing ground disturbance protocols will be employed to ensure that heritage impacts of closure and post-closure activities are appropriately mitigated.

26.2 Accountabilities for heritage management

Accountability for implementation of this plan falls broadly to RTIO's Heritage team. Specific accountabilities will be assigned during detailed planning closer to the time of closure.

27 Table of actions arising from the Heritage Management Plan

A five year action list has been created (Table 16) which identifies specific tasks required in order to meet and work towards the objectives and strategies outlined in the closure heritage management plan. These actions have been identified at the time of writing the current closure report (July 2011), and amendments and updates to this list are likely to be an ongoing requirement as the closure plan for Yandicoogina mine develops.

Table 16 Actions arising from Yandicoogina Closure Heritage Management Plan

Ref	Action	Recommended Commencement
YA20	Finalise Yandicoogina salvaged site audit and register and implement a method to maintain and update data.	2011
YA21	Finalise the Yandicoogina Cultural Heritage Management Plan and implement it as a working document.	2011
YA22	Undertake an annual review of Heritage approval consents and ensure statutory obligations and conditions have been met.	2011 (annual)
YA23	Following the provision of more detailed closure plan options, undertake a gap analysis to identify areas requiring heritage survey and areas of significance which should be avoided and managed.	Upon provision of closure plan options
YA24	Undertake heritage surveys (ethnographic and archaeological) as required with the Traditional Owners.	As required
YA25	Continued consultation and information share with the Traditional Owner groups regarding the proposed mine closure plan. Consultation should be undertaken as a staged approach both at a strategic and a detailed level, once this information is available.	ongoing
YA26	Regularly update RTIO and DIA heritage site and report registers with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	ongoing
YA27	Regularly update Gumala Aboriginal Corporation and Traditional Owners with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	ongoing
YA28	Undertake consultation with the Traditional Owner group regarding specific water values at Yandicoogina mine	2011

Risk assessment

RTIO has undertaken an assessment to identify threats and opportunities associated with closure of the Yandicoogina site. A risk assessment report has been prepared[94], and this section summarises the key risks identified.

28 Risk assessment

A risk assessment workshop was held on 12 January 2011, and was attended by RTIO personnel from the following operational areas:

- Risk management;
- Rehabilitation and closure;
- Environmental approvals;
- Mine planning;
- Technical projects; and
- Heritage management.

The aim of the workshop was to identify critical risks that require consideration as closure planning activities continue in 2011. A further workshop will be held during the course of 2011 to assess whether the risk profile has changed.

Critical risks are summarised in the following sections.

28.1 Risk 1: Currently unidentified heritage issues

Consultation conducted to date regarding Yandicoogina closure has not identified any significant heritage issues. However; it is possible that such issues may arise as operational and closure plans are varied. RTIO considers the risk of currently unidentified heritage issues impacting on the ability to implement closure strategies to be critical to the project.

Some of the possible causes of identified heritage issues may include:

- Gaps in current knowledge regarding heritage issues at the site;
- Changes to the mine plan and closure strategy;
- Surveys that do not necessarily cover the whole mining area (e.g. future deposits at Billiards, potential future mining of ore underneath and adjacent to creek lines);
- The level of understanding of Traditional Owner groups on proposed closure approaches and impacts, which is likely to be relatively limited at the present time; and
- Future assessments indicating that a proposed closure strategy may lead to a poor heritage outcome.

[94] RTIO, *Yandicoogina closure risk assessment report,* January 2011, RTIO-CR- (confidential report not for external distribution)

This risk will be managed by:

- Undertaking the necessary heritage assessments in conjunction with mine and closure planning information as it becomes available; and
- Continuing to consult with Traditional Owner groups.

28.2 Risk 2: Development of saline pit lakes

Final landform configurations being assessed, including the preferred channel configuration described in this closure study report, generally involve the retention of pit voids that will form pit lakes. Whilst detailed modelling is yet to be performed, it is expected that some degree of salinisation would occur within pit lakes.

Some of the possible causes of pit salinisation may include:

- Insufficient flow through and flushing to prevent salinisation; and
- Uncertainty regarding the salinity of water entering the RTIO Yandicoogina system following passive discharge from the upstream BHPBIO Yandi system.

This risk will be managed by:

- Developing detailed closure options to identify the most appropriate strategy to reduce the creation of saline pits;
- Undertaking hydrological modelling of relevant closure options to determine the best scenario from a salinity perspective; and
- Undertaking environmental and heritage assessments for relevant options.

28.3 Risk 3: Current status of closure planning delays JSW approval

RTIO has a business imperative to develop the Junction South West and Oxbow deposits to sustain current production volumes and grades. Existing environmental approvals do not extend to these areas, and new approvals are currently being sought.

EPA expectations regarding closure planning have increased significantly in recent times, and new Mine Closure Guidelines were published in June 2011[95]. The standard of closure plans expected for submission with environmental proposals will be much higher under the terms of these new guidelines than in the past.

Closure management has been assessed to be a significant environmental factor for Yandicoogina, and a high standard closure plan can therefore be expected as a requirement for JSW and Oxbow approval. Whilst this current report has been developed to comply with requirements outlined in the draft guidelines, there are numerous knowledge gaps and closure outcomes assessment that need to be addressed.

RTIO is continuing dedicated closure planning for the Yandicoogina site in 2011, but expects several critical components to remain incomplete when the EPA submission is finalised mid-2011. This has the potential to delay the approval.

[95] Department of Mines and Petroleum (DMP) Guidelines for Preparing Mine Closure Plans (June 2011)

This risk will be managed by:

- Continuing to undertake Yandicoogina closure planning activities in 2011, with a particular emphasis on technical studies to facilitate environmental assessment of proposed closure strategies; and
- Submission of a revised closure study report as part of the JSW approvals submission in mid-2011, including an updated plan for further closure planning work.

28.4 Risk 4: Insufficient lead time to gain approvals

This risk is linked to Risk 3, but relates more broadly to environmental and heritage approvals beyond the short-term critical JSW/Oxbow EPA approval.

This risk will be managed by:

- Ongoing closure planning work for the site;
- Ongoing consultation with key stakeholders; and
- Commencement of heritage surveys to assess the impacts of revised closure strategies as early as possible.

28.5 Risk 5: Inability to gain OEPA approval to change strategies

RTIO has previously proposed closure strategies that have been approved by Government. These strategies are no longer considered to be viable, and consultation undertaken as part of the present closure study indicates that there is qualified support for this from key Government stakeholders. However; it is the OEPA that ultimately needs to agree to a change in the approved closure strategy, and attempts to consult with the OEPA on the issue have to date been unsuccessful (see Section 17.6).

Some of the possible causes of approval not being granted may include:

- The proposed strategies being radically different to those that are already approved;
- The proposed strategies may potentially lead to significant changes to the local environment;
- The required degree of certainty about outcomes may be difficult to achieve; and
- The OEPA is likely to assess the compatibility of closure strategies employed at the RTIO Yandicoogina and BHPBIO Yandi mines.

This risk will be managed by:

- Incorporating the approved closure strategies into current impact assessments, to provide a baseline against which to compare proposed strategies;
- Progressing with a life of mine environmental approval (through S46 of the EP Act), which should facilitate reconsideration of closure strategies that were developed for individual deposits; and
- Consulting with BHPBIO to ensure compatibility of closure strategies.

Assessment of closure options for the site

This section summarises the outcomes of a sustainability assessment of potential closure options to identify preferred closure strategies.

29 The role of sustainability assessment in closure planning

Sustainable development aims to deliver more value with less impact. It occurs when social and environmental factors are considered in investment decisions.

Sustainable development concepts are relevant to RTIO closure planning. Due to the scale and nature of Pilbara iron ore operations, it is unrealistic to assume that closure can be achieved without some negative social and environmental impacts. However, impacts can be minimised by selecting and implementing the most appropriate closure options.

Sustainability assessment is a means of critically evaluating multiple closure options to select a preferred option that maximises benefit and minimises harm. RTIO conducts a semi-quantitative process that facilitates consideration of relevant social, environmental and economic factors. The process also highlights areas of strength and weakness in relation to the preferred option, which will help to guide management of its implementation.

30 Sustainability assessment

A sustainability assessment of potential closure options has been conducted[96], with the outcomes summarised below. The potential closure options are presented as figures in Appendix 1 – Yandi closure option figures.

30.1 Assessed closure options

30.1.1 Option 1: Retention of Junction Central and Oxbow pit voids

This option involves undertaking no backfill in Junction Central and Oxbow pits, and backfilling the remaining pits to ground level. This configuration was assessed because:

- A study was in progress at the time of this closure study to investigate the potential of using Junction Central as a 'store and release' system whereby excess dewatering water would be discharged into Junction Central pit, and then periodically discharged downstream to mimic natural flood events. The study was conducted as a potential solution to continuous operational water discharges, licensed limits of which were acting as a barrier to expansion. If this operational strategy is employed, then retention of Junction Central 'dam' as a pit void at closure would be a cost effective option;
- Oxbow is scheduled to be the final pit to be developed on the western portion of Yandicoogina. Retention of Oxbow as a pit void at closure would therefore be a cost effective option.

[96] RTIO, *Yandicoogina Closure Study: Sustainability Assessment Report,* September 2010, RTIO-CR-0023186

- The volume of void space created by retention of Junction Central and Oxbow as pit voids would enable the remainder of Yandicoogina pits to be backfilled to ground level with waste material, avoiding the need to quarry additional backfill material.

Model results for this option indicate that 27% of all Marillana Creek mean annual flow seeps into the three pits through groundwater, such that water levels in all pits will stabilise within 50 years with no surface discharge resulting. Salinity at the end of a 100 year period will be low but increasing until the pit lakes become sufficiently saline that the incoming salt load via groundwater, surface water, Marillana Creek seepage and rainfall is equal to the outgoing salt load. This process would likely take thousands of years. There is some potential to divert additional water (e.g., during major flood events) into the pits, however, these surface flows would only provide a short term dilution effect and would add salt loads to the forming pit lakes unless they lead to a surface discharge or increased rates of groundwater discharge to offset the additional salt load.

30.1.2 Option 2: Creation of a 'Channel'

This option involves excavation of material between individual pits so that they are form one continuous pit ('channel') from Oxbow in the west to Billiard North in the east. Backfill material would then be used to landscape the channel so that it is narrower and shallower than the original void, with gentler slopes. A pit void would be retained at below equilibrium groundwater level, and standing water would therefore be present as a pit lake. This configuration was assessed because:

- The final landform could be constructed only using waste material, avoiding further landform disturbance through borrow-pit quarrying of additional backfill material;
- Natural flushing of the channel could be expected during periods of wet season rainfall, thereby forestalling pit lake salinisation;
- The pit lake can be rapidly filled to facilitate progressive restoration and improved initial water quality[97];
- The creation of a permanent surface water body generates the potential for biodiversity enhancement; and
- The material excavated between the pits will include orebody lithologies (of unknown quality) that are currently sterilised to mining because it is located underneath or adjacent to current watercourses. There is scope to offset the cost of implementing this configuration using the revenue generated from the additional mined ore, including the Billiard North deposit which lies directly underneath Weeli Wolli Creek.

The continuous pit model assumes that the Creek is redirected to flow through the mined out pit. Water from Marillana, Weeli Wolli Creek and other minor creeks would flow through the channel pit lake with re-direction by a series of engineered structures of low-erosion rate and good landform empathy. The Creek flow through the Channel pit lake would therefore follow the profile of the excavated CID which is the base of the ancient Creek path.

As the channel pit lake regularly overflows through to the lower Weeli Wolli Creek, model results for this option indicate that little evapo-concentration of salinity occurs and channel pit

[97] Schultze, M. (2011) Rapid filling of pit lakes, In, Mining Pit Lakes: Closure and Management, McCullough, C. D. (ed) Australian Centre for Geomechanics, Perth, Australia, pp.

lake water quality remains fresh at around 130 mg/L TDS, or just over double Creek salinity (ca.50 mg/L)[98].

A number of different channel configurations are possible, however most appear unlikely to significantly alter model water quality results.

30.1.3 Option 3: Backfill to ground level

The previously approved closure strategy (applicable to existing mine pits) only required backfill of pits to 490 mRL (approximate water table level). This strategy is no longer considered to be technically viable when considering overall life of mine closure[99].

Backfill to ground level overcomes the technical issues associated with previously approved partial backfill strategy, albeit that implementing this configuration would come at a significant cost, including environmental and social costs associated with quarrying substantial amounts of additional backfill material. This configuration was assessed because:

- It is similar to the previously approved closure strategy, but avoids associated geotechnical viability issues;
- Whilst backfill to ground level would require a greater volume of quarried backfill material than the previously approved partial backfill strategy, and a greater disturbance footprint, the extent of these increases is small in relative terms;
- The option was considered by Traditional Owners to be the most favourable, although it is possible that the magnitude of impacts associated with quarrying the surrounding landscape have not been fully appreciated; and
- Whilst there is likely to be high environmental and economic costs associated with this option, it would be relatively straightforward to implement.

30.2 Pit lake hydrogeological Modelling

A water and salt balance model has been developed in-house by Aquaterra RPS to determine long term water levels and salt concentrations for the Yandi multi-pit lake system post closure[100]. The water balance model contains a number of assumptions which limit the accuracy of the results, however the model is a useful initial tool in determining the likely water levels and salt concentrations of the closure options discussed in more detail below. Within the Microsoft Excel-based model, the pit is treated as a bucket which receives inflow from surface water runoff, direct rainfall, seepage from nearby river flows and groundwater. Modelled outflows include evaporation, groundwater outflow and surface water outflow (overtopping). The model is a useful tool for evaluating the likely water levels and salt concentrations of the various closure options being considered for both the isolated pit lake and through-flow channel pit lake options.

Future model runs for multi-pit lake and thru-flow scenarios are proposed to be completed using GoldSim; a graphical, dynamic simulation program suited to the analysis of complex

[98] RPS Aquaterra, 2011, *Yandi Closure Water and Salt Balance Modelling: Progress report*.
[99] The reasons for this are fully explained in the sustainability assessment report referenced in RTIO, *Yandicoogina Closure Study: Sustainability Assessment Report,* September 2010, RTIO-CR-0023186 .
[100] RPS Aquaterra, 2011, *Yandi Closure Water and Salt Balance Modelling: Progress report*.

systems. Goldsim allows the user to evaluate how systems evolve over time, and predict their future behaviour[101].

30.3 Outcomes of the sustainability assessment

30.3.1 Assessment of economic factors

Option 3 (the backfill option) is likely to be more costly to implement than the other options assessed, which limits its economic viability.

It may be possible to offset the cost of implementing Option 2 (the channel option) through the access of additional ore reserves that are currently sterilised from mining, and this option was therefore assessed as most favourable from an economic perspective.

30.3.2 Assessment of environmental factors

Option 2 (the channel option) was assessed to be favourable over Option 1 (the pit void option) in every environmental indicator considered in the assessment.

Option 3 (the backfill option) scored substantially better than Option 2 with respect to its ability to deliver reliably stable landforms and minimal impacts to water quality. However; it scored substantially worse with respect to biodiversity indicators due to habitat losses associated with quarrying for additional backfill material.

30.3.3 Assessment of social factors

Each option was assessed to have benefits and drawbacks when social factors were considered, with no option standing out as being more favourable than others.

Option 1 (the pit void option) scored best in terms of maintaining cultural heritage values, but was assessed as having a greater potential for negative reputational impacts.

Option 2 (the channel option) would generate increased payments to Traditional Owners through royalties associated with the mining of additional ore, but this could come at the expense of heritage values associated with creek line disturbance.

Option 3 (the backfill option) was considered most likely to have the best reputational impact, but quarrying of surrounding elevated land is likely to disturb heritage sites (e.g. rock shelters) that may be significant and have not been previously surveyed.

30.3.4 Consolidation of economic, environmental and social factors

The outcomes of the assessment are shown pictorially in Figure 34.

The process used to develop Figure 34 is presented in the Sustainability Assessment Report (Footnote 95). The most favourable options are represented by bubbles located towards the top right-hand corner (the greatest potential for social and environmental benefits), and by the largest bubbles (the option that is likely to be most economically viable).

[101] Goldsim (2011), *GoldSim*, GoldSim Technology Group, Washington, USA.

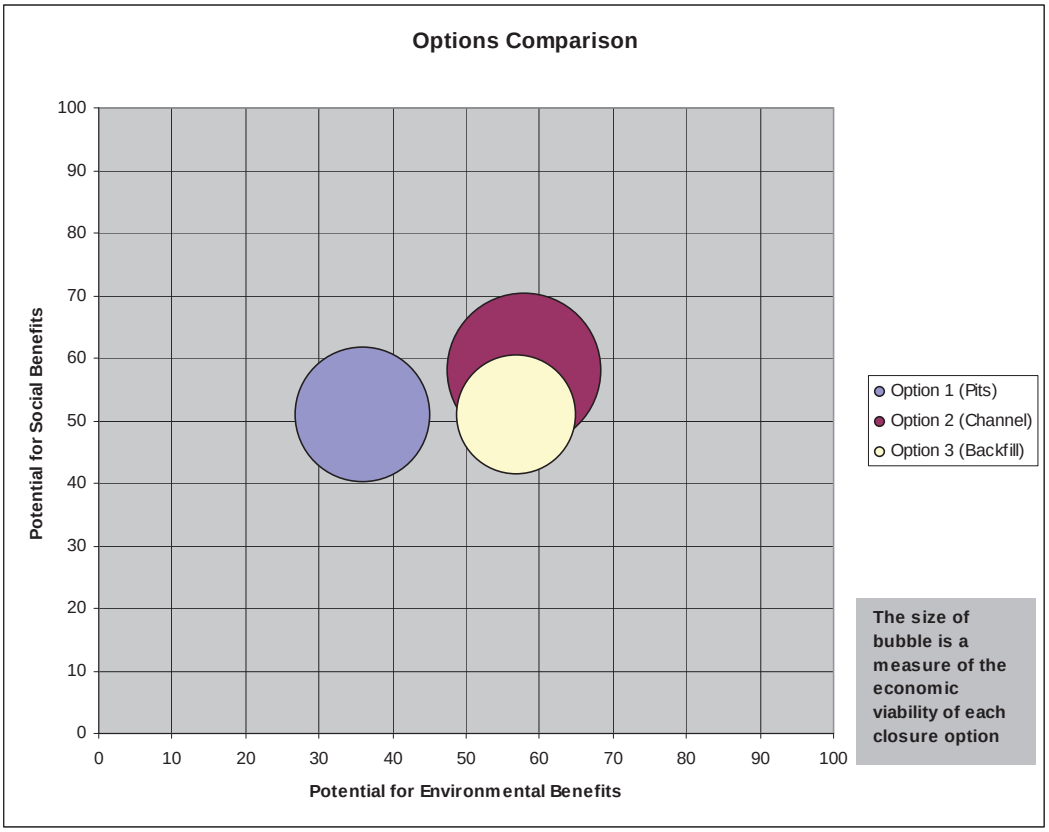


Figure 34 Comparison of closure options in the sustainability assessment

31 Preferred closure option

Based on the outcomes of the sustainability assessment, Option 2 (the channel option) is the preferred option[102]. It has been selected because:

- There is potential to offset closure costs with additional revenue generated from the mining of additional ore that is currently sterilised because it is underneath or adjacent to Marillana and Weeli Wolli Creeks. There would also be a social benefit to this as royalty payments to Traditional Owner would increase through the Indigenous Land Use Agreement. (Note that currently sterilised ore could also be accessed if the other options are implemented, but doing so would lead to an increase in the cost and/or technical challenges of closure);
- It provides greater opportunity for biodiversity enhancement compared with other options due to the creation of a permanent water source, and retention of elevated areas; and
- Whilst local flow will be radically altered (the creek lines will be moved), it is the option considered most likely to lead to positive regional water flow outcomes.

[102] It should be noted that a number of broad assumptions were made during the sustainability assessment regarding the economic, environmental and social implications associated with each option. Further investigations are required to confirm whether these assumptions are correct. If one or more key assumptions prove to be incorrect, a different closure option may be more favourable.

The following issues were identified during assessment, and will require management or mitigation in order to achieve successful closure:

- High engineering inputs will be required to manage stability and erosion risks. These issues need to be managed because any elevated sediment loads would otherwise be readily transported downstream. This assessment assumed that these issues will be able to be managed effectively through engineering design - if this assumption is incorrect then the viability of the option will be reduced;
- There would be significant disturbance to creek lines, including Weeli Wolli Creek, which will have cultural heritage implications;
- The operational mine plan may need to be significantly altered, the viability of which is yet to be assessed; and
- Numerous creek diversions would be required, the practicality of which is yet to be assessed. Management of such diversions could present a significant practical challenge, particularly during periods of high rainfall.

Completion criteria

32 Indicative completion criteria

32.1 What are indicative completion criteria?

Completion criteria can be defined as the indicators used to determine whether closure objectives have been met. They are used to measure the success of closure implementation against objectives, and to facilitate relinquishment of mining tenure. RTIO aims to have completion criteria agreed with stakeholders prior to site closure.

RTIO recognises that the process of developing criteria needs to commence early to provide clear performance goals for progressive rehabilitation conducted during the mine's operational phase. It also provides some contingency in the event of unplanned closure.

However; mining in the Yandicoogina area is planned for at least another 35 years. Criteria developed now may no longer be appropriate at the point of closure because:

- Mine plan changes could have significant impacts on closure strategies and outcomes;
- The closure knowledge base can be expected to improve;
- Stakeholder expectations may change; and
- Environmental and social values, on both a local and regional level, may change (e.g. due to the impacts of climate change, or of changes to land use)

For these reasons, criteria development needs to be viewed as an iterative process, and criteria drafted early in the life of the mine should be considered as being indicative only. Criteria will be reviewed during subsequent closure studies for the site, and may be revised accordingly. Final stakeholder agreement on completion criteria will not be sought until the site approaches closure.

32.2 Process to develop completion criteria for Yandicoogina

RTIO has commenced a project to develop completion criteria for all of its sites. The following process applies:

- Review of baseline and reference data;
- Draft of several sets of generic completion criteria for mines operating in similar environments;
- Internal and external stakeholder consultation on indicative completion criteria;
- Review of the applicability of the generic criteria to specific sites, taking into account unique environmental and social values, and any site specific closure objectives; and
- Documentation of indicative completion criteria for each site.

Following completion of the project, indicative criteria will be reviewed on a regular basis throughout the life of the mine. Final completion criteria will be agreed with stakeholders during the development of a final decommissioning plan for each; this should occur approximately five years prior to the scheduled cessation of operations.

The aim of the project is to develop a set of generic conceptual completion criteria for mines of a similar type. These will form a platform for the creation of site-specific completion criteria that take into account any unique objectives or values that may apply.

Draft generic criteria are still in the development phase. RTIO expects to commence stakeholder consultation on these in 2011, with site specific indicative completion criteria to follow.

Consideration has been given to developing specific indicative criteria for Yandicoogina in advance of the broader RTIO project described above. However; this has not occurred because:

- The final landform will significantly influence the aspects and issues that need to be addressed in completion criteria, and further studies are required to confirm viability of the currently preferred channel configuration;
- Consultation with BHPBIO (the underlying pastoral lessee) is not sufficiently advanced to confirm its expectations with respect to post-closure land use; and
- Operations are scheduled to continue for at least 35 years at Yandicoogina, with no significant rehabilitation projects planned for the next 5 years.

32.3 Commitments regarding the setting of criteria

RTIO makes the following commitments with respect to the development of indicative completion criteria:

- Criteria will be linked back to closure objectives, and will enable assessment of whether each objective has been met.
- Criteria will be measurable.
- RTIO has undertaken substantial monitoring and research to better understand the Yandicoogina environment, particularly in relation to Marillana and Weeli Wolli Creeks (e.g. ongoing tree health, vegetation condition and aquatic ecology monitoring). The results of these programs will be used as a guide to ensuring that criteria are reasonable and practicable.
- Stakeholders, including Government, Traditional Owners and BHPBIO, will be engaged in the establishment of criteria.
- RTIO will commence drafting criteria following confirmation of the final landform configuration.
- Indicative criteria will be included in the next Yandicoogina closure study review, currently scheduled for 2015.

32.4 Achieving appropriate environmental outcomes

RTIO has undertaken surveys to ascertain vegetation composition in reference sites across the Pilbara. Similar faunal studies are planned to commence in 2011 to supplement campaign surveys previously conducted. The outcome will be a more complete indication of ecosystem values in RTIO operational areas. RTIO intends to conduct regular surveys at established reference sites throughout the life of its mines.

These surveys will generate a body of knowledge that will provide a basis for determining whether closure has been implemented in a manner that achieves the objective of achieving compatible environmental outcomes. Criteria for measuring success are likely to focus on comparisons between rehabilitated areas and reference sites with respect to parameters such as native and introduced species distribution, density and richness.

Yandicoogina presents RTIO with a potential opportunity to achieve positive biodiversity outcomes, through:

- Implementation of the channel final landform configuration, which:
    - Avoids the disturbance of hillside habitats, which would occur under the closure strategy previously approved for the site, and,
    - May lead to the creation of a permanent surface water body of reasonable water quality, and
- Creation of habitats that may be suitable for species with high conservation value, such as the Northern Quoll and/or the Pilbara Olive Python.
- Further investigation is required to maximise this potential.

It should be noted that the potential to achieve positive local biodiversity outcomes would be contingent on whether the land will be actively used for pastoral activities following mine closure. Since the mine is located on a BHPBIO pastoral lease, RTIO is not in a position to excise the land for biodiversity management purposes. This possibility will be raised in consultation with BHPBIO.

Financial provision for closure

RTIO considers specifics of the closure cost estimate to be commercially sensitive information. Closure cost assumptions[103] and calculations[104] are contained in separate reports. This section outlines the general process used to develop the closure cost estimate.

33 Principles of RTIO closure cost estimation

Two closure costs have been developed:

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

The cost estimates consider the following components:

- Decommissioning (i.e. removal of infrastructure)[105];
- Final landform construction[106];
- Biodiversity management (i.e. revegetation);
- Heritage management[107];
- Decontamination;
- Workforce management (i.e. training costs and redundancy payments)[108];
- Monitoring costs;
- Costs associated with the development of a Final Decommissioning Plan;
- Costs associated with undertaking a final shutdown of operations;

---

[103] RTIO, *Yandicoogina closure cost estimate assumptions: 2010 closure study,* December 2010, RTIO-CR-0025671 (confidential report not for external distribution)

[104] RTIO, *Yandicoogina closure cost estimate spreadsheet: 2010 closure study,* December 2010, RTIO-CR-0025670 (confidential report not for external distribution)

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

[106] The PCO considers the cost of backfilling Junction Central and Junction South East pits to 490m RL, as required under the currently approved closure strategy. The TPC considers the cost of creating the 'channel' landform configuration as described in Section 20.

[107] No heritage management costs have been assigned to Yandicoogina closure, but this may change if specific management programs are identified in future closure planning for the site.

[108] Workforce management costs have only been included in the TPC.

- Allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas;
- Assignment of indirect costs in accordance with Rio Tinto Accounting Policy; and
- Inflation of the cost estimate by a 20% contingency factor.

The largest individual components of the cost estimate relate to final landform construction and decommissioning. SKM was contracted to prepare estimates for both of these components[109][110]. Remaining costs were estimated, and the final estimate collated, by the RTIO Closure Planning Specialist. Financial provision will reviewed every five years or as circumstances dictate

[109] SKM, *Rio Tinto Yandicoogina Iron Ore Operation: Final Landform Option Costs,* October 2010, RTIO-CR-0025220 (confidential report not for external distribution).

[110] SKM, *Yandicoogina Decommissioning Estimate Revision,* November 2010, RTIO-CR-0025603 (confidential report not for external distribution).

Closure implementation

34 Plans for management of other closure aspects

The following aspects are addressed by generic strategies that apply to all RTIO mine sites. Specific implementation plans will be developed closer to the time of mine closure:

- Decommissioning[111]
- Decontamination[112]
- Workforce management (yet to be developed)
- Communication and consultation[113].

35 Unexpected Closure

The consideration of alternative closure scenarios within closure planning activities is a specific requirement of the Strategic Framework for Mine Closure (ANZMEC/MCA, 2000).

The mining method proposed for the Yandi extension is essentially strip-mining. This means that from the early stages of mining excavated mine waste will be progressively backfilled where possible as the mine progresses along the strike of the ore bodies. In this way the active mining area, which will consist of several operating faces in both ore and waste, is kept to a practicable minimum. At any stage of the operation this active area is the potential pit void at closure.

Waste rock backfilled behind the advancing operation will be progressively rehabilitated.

At any time during the operation temporary closure will require the monitoring of groundwater levels and the management of dewatering pumps to keep the water table in the pit at least one metre below the pit floor which varies across the CID.

If the mine is prematurely permanently closed then the void formed by the active mining area will be backfilled to above groundwater level using previously excavated mine waste in a manner similar to that proposed for the final closure of the operation. At all stages of mining there will be sufficient excavated mine waste available to backfill the pit void to above groundwater, should a premature permanent closure be required.

36 Closure Monitoring and Maintenance

This plan documents the monitoring program to be employed following closure to assess performance against objectives. It provides an indication of the criteria that will be used in performance assessment, and management actions to be employed if objectives are not met.

---

[111] *Iron Ore Infrastructure Decommissioning Strategies,* December 2009, RTIO-CR-0021242

[112] *Contaminated Sites Management Plan,* January 2007, RTIO-HSE-0035253

[113] *RTIO Closure Guidance Document 3: Stakeholder Consultation,* RTIO-CR-0018104 (document in preparation)

36.1 Closure monitoring program

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

36.2 Phases of monitoring

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

- Baseline monitoring, which is conducted as operations expand into new mining areas. Results that are relevant to closure are summarised in the closure knowledge base,
- Operational monitoring, which occurs throughout the life of the mine. Results that are relevant to closure are incorporated in the closure knowledge base when it is reviewed from time to time,
- Pre-closure monitoring, which occurs as the site approaches closure to provide a baseline against which closure performance can be assessed,
- Closure monitoring, which is conducted during the period of active site closure (assumed to be two years following the cessation of mining), and,
- Post-closure monitoring, which is conducted on an regular basis until either:
    - There is a demonstration that closure objectives have been met and that the site is able to be relinquished, or,
    - Parameters being monitored reach a steady state.

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

36.3 Expected monitoring program

The monitoring program will be finalised during development of a Final Decommissioning Plan as the site approaches closure. However, the program could be expected to include components indicated in Table 17. The monitoring program will focus on measuring performance against indicative completion criteria (Section 32). The monitoring program will be sufficiently flexible to enable adjustments if results indicate that more or less monitoring is warranted at any particular phase.

Table 17 Expected components of the closure monitoring program

Aspect	Phase		
	Pre-closure	Active closure	Post-closure
Erosion monitoring		✓	✓
Vegetation monitoring (i.e. revegetation success)		✓	✓
Fauna survey	✓	✓	✓
Stygofauna survey	✓	✓	✓
Water quality monitoring	✓	✓	✓
Contaminated sites assessment		✓	
Ecology function study	✓		✓
Hydrology/hydrogeology study	✓		✓
Heritage survey	✓		✓

37 Research actions

Closure planning is an ongoing process, and closure studies are periodically reviewed to maintain currency. The research actions outlined in Table 18 have been identified as having the ability to improve closure outcomes by:

- Filling gaps in the knowledge base,
- Validating assumptions made in this conceptual closure study, or,
- Predicting the impacts of closure strategy implementation.

Table 18 is unlikely to represent a complete list of research actions that will be undertaken prior to closure of the site. However, it does represent actions that are recommended prior to the next site closure study review (currently scheduled 2015).

Table 18 Consolidated table of research actions

Ref	Action	Recommended Commencement
YA1	Confirm that the mine plan and schedule can be accommodated to enable delivery of the channel configuration without compromising ongoing production schedule and grades (or develop an appropriate alternative final landform configuration)	2011
YA2	Develop a staged creek diversion program to enable excavation of material between pits (if the channel configuration remains the preferred option)	2011
YA3	Undertake drilling to determine ore quality in currently unmined areas	2011
YA4	Develop a closure water model to predict impacts of the channel configuration	2011
YA5	Undertake detailed hydrological and engineering assessment to determine the extent of structures required to control erosion	2011
YA6	Undertake heritage surveys across the length of the Yandicoogina mining operation, including currently undisturbed and un-surveyed areas along creek lines, to identify cultural heritage implications of the channel configuration	2011
YA7	Consult with BHPBIO to ascertain compatibility of closure strategies with the BHPBIO Yandi mine	2011
YA8	Confirm the channel configuration as the preferred closure option, or develop an alternative option if required	Completion of YA1 to YA7
YA9	Develop a progressive rehabilitation schedule	Completion of YA8
YA10	Research Northern Quoll habitat requirements to enhance habitat potential in final landforms	2012
YA11	Research Pilbara Olive Python habitat requirements to enhance habitat potential in final landforms	2012
YA12	Assess impacts of closure implementation on stygofauna populations	Completion of YA4
YA13	Undertake research to improve knowledge of rehabilitation of riparian environments, including the best methods for restoration of Pilbara creek line habitats	Completion of YA9
YA14	Investigate how to balance the requirement to apply topsoil on channel banks to enable vegetation establishment with short-term erosion management goals	2011

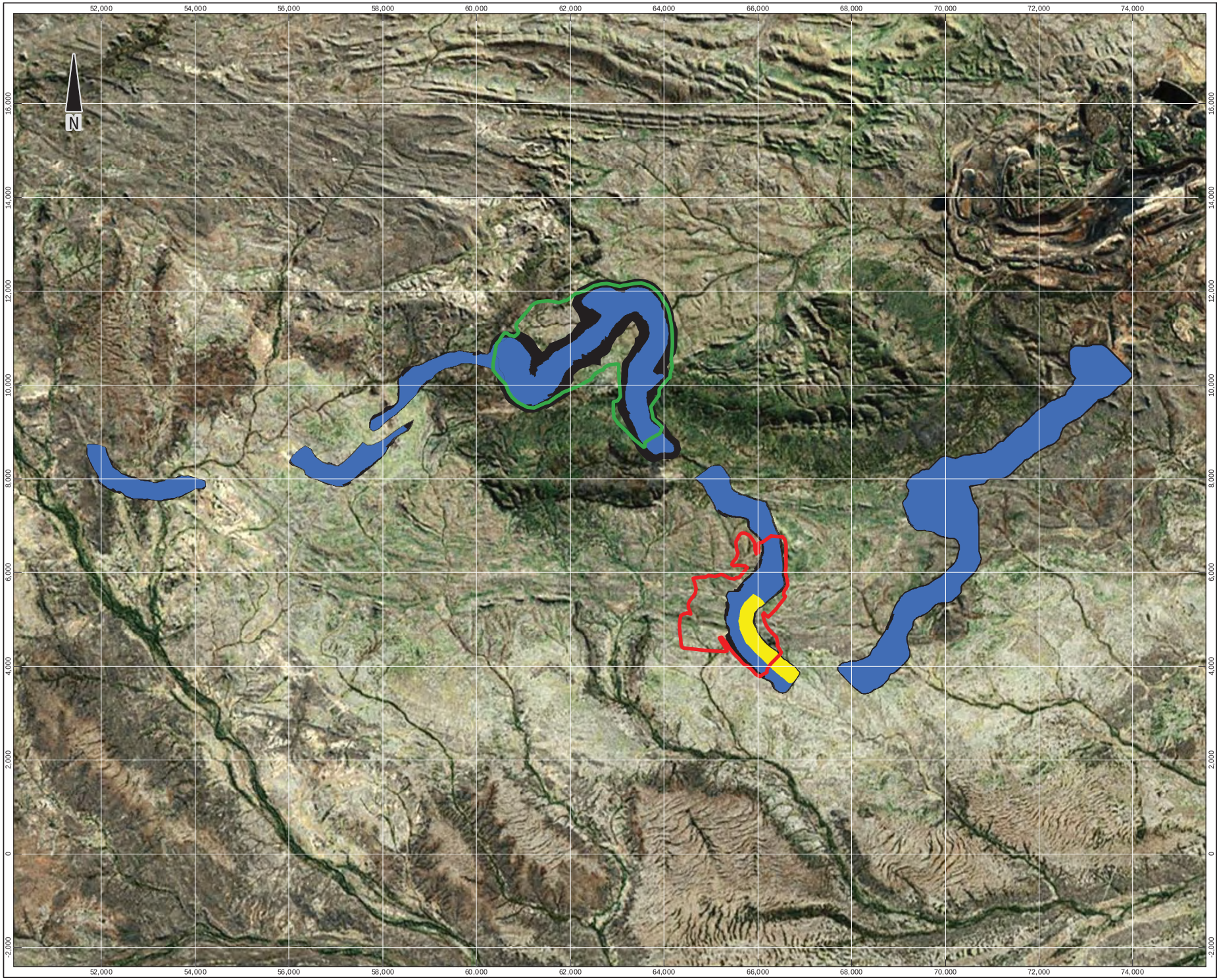
Ref	Action	Recommended Commencement
YA15	Establish faunal reference sites, and commence monitoring faunal assemblages	2011
YA16	Investigate alternative growth media to partially address topsoil deficits	2011
YA17	Assess the ability of pit lake water to sustain aquatic flora and fauna, and support other species	Completion of YA4 (Table 11)
YA18	Assess the impacts of closure implementation on groundwater dependent vegetation	Completion of YA4 (Table 11)
YA19	Assess the impacts of seasonal flushing of channel water downstream (towards Fortescue Marsh) during periods of heavy rainfall	Completion of YA4 (Table 11)
YA20	Finalise Yandicoogina salvaged site audit and register and implement a method to maintain and update data.	2011
YA21	Finalise the Yandicoogina Cultural Heritage Management Plan and implement it as a working document.	2011
YA22	Undertake an annual review of Heritage approval consents and ensure statutory obligations and conditions have been met.	2011 (annual)
YA23	Following the provision of more detailed closure plan options, undertake a gap analysis to identify areas requiring heritage survey and areas of significance which should be avoided and managed.	Upon provision of closure plan options
YA24	Undertake heritage surveys (ethnographic and archaeological) in remaining un-surveyed areas as required with the Traditional Owners.	As required
YA25	Continued consultation and information share with the Traditional Owner groups regarding the proposed mine closure plan. Consultation should be undertaken as a staged approach both at a strategic and a detailed level, once this information is available.	ongoing
YA26	Regularly update RTIO and DIA heritage site and report registers with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	ongoing
YA27	Regularly update the Gumala Aboriginal Corporation and Traditional Owners with new information on sites (recording, salvage etc) in the Yandicoogina mine area.	ongoing
YA28	Undertake consultation with the Traditional Owners regarding specific water values at Yandicoogina mine	2011

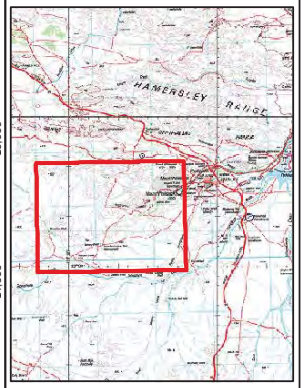
38 Management of Information and Data

Closure information for the Yandicoogina mine will be managed in accordance with relevant RTIO standards and protocols.

Appendix 1

Yandicoogina closure option figures





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Water Table +2m
- Existing Pit

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

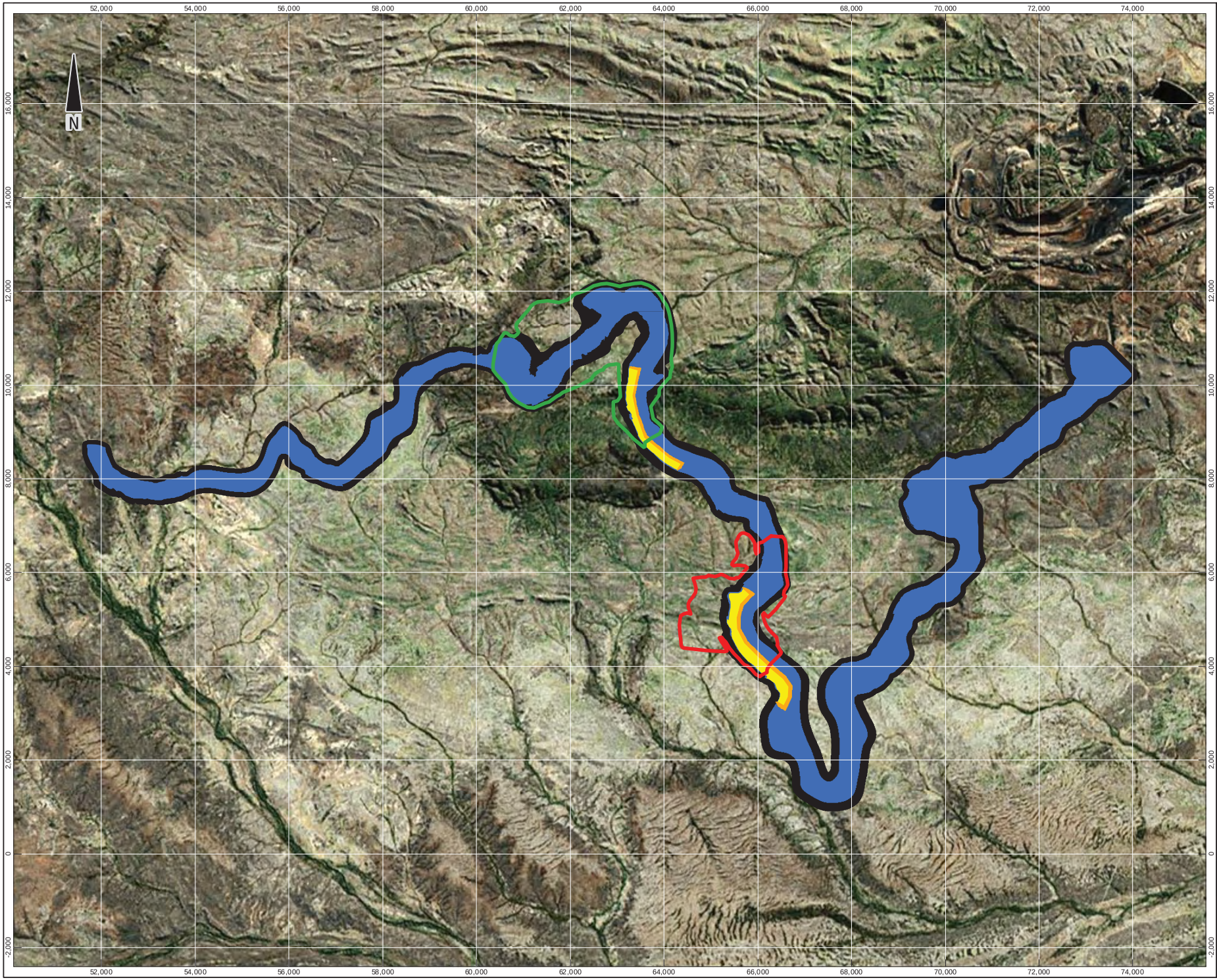
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

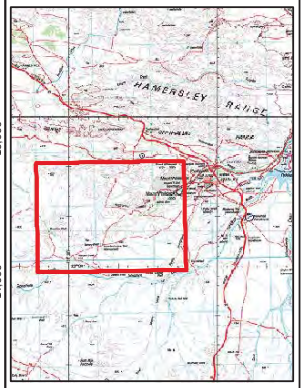
Yandi Closure Options

Scenario 1
Fill to 2m above Water Table - Current Pits

SKETCH 1

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-001-Rev0_Scenario_1.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Fines Waste Bund
- Water Table +2m
- Complete Pit System

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

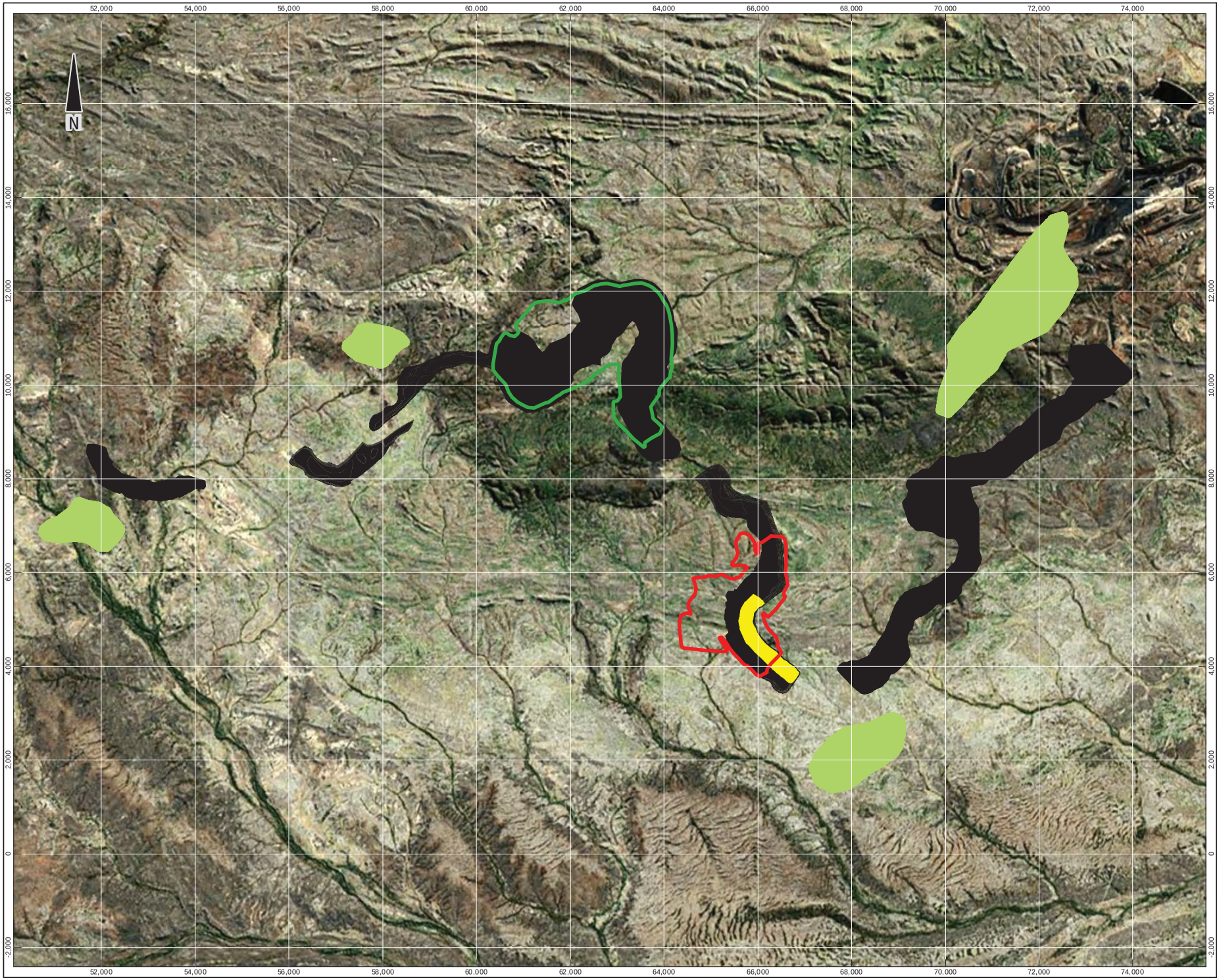
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

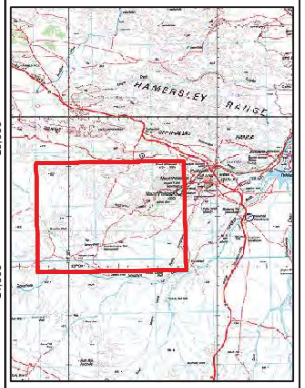
Yandi Closure Options

Scenario 2 - Fill to 2m above water table - Complete Pit System

SKETCH 2

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-002-Rev0_Scenario_2.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Waste Dump
- Existing Pit

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

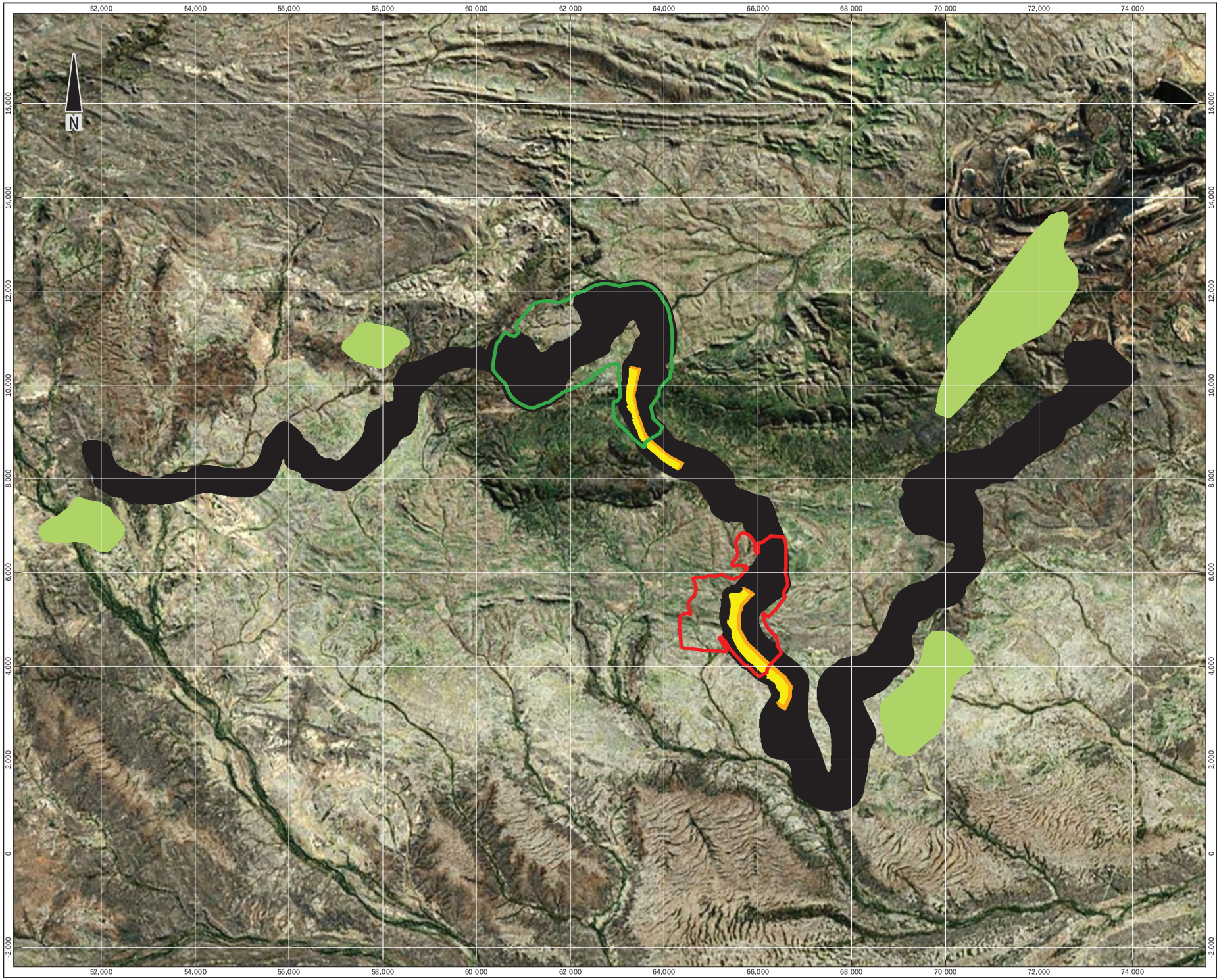
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

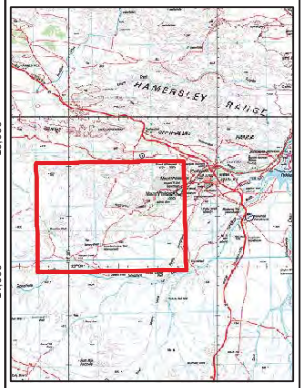
Yandi Closure Options

Scenario 3 - All mined waste in surface waste dumps - Current Pits

SKETCH 3

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-003-Rev0_Scenario_3.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Fines Waste Bund
- Waste Dump
- Complete Pit System

NOTES

Coordinate System: Yandi Mine Grid

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

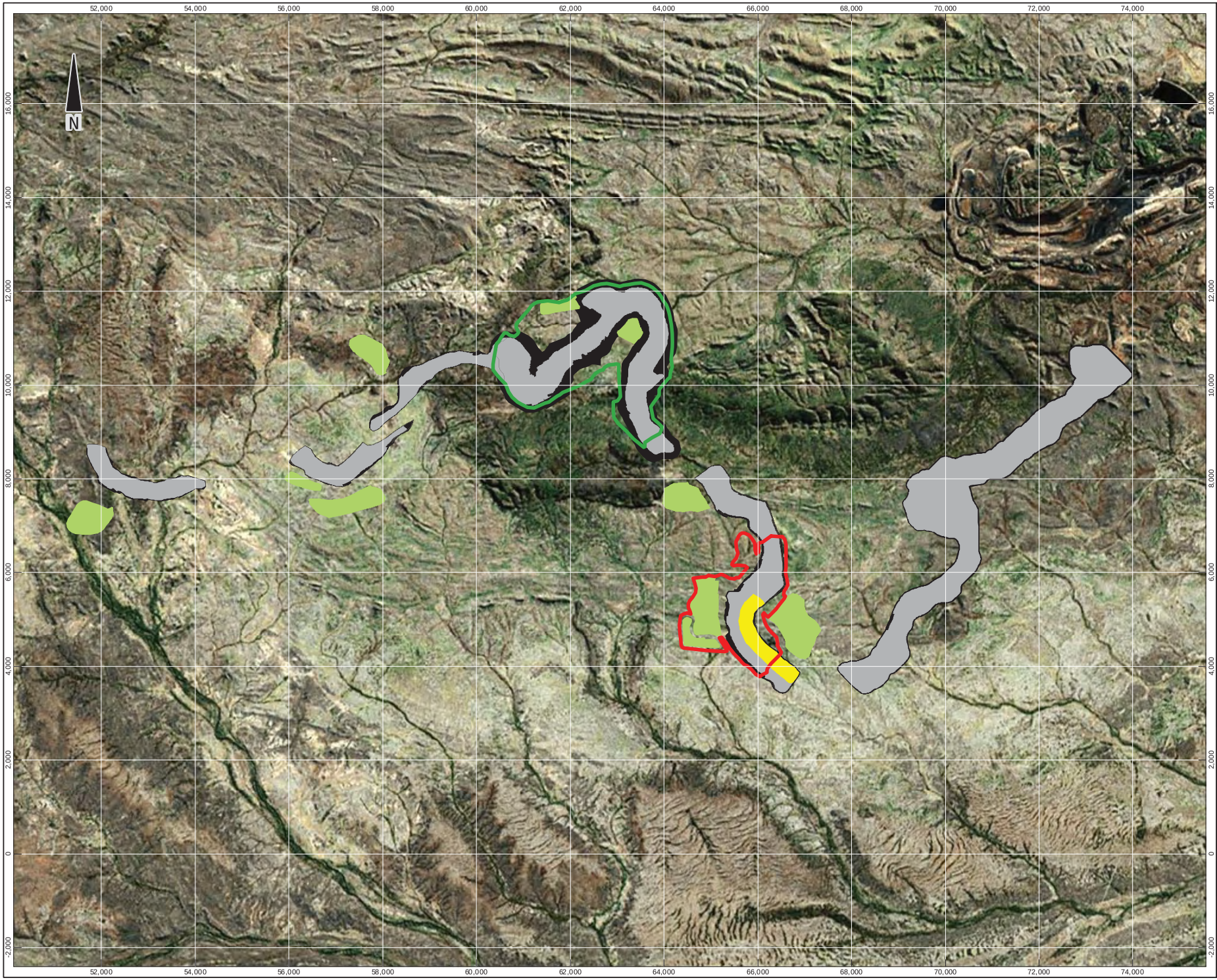
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

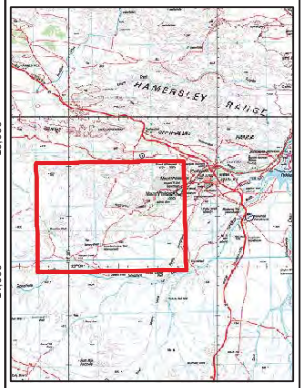
Yandi Closure Options

Scenario 4 - All mined waste in surface waste dumps - Complete Pit System

SKETCH 4

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-004-Rev0_Scenario_4.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Surface Waste Dump
- Backfill
- Existing Pit

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

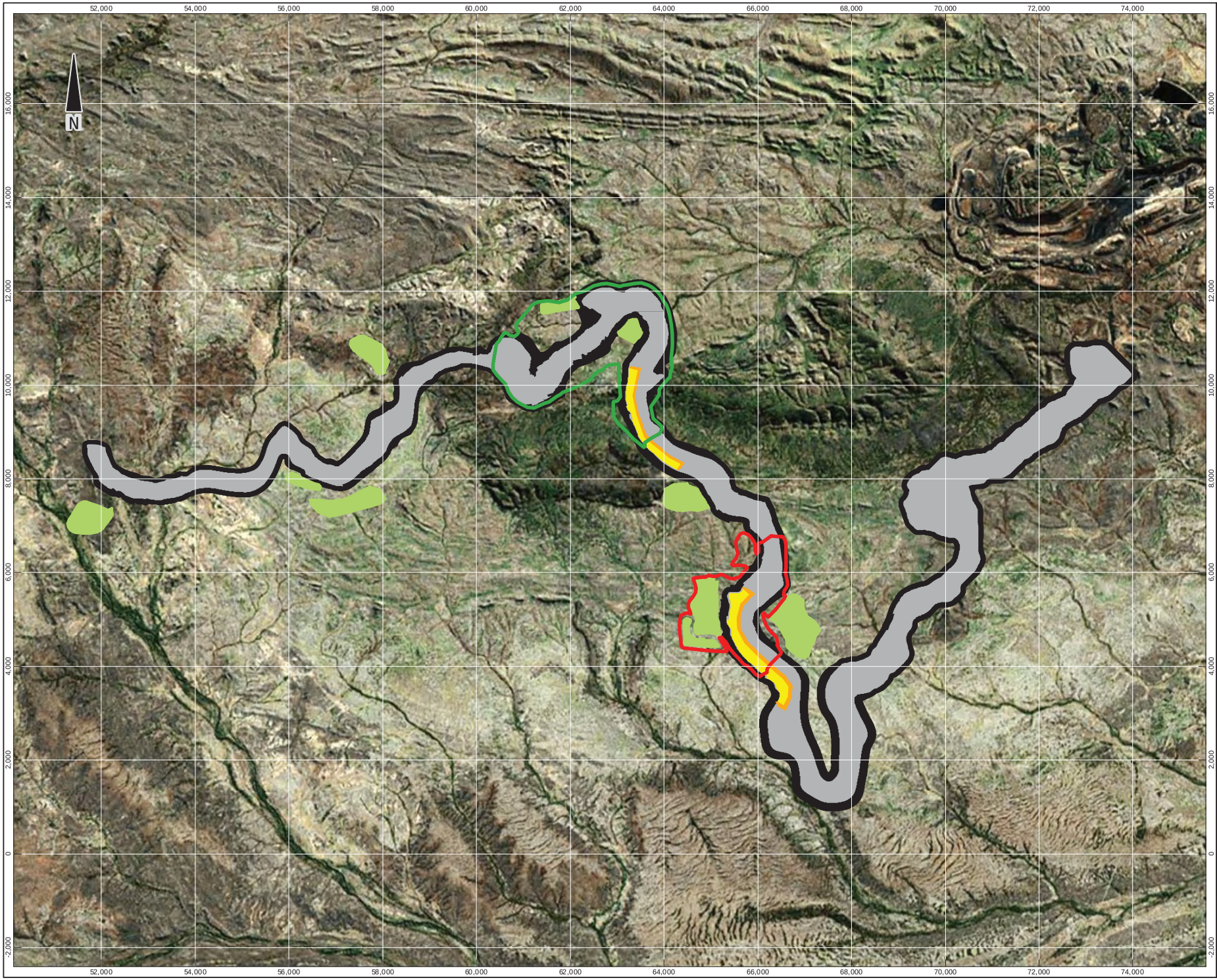
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

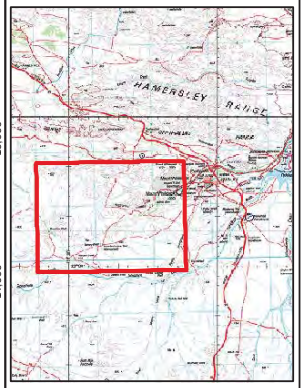
Yandi Closure Options

Scenario 5 - Surface waste dumps at 100% capacity - Current Pits

SKETCH 5

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-005-Rev0_Scenario_5.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Fines Waste Bund
- Backfill
- Complete Pit System

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

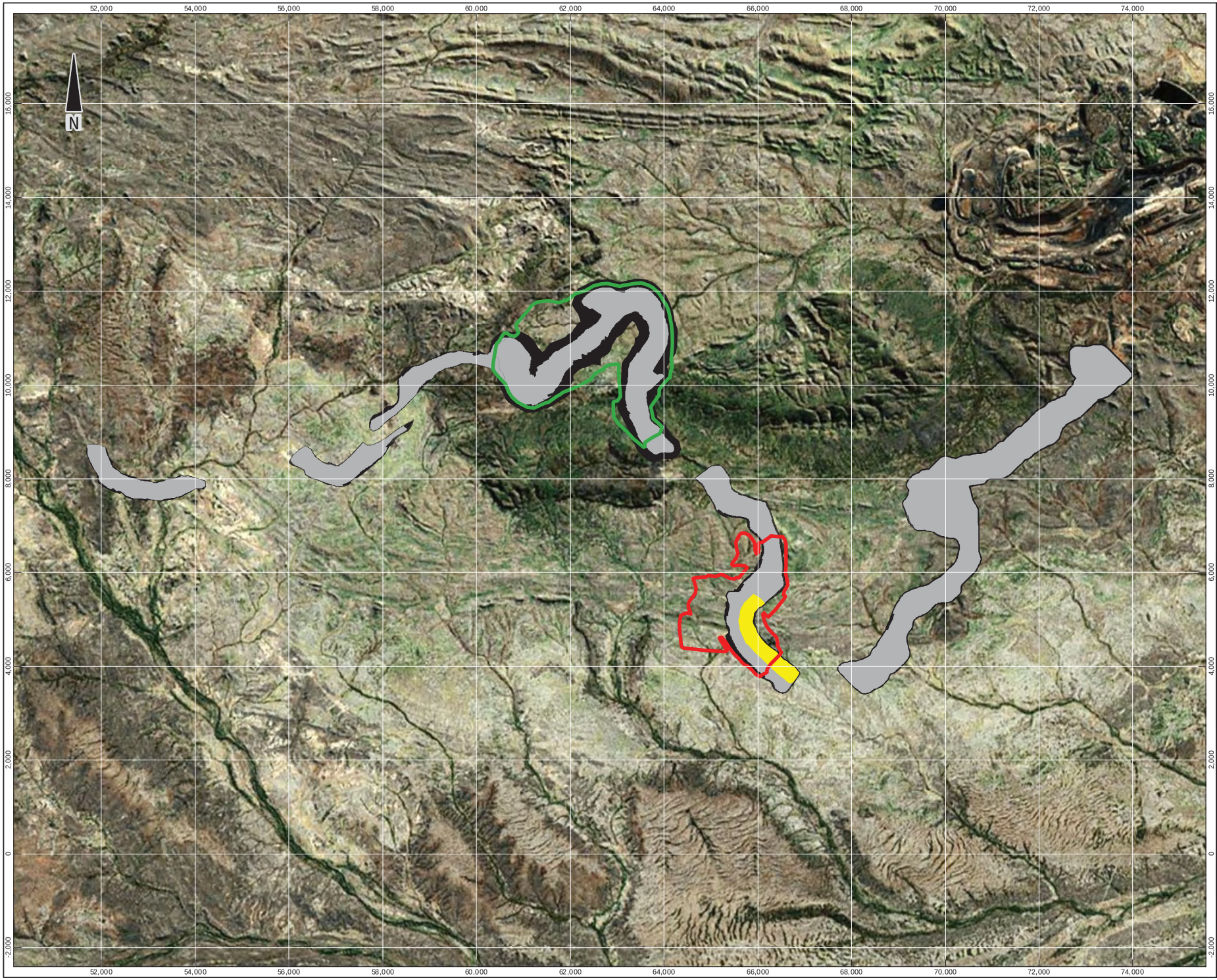
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

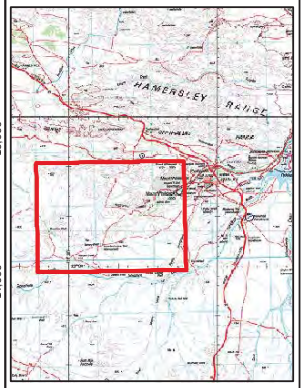
Yandi Closure Options

Scenario 6 - Surface waste dumps at 100% capacity - Complete Pit System

SKETCH 6

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-006-Rev0_Scenario_6.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Backfill
- Existing Pit

NOTES

Coordinate System: Yandi Mine Grid

COPYRIGHT

Data provided by client.
Imagery copyright Microsoft and or its suppliers.

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

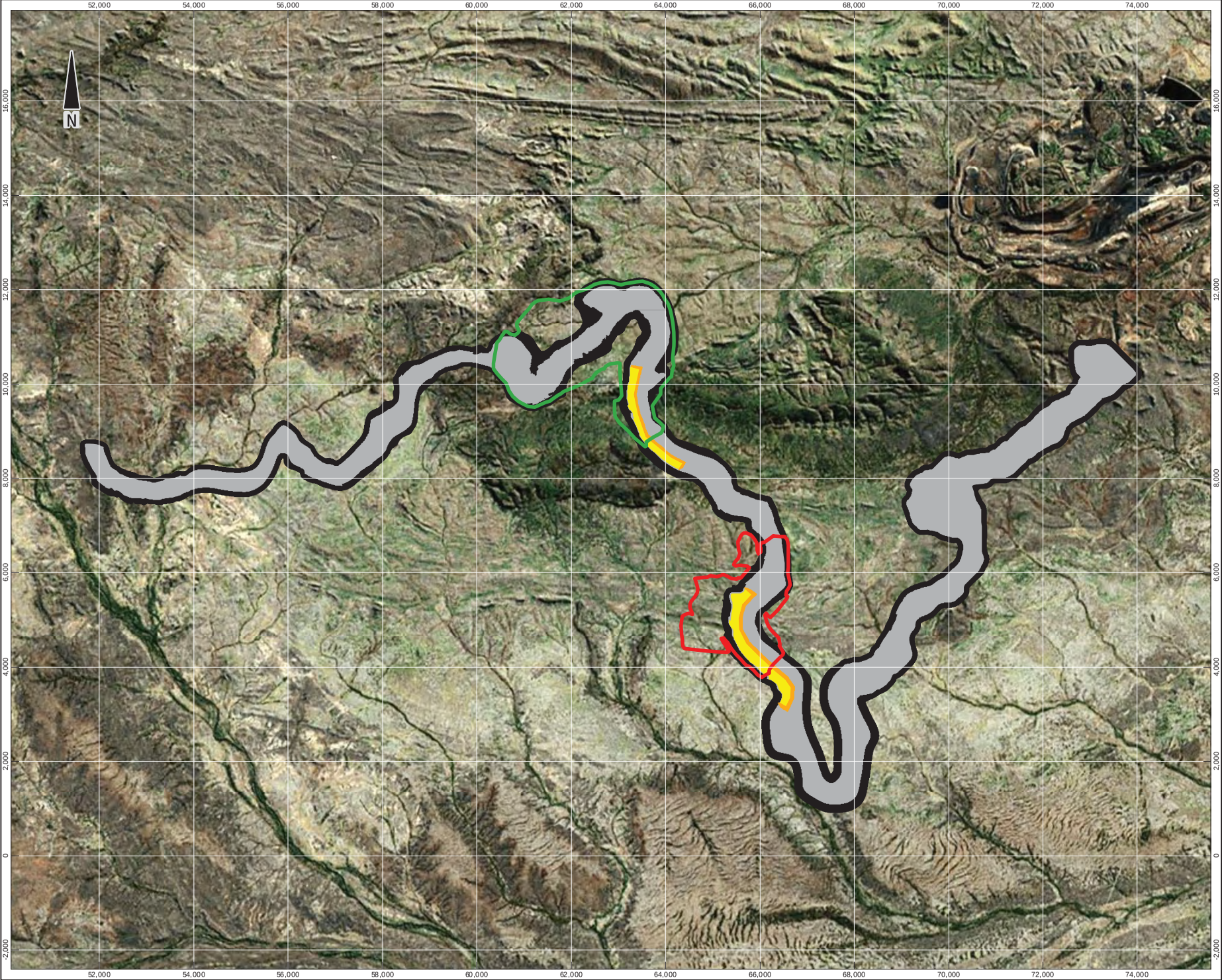
CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

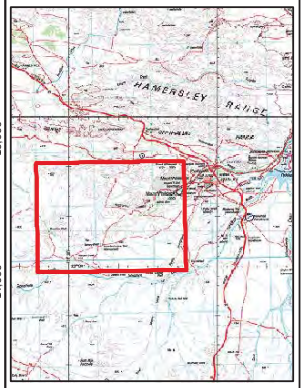
Yandi Closure Options

Scenario 7
No external waste dumps - Current Pits

SKETCH 7

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-007-Rev0_Scenario_7.mxd





LEGEND

- Junction Central
- Junction South East
- Fines Waste Repository
- Fines Waste Bund
- Backfill
- Complete Pit System

NOTES

Coordinate System: Yandi Mine Grid

0 730 1,460 2,190 2,920 3,650
metres

SCALE (at A3) 1:75,000

Golder Associates

CLIENT	Rio Tinto
DOCUMENT	117645035
DATE	24 Jun 2011
COMPILED	LB
APPROVED	CM

Yandi Closure Options

Scenario 8
No external waste dumps - Complete Pit System

SKETCH 8

File Location: R:\01 Client\Rio Tinto\117645035\Programs\ArcGIS\117645035-008-Rev0_Scenario_8.mxd