YOONGARILLUP
Mineral Sands Project

Preliminary Mine Closure Plan
M70/458 and M70/459

Commercial Information Removed

Submitted for OEPA Review

Date Submitted : 15 September 2014

Doral Reference: DMS-EMP-6.9/Ver 03

This page left blank intentionally

AMENDMENT REGISTER

Date	Rev	Description of Revision	Review	Approved
07/03/2014	A	Draft issued for EPA review	AW / CB	AT
26/05/2014	B	Document formatting updated.	AW	AT
15/09/2014	C	Document updated in response to comments provided by EPA 17/07/2014	AW	AT

DMP MINE CLOSURE PLAN CHECKLIST

No.	Mine Closure Plan (MCP) Checklist	Y/N/ NA	Page No.	Comments
1	Has the Checklist been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist.)	Y	vi	Document signed by Doral Mineral Sands, General Manager
2	How many copies were submitted to DMP?	Submitted to the OEPA as Appendix 12 of the proposed Yoongarillup Mineral Sands Project Public Environmental Review		
Cover Page, Table of Contents				
3	Does the cover page include: • Project Title • Company Name • Contact Details (including telephone numbers and email addresses) • Document ID and version number • Date of submission	Y		Cover Page
4	Has a Table of Contents been provided?	Y		
Scope and Project Summary				
5	State why is the MCP submitted (as part of a Mining Proposal or a reviewed MCP or to fulfil other legal requirements)	Y		To fulfil the requirements of the Environmental Scoping Document (January 2013) for the proposed Yoongarillup Mineral Sands Project Public Environmental Review
6	Does the project summary include:			
	• Land ownership details;	Y	2-1	Section 2.2
	• Location of the project;	Y	2-1	Section 2.1
	• Comprehensive site plan(s);	Y		Appendix A - Figure 2-3
	• Background information on the history	Y	2-2	Section 2.3
Legal Obligations and Commitments				
7	Has a consolidated summary or register of closure obligations and commitments been included?	Y	3-1	Section 3

No.	Mine Closure Plan (MCP) Checklist	Y/N/ NA	Page No.	Comments
Data 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	4-1	Section 4 Appendix C Appendix D Appendix E Appendix F Appendix G
9	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?	Y	4-64	Section 4.16
Stakeholder Consultation				
10	Have all stakeholders involved in closure been identified?	Y	5-1	Section 5
11	Has a summary or register of stakeholder consultation been provided, with details as to who has been consulted and the outcomes?	Y	5-2	Table 5-1
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	6-1	Section 6
13	Does the MCP identify all potential (or pre-existing) environmental legacies, which may restrict the post mining land use (including contaminated sites)?	Y		Appendix H
Identification and Management of Closure Issues				
14	Does the MCP identify all key issues impacting mine closure objectives and outcomes?	Y	7-1	Section 7
15	Does the MCP include proposed management or mitigation options to deal with these issues?	Y	7-3	Section 7.2
16	Have the process, methodology, and rationale been provided to justify identification and management of the issues?	Y	7-1	Section 7.1 Appendix H

No.	Mine Closure Plan (MCP) Checklist	Y/N/ NA	Page No.	Comments
Closure Criteria				
17	Does the MCP include an appropriate set of specific closure criteria and/ closure performance indicators?	Y	8-1	Section 8 Table 8-1
Closure Financial Provisioning				
18	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	9-1	Section 9 Table 9-1. This financial information is confidential and not to be made available to public.
19	Does the MCP include a process for regular review of the financial provision?	Y	9-2	Section 9.2
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	10-1	Section 10
21	Does the MCP include a closure work program for each domain or feature?	Y	10-9	Section 10.7 Figure 2-5
22	Have site layout plans been provided to clearly show each type of disturbance?	Y	2-20	Figure 2-3
23	Does the MCP contain a schedule of research and trial activities?	Y	10-11	Section 10.10
24	Does the MCP contain a schedule of progressive rehabilitation activities?	Y	10-9	Section 10.7
25	Does the MCP include details of how unexpected closure and care and maintenance) will be handled	Y	10-10	Section 10.8
26	Does the MCP contain a schedule of decommissioning activities?	Y	7-6	Section 7.2.11 Section 7.2.12 Section 7.2.13 Section 7.2.14
27	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	11-1	Section 11

No.	Mine Closure Plan (MCP) Checklist	Y/N/ NA	Page No.	Comments
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?	Y	11-1	Section 11
Closure Information and Data Management				
29	Does the mine closure plan contain a description of management strategies including systems, and processes for the retention of mine records?	Y	12-1	Section 12.1
30	Confidentiality	Y	12-1	Section 12.2

CORPORATE ENDORSEMENT:

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

Name: Andrew Templeman **Signed**:

Position: General Manager **Date**: 15/09/2014

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

This page left blank intentionally

TABLE OF CONTENTS

1	**SCOPE AND PURPOSE**		**1-1**
1.1	**PURPOSE OF THIS DOCUMENT**		**1-1**
1.2	**SCOPE OF THIS DOCUMENT**		**1-2**
2	**PROPOSED YOONGARILLUP MINE OVERVIEW**		**2-1**
2.1	**PROJECT LOCATION AND OWNERSHIP**		**2-1**
2.2	**LAND OWNERSHIP**		**2-1**
2.3	**ENVIRONMENTAL APPROVALS HISTORY**		**2-2**
2.4	**MINE OPERATIONS**		**2-3**
	2.4.1	Overview	2-3
	2.4.2	Life of Mine	2-5
	2.4.3	Pre-mine Establishment Works	2-8
	2.4.4	Mining Phase	2-8
	2.4.5	Ore Processing	2-15
	2.4.6	Ancillary Infrastructure	2-16
	2.4.7	Water and Power Supply	2-18
	2.4.8	Workforce	2-19
	2.4.9	Ground Disturbance and Rehabilitation	2-19
2.5	**FIGURES**		**2-20**
3	**CLOSURE OBLIGATIONS AND COMMITMENTS**		**3-1**
3.1	**LEGISLATIVE REQUIREMENTS**		**3-1**
3.2	**MINING TENEMENT CONDITIONS**		**3-3**
3.3	**MINISTERIAL STATEMENT CONDITIONS**		**3-4**
3.4	**CONDITIONS OF LICENCES AND PERMITS**		**3-4**
3.5	**ENVIRONMENTAL COMMITMENTS**		**3-4**
3.6	**OTHER STAKEHOLDERS COMMITMENTS**		**3-5**
4	**CLOSURE DATA**		**4-1**
4.1	**CLIMATE**		**4-1**
4.2	**BIOREGION**		**4-1**
4.3	**GEOLOGY**		**4-2**
4.4	**CONCEPTUAL HYDROLOGY**		**4-6**
4.5	**WATER QUALITY**		**4-8**
4.6	**WATER MANAGEMENT AREAS**		**4-8**
	4.6.1	Superficial and Leederville Aquifers	4-8
	4.6.2	Yarragadee Aquifer	4-9
	4.6.3	Hydrology	4-9
4.7	**SOIL AND LANDFORMS**		**4-9**
	4.7.1	Regional Soils and Landforms	4-9
	4.7.2	Soils of the Yoongarillup Mine	4-10
	4.7.3	Soil Analysis Results	4-16
	4.7.4	Available Soil Resources	4-18
	4.7.5	Acid Sulfate Soils	4-20
	4.7.6	Post-mining Soil Profiles	4-20
4.8	**WETLANDS AND GROUNDWATER DEPENDANT ECOSYSTEMS**		**4-22**
	4.8.1	Wetlands	4-22
	4.8.2	Groundwater Dependant Ecosystems	4-22

4.9 FLORA AND VEGETATION 4-23
4.9.1 Flora and Vegetation Surveys Undertaken 4-23
4.9.2 Whicher Scarp Soil-Landscape System 4-24
4.9.3 Vegetation Complexes within the Proposed Yoongarillup Mine 4-24
4.9.4 Vegetation Communities within the Proposed Yoongarillup Mine 4-26
4.9.5 Vegetation Condition within the Proposed Yoongarillup Mine 4-31
4.9.6 Vegetation of Conservation Significance 4-32
4.9.7 Flora within the Proposed Yoongarillup Mine 4-36
4.10 DIEBACK 4-41
4.11 FAUNA 4-41
4.11.1 Existing Environment 4-41
4.11.2 Regional Endemism, Distribution Limits and Rare Assemblages 4-59
4.12 AGRICULTURAL PRODUCTIVITY 4-61
4.13 GEOTECHNICAL STABILITY (SUBSIDENCE) 4-62
4.14 RADIATION 4-62
4.15 HERITAGE 4-63
4.15.1 Ethnographic Survey 4-63
4.15.2 Archaeological Survey 4-63
4.15.3 European Heritage 4-64
4.16 CLOSURE DATA GAPS 4-64
4.17 FIGURES 4-64
5 STAKEHOLDERS CONSULTATION 5-1
5.1 CONSULTATION OVERVIEW 5-1
6 POST MINING LAND USE AND CLOSURE OBJECTIVES 6-1
6.1 POST-MINING LAND USE OBJECTIVES 6-1
6.1.1 Land Use: Agriculture 6-1
6.1.2 Land Use: Rehabilitated Native Vegetation 6-1
6.1.3 Land use: Road and Road Reserve 6-1
6.2 CLOSURE OBJECTIVES 6-1
6.2.1 Compliance 6-1
6.2.2 Landforms 6-1
6.2.3 Radiation 6-2
6.2.4 Water 6-2
6.2.5 Infrastructure 6-2
7 IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES 7-1
7.1 PROCESS FOR IDENTIFYING CLOSURE ISSUES AND MANAGEMENT RESPONSES 7-1
7.2 MANAGEMENT OF CLOSURE ISSUES 7-3
7.2.1 Compliance with Obligations and Requirements 7-3
7.2.2 Geotechnical Stability 7-3
7.2.3 Land use 7-3
7.2.4 Landforms 7-4
7.2.5 Agriculture 7-4
7.2.6 Weeds 7-5
7.2.7 Agricultural Productivity 7-5
7.2.8 Erosion 7-5
7.2.9 Groundwater 7-5
7.2.10 Contaminated Sites 7-6
7.2.11 Decommissioning 7-6

7.2.12 Infrastructure reinstatement 7-7
7.2.13 Closure Provisioning 7-7
7.2.14 Scheduling 7-7

8 DEVELOPMENT OF COMPLETION CRITERIA 8-1

8.1 COMPLETION CRITERIA 8-1

9 FINANCIAL PROVISION FOR CLOSURE 9-1

9.1 FINANCIAL PROVISIONAL PROCESS 9-1
9.2 CLOSURE COST ESTIMATE AND PROVISION 9-2

10 CLOSURE IMPLEMENTATION 10-1

10.1 IMPLEMENTATION STRATEGY 10-1
10.2 MINE CLOSURE PHASE 10-1
10.2.1 Haddon West, Haddon East and Piggott Sub-areas (Agricultural Areas) 10-1
10.2.2 State Forest Sub-areas 10-1
10.3 ORGANISATION STRUCTURE AND RESOURCES 10-3
10.4 TOPSOIL AND SUBSOIL MANAGEMENT 10-4
10.4.1 Topsoil and Subsoil Stripping 10-4
10.4.2 Topsoil and Subsoil Handling 10-4
10.4.3 Topsoil and Subsoil Storage 10-4
10.4.4 Topsoil and Subsoil Placement 10-5
10.5 PIT BACKFILL AND SOIL PROFILE CONSTRUCTION 10-5
10.5.1 Pit Backfill 10-5
10.5.2 Soil Profile Construction 10-6
10.5.3 Pasture Management 10-6
10.5.4 Grazing 10-6
10.5.5 Weed and Pest Control 10-6
10.5.6 Fertiliser 10-7
10.6 NATIVE REVEGETATION 10-7
10.6.1 Photo-point Setup 10-7
10.6.2 Weed Control 10-7
10.6.3 Slashing 10-7
10.6.4 Ripping 10-7
10.6.5 Mounding 10-8
10.6.6 Furrowlining 10-8
10.6.7 Revegetation Method (Seedling/Direct seeding) 10-9
10.6.8 Seed Sourcing and Collection: Seedling Sourcing 10-9
10.7 SCHEDULE 10-9
10.8 UNEXPECTED CLOSURE OR TEMPORARY CLOSURE (UNSCHEDULED CARE AND MAINTENANCE) 10-10
10.9 RELINQUISHMENT 10-10
10.10 REHABILITATION TRIALS 10-11

11 CLOSURE MONITORING AND MAINTENANCE 11-1

11.1 CLOSURE MONITORING 11-1
11.1.1 Compliance 11-1
11.1.2 Landforms 11-1
11.1.3 Native Vegetation 11-1
11.1.4 Radiation 11-2
11.1.5 Water 11-2

11.1.6 Infrastructure 11-2
11.2 CLOSURE MAINTENANCE 11-2
12 MANAGEMENT OF INFORMATION AND DATA 12-1
12.1 MANAGEMENT OF DATA 12-1
12.2 REPORTING 12-1
13 REFERENCES 13-1

APPENDICES

APPENDIX A FIGURES
APPENDIX B IN-PRINCIPAL CONSENT FORMS
APPENDIX C HYDROLOGICAL STUDIES
APPENDIX D BASELINE SOIL ASSESSMENTS
APPENDIX E FLORA AND VEGETATION SURVEYS
APPENDIX F FAUNA SURVEY
APPENDIX G ARCHAEOLOGY AND ETHNOGRAPHIC SURVEYS
APPENDIX H RISK ASSESSMENT
APPENDIX I YOONGARILLUP MINE CLOSURE OBLIGATIONS CHECKLIST
APPENDIX J PRE-MINING DATA COLLECTION SHEET

TABLE OF FIGURES

Figure 2-1 Regional Location 2-20
Figure 2-2 Land Ownership 2-20
Figure 2-3 Mine Site Layout 2-20
Figure 2-4 Proposed Sues Road Deviation – Preliminary Concept Alignment 2-20
Figure 2-5 Yoongarillup Mine Rehabilitation Schedule 2-20
Figure 4-1 Structural Geology 4-64
Figure 4-2 Hydrogeological Cross Sections 4-64
Figure 4-3 Water Management Areas 4-64
Figure 4-4 Soil Landscape Systems 4-64
Figure 4-5 Soil Mapping of the Proposal Area 4-64
Figure 4-6 Predicted Drawdown of the Superficial Aquifer 4-64
Figure 4-7 Predicted Drawdown of the Mowen Member (Aquitard) 4-64
Figure 4-8 Predicted Drawdown of the Vasse Member (Leederville Aquifer) From Production Bores 4-64
Figure 4-9 Vegetation Complexes 4-64
Figure 4-10 Vegetation Communities 4-64
Figure 4-11 Quadrat Locations 4-64
Figure 4-12 Vegetation Condition 4-64
Figure 4-13 Priority Ecological Communities 4-64
Figure 4-14 Locations of Threatened and Priority Flora 4-64
Figure 4-15 Conservation Significant Flora 4-64
Figure 4-16 Locations of Declared Plants 4-64
Figure 4-17 Fauna Habitats 4-64
Figure 4-18 Black Cockatoo Potential Breeding Trees 4-64
Figure 4-19 Location of Archaeological Finds 4-64

TABLES IN TEXT

Table 1-1: Closure Guidance Documents 1-1
Table 2-1: Land Tenure and Landowner Status for the Yoongarillup Mineral Sands Project 2-1
Table 2-2: Tenement Summary 2-2
Table 2-3: Mine Environmental Approvals History 2-2
Table 2-4: Proposal Summary 2-4
Table 2-5: Key Proposal Characteristics Table (AS presented in the PER) 2-5
Table 2-6: Proposed Mining Shedule 2-7
Table 2-7: Area Disturbed and Rehabilitated 2-21
Table 3-1: State Legislation Closure Obligations 3-1
Table 3-2: Mining Tenements Mine Closure Conditions 3-3
Table 3-3: Ministerial Statement Closure Conditions 3-4
Table 3-4: Yoongarillup Licence and Permits Closure Conditions 3-4
Table 3-5: Project Closure Commitments 3-5
Table 3-6: Other Stakeholder Commitments 3-5
Table 4-1: Generalised Stratigraphy and Associated Aquifers of the Proposed Yoongarillup Mine 4-7
Table 4-2: Soil Mapping Units Occurring within the Proposed Yoongarillup Mine 4-10
Table 4-3: Characteristics Of Deep Pale Sand Soils 4-13
Table 4-4: Soil Analysis Results for the Yoongarillup Mineral Sands Project 4-17
Table 4-5: Mine Void Backfill Material and Soil Profile Description 4-21
Table 4-6: Flora and Vegetation Surveys Conducted in each Sub-Area 4-24
Table 4-7: Whicher Scarp Soil-Landscape System 4-24
Table 4-8: Vegetation Complexes within the Proposed Yoongarillup Mine 4-25
Table 4-9: Most Frequent Species Occurring within Each Vegetation Community 4-28
Table 4-10: Vegetation Communities within the State Forest Sub-Area 4-30
Table 4-11: Vegetation Communities within the Haddon East Sub-Area 4-31
Table 4-12: Vegetation Condition Ratings (Keighery, 1994) 4-31
Table 4-13: Threatened and Priority Ecological Communities Data Search Results 4-34
Table 4-14: Threatened and Priority Flora Potentially Occurring within or adjacent to the Proposed Yoongarillup Mine 4-36
Table 4-15: Details of Threatened and Priority Flora Surveys Conducted within the Proposed Yoongarillup Mine 4-40
Table 4-16: Fauna Habitats within the Proposed Yoongarillup Mine 4-42
Table 4-17: Potentially Occurring Conservation Significant Vertebrate Fauna Species 4-47
Table 4-18: Summary of Fertility Results for the Topsoil of the Yoongarillup Mine 4-62
Table 5-1: Stakeholder Consultation 5-2
Table 7-1: Risk Assessment Likelihood Criteria 7-1
Table 7-2: Risk Assessment Consequence Criteria 7-1
Table 7-3: Risk Assessment Rating Matrix 7-2
Table 7-4: Risk Assessment Management Description 7-3
Table 8-1: Completion Criteria 8-1
Table 9-1: Deconstruction Cost Estimate 9-3
Table 9-2: Rehabilitation Cost Estimate Yoongarillup Mine 9-5

Table 10-1: Rehabilitation Schedule 10-10

PLATES IN TEXT

Plate 2-1	Typical Cross Section of Drainage Control in Mine Pits	2-9
Plate 2-2	Proposed Mining Method for Mine Blocks West of Sues Road, Inc.State Forest	2-10
Plate 2-3	Flowchart of Mining Operation	2-15
Plate 2-4	Solar Evaporation Pond Design Clay and Overburden Structures	2-16
Plate 2-5	Solar Evaporation Pond Design Tailings Sand Structures	2-17
Plate 4-1	Annual Average Climate Data	4-1
Plate 4-2	Map of the Regional Geology of the Yoongarillup Mineral Sand Mine, Southeast of Busselton	4-4
Plate 4-3	Digital Elevation Model of the Yoongarillup Mine Surrounds	4-5
Plate 4-4	Cross Section of the Dune-Scarp Local Geology of the Busselton Area	4-6
Plate 4-5	Typical Grey Sandy Topsoil Over Deep Yellow Sand	4-12
Plate 4-6	Detail of Grey A1 Horizon	4-12
Plate 4-7	Pit Dl4 Showing Pale Sandy B Horizon	4-13
Plate 4-8	Evidence of Hydrophobicity in Surface Soils	4-13
Plate 4-9	Laterite Outcrop	4-15
Plate 4-10	Shallow Gravel Material with Surface Course Fragments and Exposed Underlying Rock in Forested Areas	4-15
Plate 4-11	Abandoned Gravel Pit and Lake	4-16
Plate 4-12	Detail of Rehabilitated Surface Soil with Building Rubble, Weeds and Bare Surfaces	4-16
Plate 10-1	Soil Profile Pre/Post Mining of Blocks 24 and 25	10-2
Plate 10-2	Closure Implementation Organogram	10-3
Plate 10-3	Schematic Representation of Mounding for Revegetation	10-8
Plate 10-4	Schematic Representation of Furrowlining for Revegetation	10-9

LIST OF ABBREVIATIONS

AER	Annual Environmental Report
ACMC	Aboriginal Cultural Material Committee
ASS	Acid Sulfate Soil
bcm	Bank cubic metre
CMP	Conservation Management Plan
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DoW	Department of Water
DMP	Department of Mines and Petroleum
DPaW	Department of Parks and Wildlife
ESD	Environmental Scoping Document
EC	Electrical Conductivity
ECEC	Effective Cation Exchange Capacity
EFA	Ecosystem function analysis
EMS	Environmental Management System
EPA	Environmental Protection Authority
FEL	Front end loader
FCT	Floristic community type
GDE	Groundwater Dependent Ecosystem
GL	Gigalitre
ha	Hectare
HMC	Heavy mineral concentrate
km	Kilometre
LTV	Long-term irrigation value
mBGL	Meters Below Ground Level
M	million
m^3	Cubic metre
MCP	Mine Closure Plan
Mg/L	milligram per litre
ML	megalitre

mm	millimetre
OEPA	Office of the Environmental Protection Authority
PER	Public Environmental Review
POW	Programme of Work
PWP	Process Water Pond
SEP	Solar Evaporation Pond
SRE	Short range endemic
TEC	Threatened Ecological Community
t	tonne
TBC	To be confirmed
tpa	Tonnes per annum
TPH	Tonnes per hour
WRP	Western ringtail possum

1 SCOPE AND PURPOSE

1.1 PURPOSE OF THIS DOCUMENT

Doral Mineral Sands Pty Ltd (Doral) has developed this Mine Closure Plan (MCP) to provide the framework for the planning of activities associated with Mine Closure for the proposed Yoongarillup Mineral Sands Project (herein referred to as the 'proposed Yoongarillup Mine') on Mining Leases M70/458 and M70/459.

This MCP describes Doral's strategies for decommissioning mining infrastructure, rehabilitating the land disturbed by mining and releasing the area for future use.

This MCP has been prepared to address the work required as described in the environmental factor rehabilitation and mine closure in the Environmental Scoping Document (ESD).

This document has been prepared in accordance with the Department of Mines and Petroleum (DMP) and Environmental Protection Authority (EPA) Guidelines for Preparing Mine Closure Plans (the Guidelines) (DMP and EPA, 2011) and is based upon existing information available from applicable site studies and investigations, legislative and policy needs.

As detailed in the Guidelines (DMP and EPA, June 2011), the EPA will generally not assess mine closure as part of its Environmental Impact Assessment of mining proposals under the Environmental Protection Act 1986 (EP Act), where they are subject to the Mining Act 1978. The EPA will only assess mine closure in these circumstances if it considers there are particular issues which pose a high environmental risk. The EPA would consult with the DMP before making any such decision.

Where the EPA assesses mine closure, an approval condition will normally be applied under the Environmental Protection Act 1986, requiring a MCP to be prepared in accordance with the Guidelines. Where it is considered that regulatory efficiencies would be gained, compliance monitoring of these conditions may be delegated to the DMP. This would assist in achieving consistency of application of the Guidelines, and minimise the potential for any duplication.

The documents as listed in Table 1-1 have also be used to inform the content of this MCP and will continue to inform the content during the regular updates as information becomes available.

TABLE 1-1: CLOSURE GUIDANCE DOCUMENTS

GUIDELINE/DOCUMENT	PURPOSE
Australian Minerals Industry (AMI) Code for Environmental Management (Minerals Council of Australia, 2000).	Framework including consultation, progressive rehabilitation and reporting.
Strategic Framework for Mine Closure (Australian and New Zealand Minerals and Energy Council (ANZMEC) /Minerals Council of Australia, 2000) (a joint government and industry guideline).	Framework including upfront planning for closure, consultation, progressive rehabilitation and reporting.
Mine Closure Guideline for Mineral Operations in Western Australia (Chamber of Minerals and Energy WA Inc. 2004).	Framework including consultation, progressive rehabilitation and reporting.

GUIDELINE/DOCUMENT	PURPOSE
Mine Closure Policy (Minerals Council of Australia, 1999).	Policy on mine closure.
Mine Rehabilitation Handbook 2nd edition (Minerals Council of Australia, 1998).	Stakeholder consultation and financial provisioning.
Guidelines for Mining in Arid Environments (Department of Minerals and Energy, June 1996).	Provides guide to rehabilitation techniques in arid areas
Assessment Levels for Soil, Sediment and Water (Department of Environment and Conservation, 2010).	Threshold levels for contaminated soils.
ANZECC/ARMCANZ: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.	Establishing water quality criteria using previous monitoring data and site specific factors, to establish standards to be achieved at closure.
'Best Practice Environmental Management in Mining' The Commonwealth Environmental Protection Agency series.	Industry examples of mining practices.
Guidance for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems. Draft No. 6 (EPA, 2006a).	Closure strategy and description of objectives, targets and review during mine

This MCP is a living document that will evolve as new information is collected to address the information gaps. This document and all comments and information contained within must be read in entirety, with reference to the gaps and uncertainties identified in the relevant sections.

1.2 SCOPE OF THIS DOCUMENT

The proposed Yoongarillup Mine will operate on the following mining tenements which provide tenure to the operations under the Mining Act 1978:

- M70/458;
- M70/459.

A description of the activities to be undertaken at the Yoongarillup Mine is contained within Section 2. The groundwork located on M70/458 and M70/459 that will be subject of this MCP includes:

- Pits;
- Solar evaporation ponds (SEPs);
- Infrastructure such as internal roads, offices and contractor lay down area;
- Process water pond (PWP);
- Gazetted Roads.

This MCP does not include the Picton Dry Separation Plant.

2 PROPOSED YOONGARILLUP MINE OVERVIEW

2.1 PROJECT LOCATION AND OWNERSHIP

The proposed Yoongarillup Mine will be located approximately 17 km southeast of Busselton and 250 km south of Perth, Western Australia, within the local government boundary of the City of Busselton (Figure 2-1). The proposed Yoongarillup Mine will be located within the bounds of Mining Leases M70/458 and M70/459.

The City's Town Planning Scheme No. 20 (TPS 20) shows the proposed Yoongarillup Mine mostly as 'Agriculture' zoning with the portion contained in State Forest No. 33 being reserved for 'Recreation'.

The proposed Yoongarillup Mine will be owned and operated by Doral. Doral is a wholly owned subsidiary of Perth-based Doral Pty Ltd, which itself is an unlisted public company owned by Iwatani International Corporation of Japan.

Doral plan to commence construction of the proposed Yoongarillup Mine in March 2015 using continuous (24 hours a day) open cut mining.

The proposed Yoongarillup Mine (total project area of 151.97 ha) will have a total ground disturbance of 95.71 ha. Approximately 86.81 ha of the disturbance area is located on previously cleared land (currently used for farming beef cattle, dairy cattle and pasture), and an additional 8.90 ha is located within State Forest No. 33, of which 0.22 ha has previously been cleared. This area is referred to as the State Forest sub-area.

2.2 LAND OWNERSHIP

There are three individual landowners, two gazetted roads and crown land (State Forest 33, managed by the Department of Parks and Wildlife (DPaW)) within the proposed Yoongarillup Mine (Figure 2-2). Access to landowner's properties will be via compensation agreements with the individual landowners including the DPaW. Tenement condition 17 of M70/458 and M70/459 requires compensation to be paid to the Department of Conservation and Land Management, now known as the DPaW.

In-principal consent forms to mine private land and gazetted roads are included in Appendix B. Any specific landowner requirements are included in the other stakeholder commitments (Section 3.6). The lot numbers, landowners and land tenure that will be affected by this proposed Yoongarillup Mine are summarised in Table 2-1 below.

TABLE 2-1: LAND TENURE AND LANDOWNER STATUS FOR THE YOONGARILLUP MINERAL SANDS PROJECT

LOT NUMBER	LANDOWNER	LAND TENURE
101	Private owner	Freehold
102	Private owner	Freehold
1870	Private owner	Freehold
1871	Private owner	Freehold
1872	Private owner	Freehold
1873	Private owner	Freehold

LOT NUMBER	LANDOWNER	LAND TENURE
1874	Private owner	Freehold
F33	State Forest	Crown land
Goulden Road	City of Busselton	Gazetted Road
Sues Road	Main Roads Western Australia	Gazetted Road

The summary tenement details for M70/458 and M70/459 are provided in Table 2-2.

TABLE 2-2: TENEMENT SUMMARY

TENEMENT	HOLDER	AREA (HA)	COMMENCED	EXPIRY
M70/458	Doral Mineral Sands Pty Ltd	121.40	26/03/1993	25/03/2014 (renewal application submitted February 2014)
M70/459	Doral Mineral Sands Pty Ltd	121.40	26/03/1993	25/03/2014 (renewal application submitted February 2014)

2.3 ENVIRONMENTAL APPROVALS HISTORY

A history of the approvals process to date for the Yoongarillup mine is provided in Table 2-3.

TABLE 2-3: MINE ENVIRONMENTAL APPROVALS HISTORY

DATE	APPROVALS HISTORY
22 Mar 2012	The proposal to develop the Yoongarillup Mine was referred to the EPA under section 38 of the EP Act.
27 Aug 2012	EPA determined the level of assessment for the Proposal as Public Environmental Review (PER) with a four week public review period.
29 Aug 2012	The proposal to develop the Yoongarillup Mine was referred to the Department of Sustainability, Environment, Water, Population and Communities (now the Department of the Environment).
26 Sep 2012	Department of Sustainability, Environment, Water, Population and Communities notification of referral decision and designated proponent – controlled action – decision on assessment approach. Relevant controlling provisions – listed threatened species and communities (Section 18 and 18A) and wetlands of international importance (Sections 16 & 17B) under the *Environment Protection and Biodiversity Conservation Act 1999*. Assessment approach - the action will be assessed by public environmental review under bilateral agreement with the WA Government).
Jan 2013	The EPA issued final ESD.
10 Mar 2014	Draft PER submitted to the OEPA for review.

2.4 MINE OPERATIONS

2.4.1 Overview

A mine site layout plan is provided in Figure 2-3 and illustrates the location of:

- Cadastre and mining lease boundaries;
- Main infrastructure - such as the wet concentration plant, process water pond (PWP), drop out pond and the sand tailings storage areas;
- Soil stockpiles, roads, active tailings areas, solar evaporation ponds (SEPs), and other disturbed areas.

Doral propose to mine the Yoongarillup Mineral Sands Deposit, a strand of heavy mineral deposit located adjacent to the Whicher Scarp, 17 km southeast of Busselton, WA.

Ore from the deposit will be mined progressively via a series of open-cut pits using dry mining techniques. Dewatering of groundwater inflows into the pit will be required to enable dry mining to occur. Mining will be staged in order to minimise the area of disturbance (at any one time) with the aim of achieving focussed and effective management of the environmental factors at each pit location, prior to moving onto the next pit location.

Processing of ore will commence in-pit and then slurry will be pumped to the feed preparation plant and wet concentration plant for further processing. Waste clay and sand materials from processing of the ore will be combined and backfilled into the mine voids using co-flocculation (co-disposal system) where possible. Some material will be initially placed in a Tailing Storage Facility, herein referred to as SEPs, to allow drying of the clay and recycling of water back to the PWP (return water), prior to being co–disposed into mine voids. The mined area will be rehabilitated back to pasture and/or native vegetation, consistent with the post-mine land use requirements.

Heavy mineral concentrate (HMC) resulting from the wet concentration plant processing will be stockpiled on site prior to transport to Doral's Picton Dry Separation Plant, located approximately 63 km northeast of the mine, for separation using magnetic processes. The Picton Dry Separation Plant has a licence to process 250,000 t of HMC sourced from Doral's mines and external suppliers. Processing of HMC into products of zircon, ilmenite, and leucoxene has occurred since the Picton Dry Separation Plant was approved by Ministerial Statement 484 in 1998. Once processed, HMC products are hauled by truck to either the Bunbury Port or Fremantle Port for export.

Processing activities at the Picton Dry Separation Plant and exporting of HMC product are not part of this MCP and are not further described in this MCP.

Key characteristics for the Proposal are summarised in Table 2-4 and Table 2-5.

TABLE 2-4: PROPOSAL SUMMARY

ELEMENT	PROPOSAL
Proponent	Doral Mineral Sands Pty Ltd, Lot 7 Harris Road, Picton WA 6229
Life of mine	3 years
Total disturbance area	95.71 ha (mine pits and all infrastructure)
Mineable reserve	4,000,000 tonnes
Overburden volume	478,000 Bank Cubic Metres (BCM)
Rates of extraction (overburden and ore)	6,400,000 tonnes per annum (tpa)
Processing rate/mining rate	200 tonnes per hour (TPH)
HMC production	256,000 tonnes
Extraction method	Dry Mining
Water supply sources	1.6 gigalitres (GL) per annum abstracted from the Yarragadee aquifer Pit dewater and rainfall catchment will supplement the abstracted water where possible
HMC transport to Picton Dry Separation Plant	Six round trips (12 movements) per day

TABLE 2-5: KEY PROPOSAL CHARACTERISTICS TABLE (AS PRESENTED IN THE PER)

SUMMARY OF THE PROPOSAL	
Proposal Title	Yoongarillup Mineral Sands Project
Proponent Name	Doral Mineral Sands Pty Ltd
Short Description	The proposal is to extract ore from the Yoongarillup Mineral Sands Deposit, 17km southeast of Busselton, including the construction of associated mine infrastructure (offices, workshops, laydown area, roads, ore processing facilities and solar evaporation ponds).

PHYSICAL ELEMENTS		
ELEMENT	**LOCATION**	**PROPSOED EXTENT AUTHORISED**
Mine Pits	Figure 2-1 – Regional Location	Clearing no more than 9ha of native vegetation and 32ha of pasture within a 152ha development envelope
Associated Infrastructure	Figure 2-3 – Mine Site Layout	Clearing of no more than 27ha of pasture within a 152ha development envelope.
Solar Evaporation Ponds (i.e. Tailings Storage Facility)	Figure 2-3 – Mine Site Layout	Clearing no more than 29ha of pasture within a 152ha development envelope.

OPERATIONAL ELEMENTS		
ELEMENT	**LOCATION**	**PROPOSED EXTENT AUTHORISED**
Ore Processing (waste)	Solar Evaporation Ponds Figure 2-3 – Mine Site Layout	No more than 250,000 tonnes per annum
Dewatering	-	Extraction of no more than 1.6 Gigalitres per annum

2.4.2 Life of Mine

The operational mine life is three years which includes:

- Pre-mine establishment phase where the mine infrastructure and support facilities are constructed as described in Section 2.4.3. The duration of the phase is expected to be four months.
- Mining phase (Table 2-6, Section 2.4.4, Figure 2-3):
    - Haddon West sub-area-mining of blocks 14 to 23 and the realignment of Sues Road, (subject to approval from Main Roads WA – See Section 5).

- State Forest sub-area-mining of blocks 24 and 25.
- Haddon East sub-area -mining of blocks 2, and 4 to 13.

Following the operational phase of mining (three years), the mine closure phase will commence where rehabilitation and closure of mining domains will be undertaken in accordance with this MCP. Doral expects mine closure to occur for up to five years, however this will depend on the success of rehabilitation.

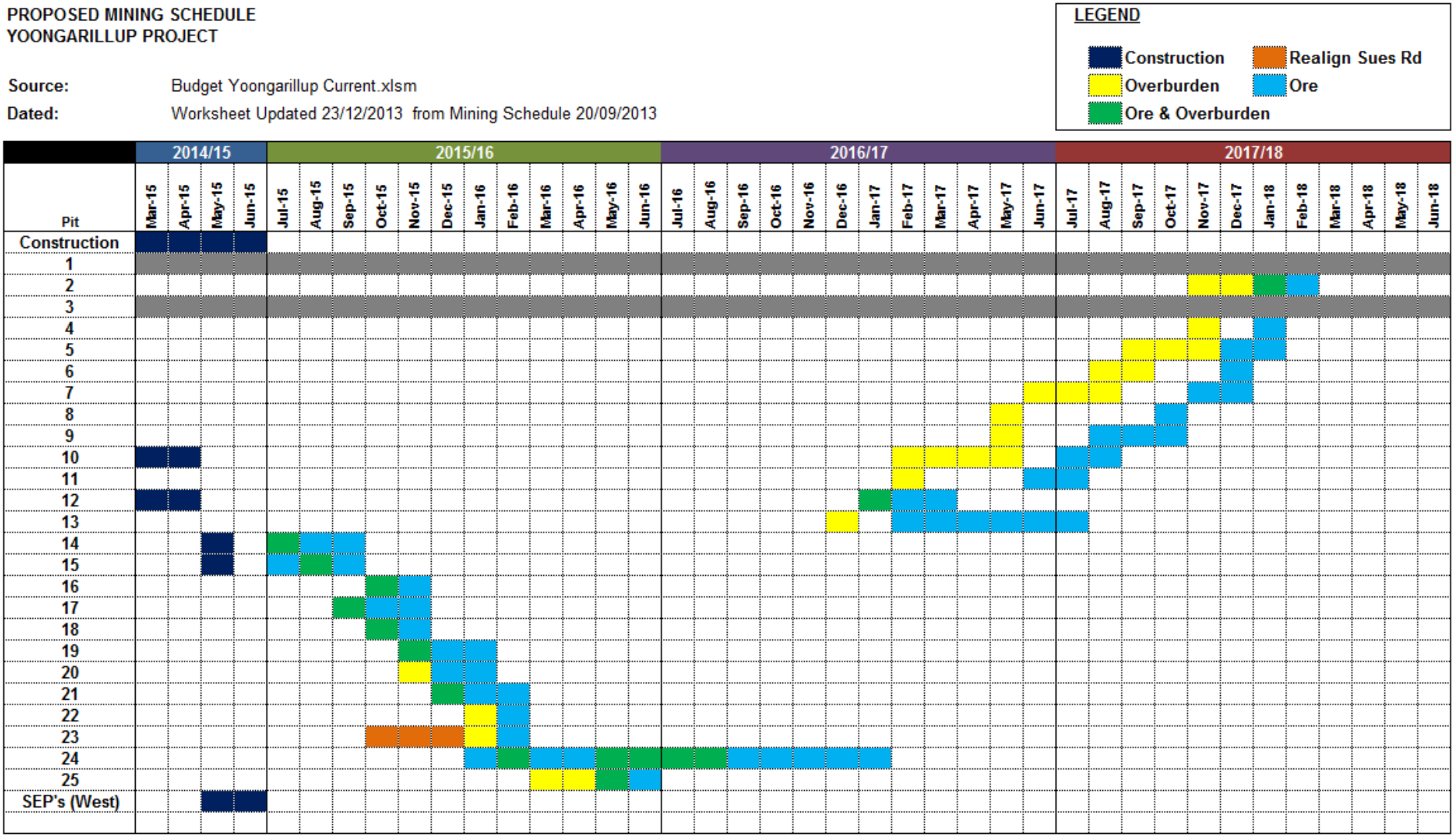
A description of the activities conducted at each stage of the mine life is described after Table 2-6. A mine site layout plan is shown in Figure 2-3 which also shows the State Forest, Haddon West, Haddon East and Piggott sub-areas.

TABLE 2-6: PROPOSED MINING SHEDULE

PROPOSED MINING SCHEDULE
YOONGARILLUP PROJECT

Source: Budget Yoongarillup Current.xlsm

Dated: Worksheet Updated 23/12/2013 from Mining Schedule 20/09/2013



2.4.3 Pre-mine Establishment Works

Pre-mine establishment activities will be undertaken between the hours of 7am to 7pm Monday to Saturday (excluding public holidays). The pre-mine establishment works will occur for a period of four months during dry months as shown in Table 2-6. Activities to be conducted are:

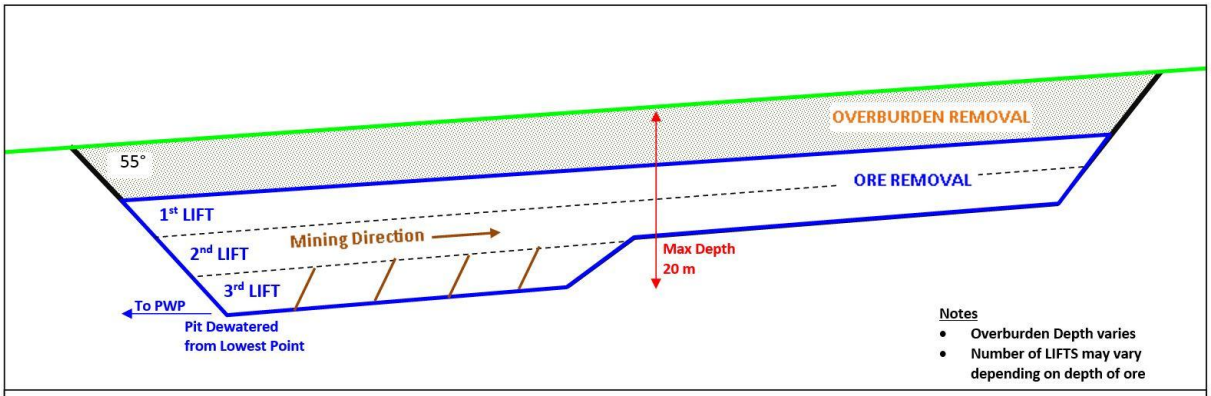
- Sub–soil drainage of paddocks;
- Clearing of remnant paddock trees within the disturbance area;
- Construction of the PWP and drop out pond on mine blocks 10 and 12;
- Stripping of topsoil and subsoil on blocks 14 and 15 using scrapers and trucks;
- Construction of SEPs;
- Construction of internal haul roads;
- Installation of production bores and associated water infrastructure (e.g. pipeline);
- Construction of two amenities buildings; one containing offices and lunchroom and a second for ablution facilities. A local government approved septic tank and leach drain system will be established for effluent disposal;
- Construction of feed preparation plant, wet concentration plant and associated infrastructure;
- Construction of workshop and hardstand areas;
- Fencing where required (e.g. between SEPs and native vegetation);
- Erection of signage (e.g. State Forest sub-area);
- Ongoing monitoring of groundwater bore network;
- Pre-mine baseline surveys.

2.4.4 Mining Phase

Mining of Haddon West, Haddon East and Piggott Sub-Areas

Ore from the Yoongarillup Mineral Sands Deposit will be mined progressively via a series of open-cut pits using dry mining techniques. Once the topsoil and subsoil is stripped and stockpiled, overburden will be removed via scrapers or excavators. Removed overburden will be stockpiled or immediately used in progressive rehabilitation of previously mined areas. Exact depths of ore and overburden will vary for each pit, but will not exceed 20m below ground level (mbgl). Ore will be mined in a series of lifts, to a maximum depth of 20mbgl. Pits will be mined on a slight incline from the deepest point and then mined moving upgradient in order to retain pit water within a sump at the deepest point on the pit floor (Plate 2-1). This form of dewatering is known as ‘passive’ as no dewatering apparatus (e.g. spears) are used to actively abstract water and groundwater drawdown below the base of the pit (i.e. below 20m) is highly unlikely to occur. Mine pit dewater is pumped from the sump to the PWP for reuse. It should be noted that the use of scrapers is not recommended for topsoil removal and is not permitted under the tenement conditions unless approval is obtained from DMP.

PLATE 2-1 TYPICAL CROSS SECTION OF DRAINAGE CONTROL IN MINE PITS



TYPICAL CROSS SECTION – DRAINAGE CONTROL

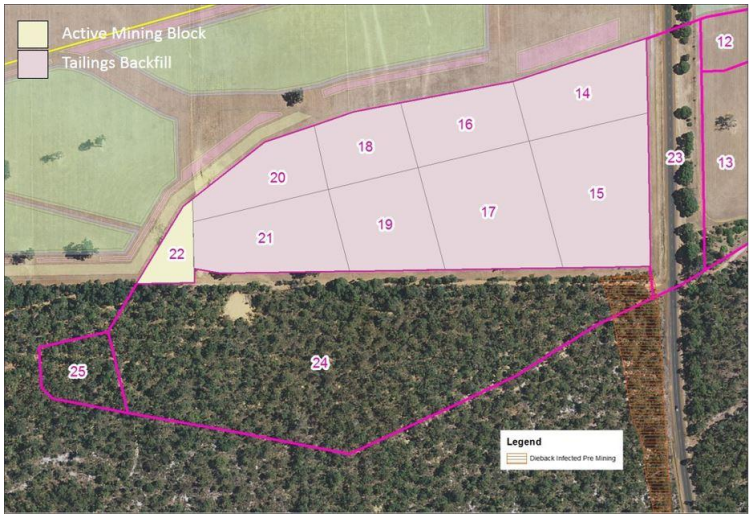
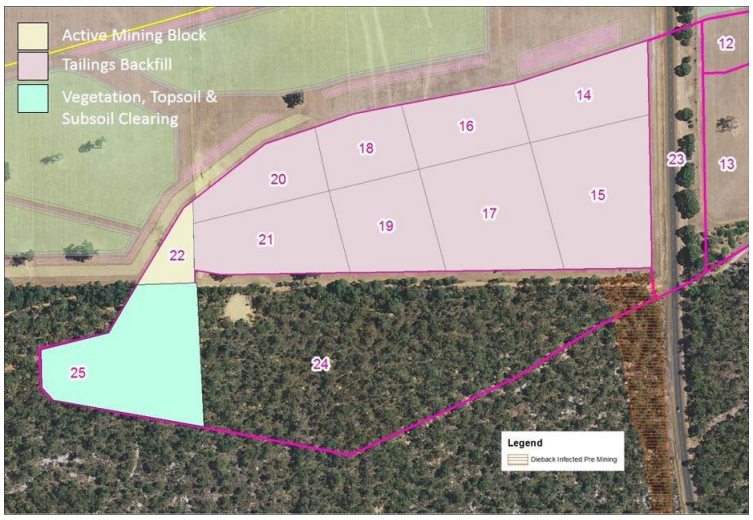
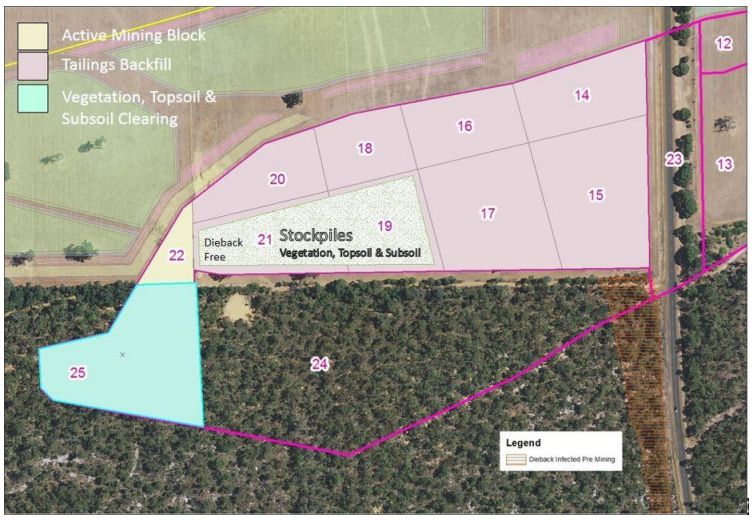
Mining of ore and overburden within blocks 14 to 23 (Haddon West sub-area) is likely to occur over an eight month period. In order to mine block 23, Doral are planning on realigning a 300 m section of Sues Road temporarily before reinstating the road at the completion of mining activities to its original alignment. The concept temporary road alignment is shown on Figure 2-4. Preliminary discussions have been held with Main Roads WA, whom have provided agreement to temporarily realign Sues Road, subject to a formal agreement being established and all Main Roads WA requirements being met.

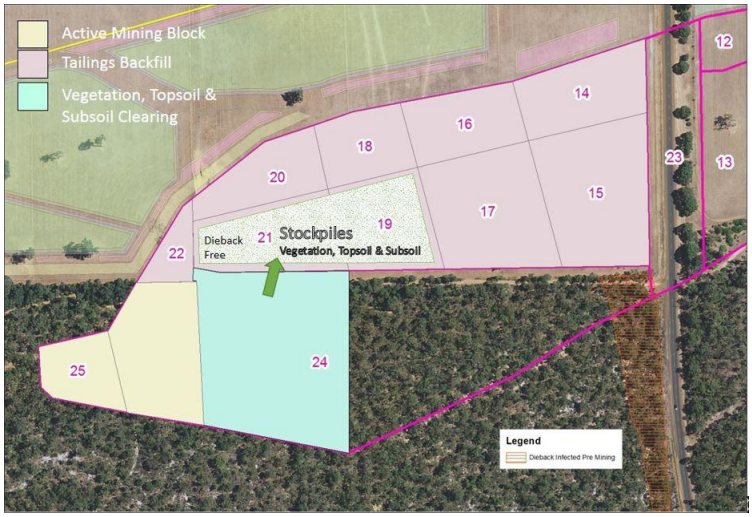
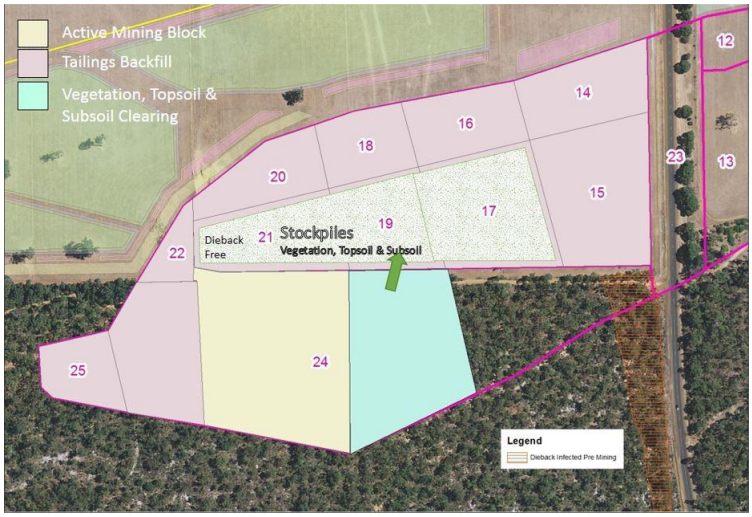
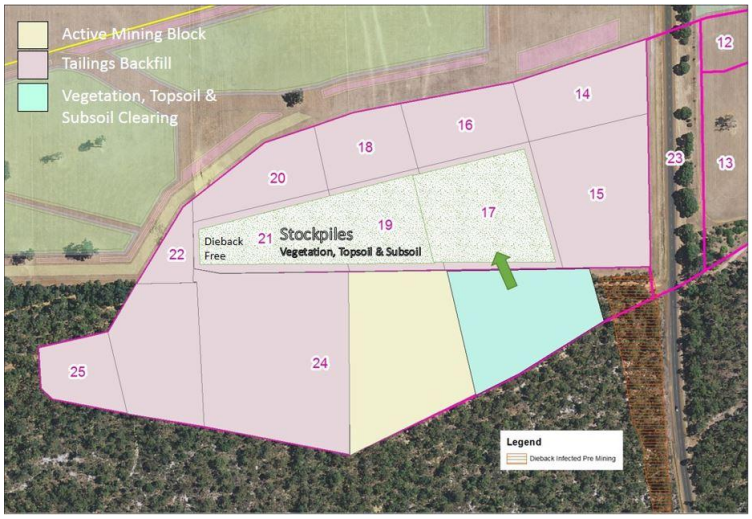
Mining of ore and overburden within blocks 2, 4 to 13 (Haddon East sub-area) is likely to occur over a 14 month period following mining of the State Forest sub-area. Ore will be processed as described in Section 2.4.5.

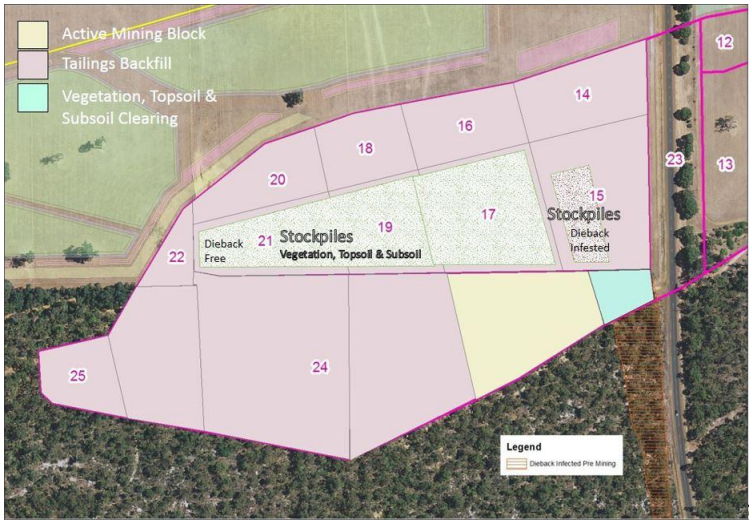
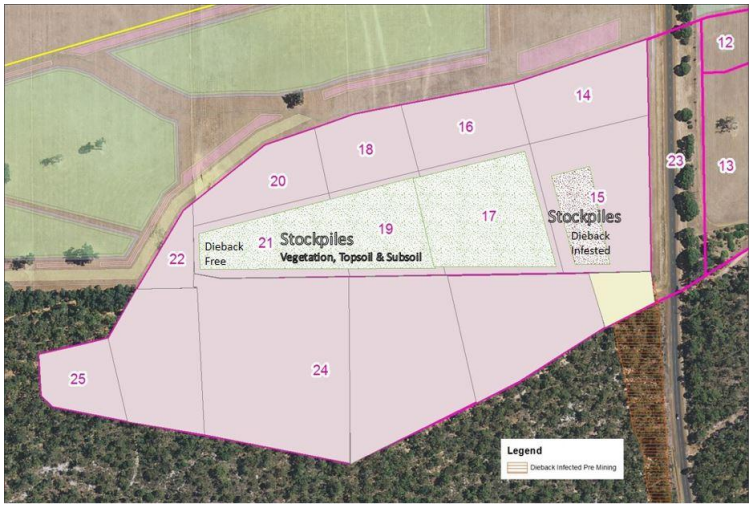
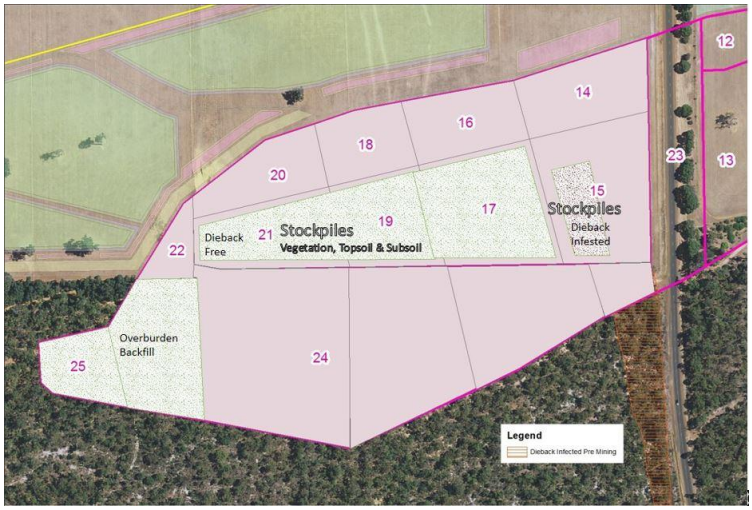
Mining of State Forest Sub-Area

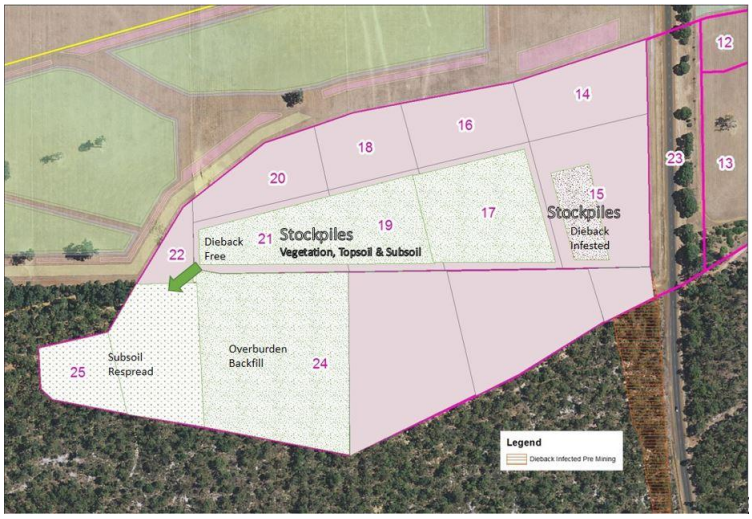
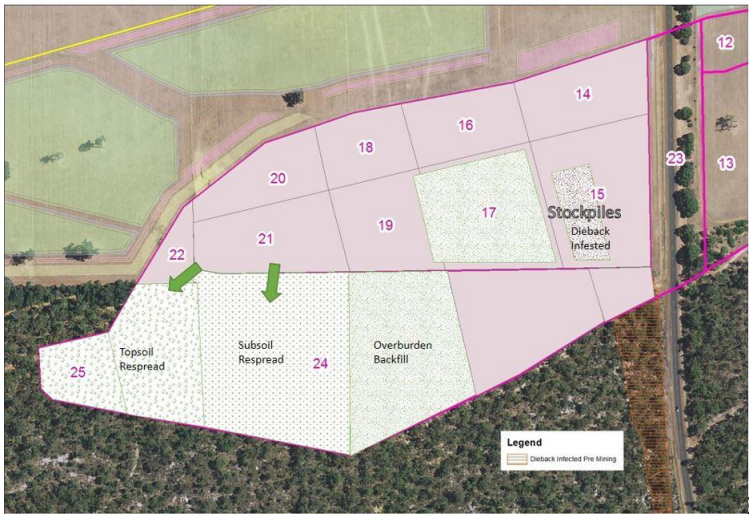
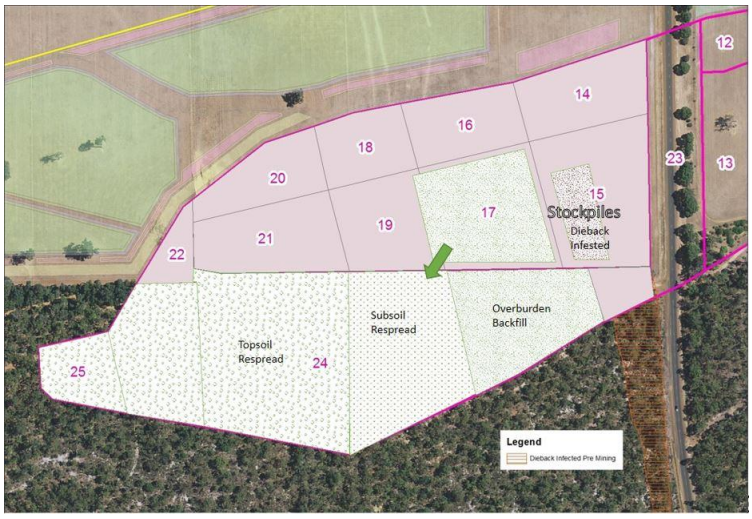
As mining nears completion in the Haddon West sub-area (block 22), stripping of dieback free vegetation from the State Forest sub-area will commence within block 25 and block 24 from west to east. Salvaged vegetation, topsoil and subsoil from the dieback free areas will be segregated separately and stockpiled onto backfilled areas in block 19 and 21 while observing hygiene protocols. Mining will then continue using the same techniques as the Haddon West and Haddon East sub-areas, with progressive backfilling occurring as mining progresses towards the east. Clearing will then commence in the dieback infested area (eastern end of block 24), with salvaged vegetation, topsoil and sub-soil segregated and stockpiled separately onto backfilled areas (block 15). Hygiene measures will be established to prevent cross-contamination of dieback free areas and stockpiles (refer to the Dieback Management Plan).

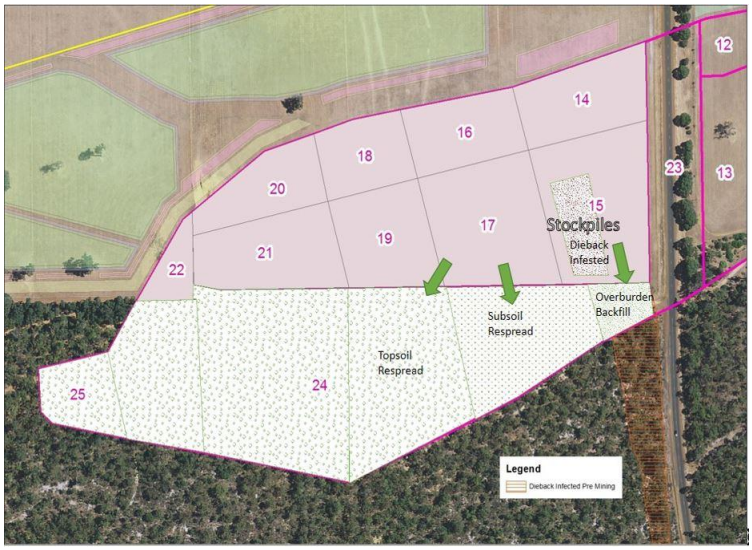
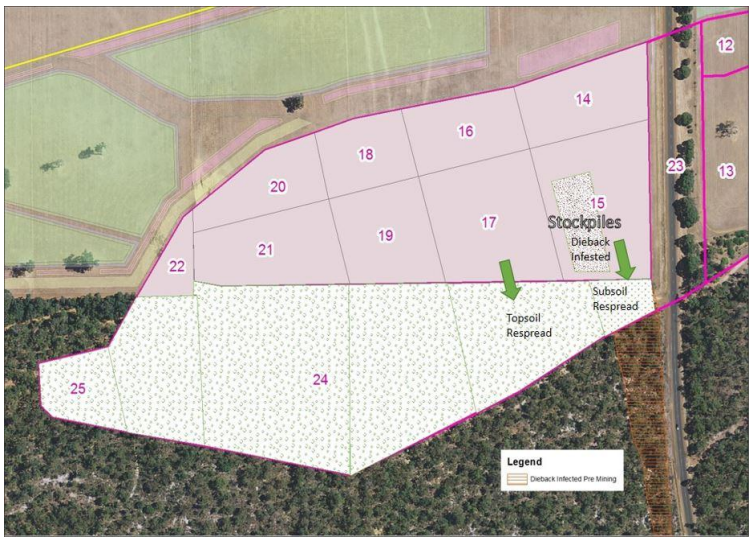
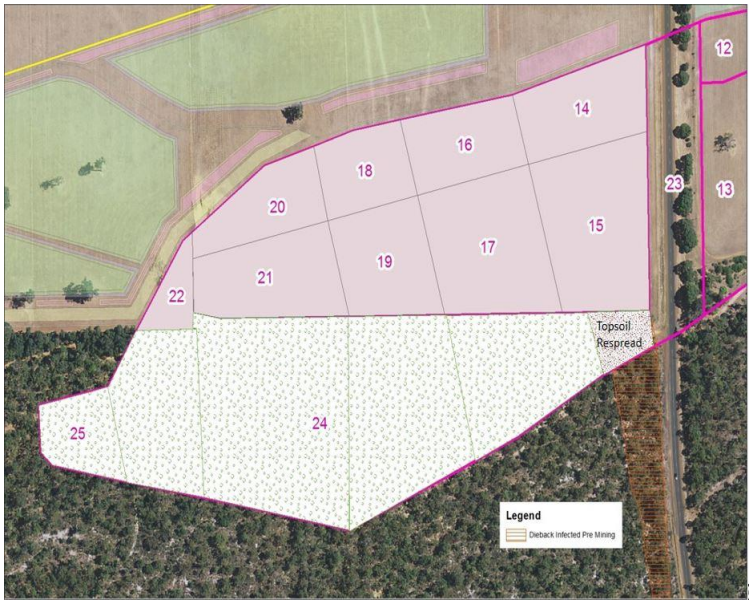
PLATE 2-2 PROPOSED MINING METHOD FOR MINE BLOCKS WEST OF SUES ROAD, INC.STATE FOREST

1. Completion of mining within Haddon West sub-area (block 22) with tailings backfill occurring progressively behind mining in a westerly direction.	
2. Clearing commences within the State Forest sub-area (blocks 24 and 25) in an easterly direction.	
3. Cleared vegetation, topsoil and subsoil from the dieback free areas will be segregated and stockpiled separately on backfilled areas (blocks 19 and 21).	

4. Clearing of block 24 commences and progresses to the east, with cleared vegetation, topsoil and subsoil continuing to be segregated and stockpiled on backfilled areas (blocks 19 and 21).	
5. Clearing of block 24 continues to the east, with block 25 and the western end of block 24 being progressively backfilled with tailings from the west.	
6. Clearing of block 24 continues to the east, with block 24 continuing to be backfilled with tailings from the west.	

7. Clearing commences in dieback infested area (eastern end of block 24). Vegetation, topsoil and subsoil is segregated and stockpiled seperately on backfilled areas (block 15). Dieback hygiene management is established to prevent cross-contamination with uninfested stockpiles on blocks 19 and 21.	
8. Mining commences in the dieback infested area (eastern end of Block 24) and tailings backfill continues in block 24.	
9. Overburden backfill placement commences in blocks 25 and western end of block 24. Overburden material sourced from western side of Sues Road.	

10. Overburden placement continues, progressing towards the east. Subsoil placement commences on block 25 and western end of block 24, sourced from stockpiles located on block 19 and 21.	
11. Overburden backfill placement continues towards the east of block 24. Subsoil respread continues and topsoil placement commences in block 25 and western end of block 24 from stockpiles located on block 19 and 21.	
12. Overburden backfill placement continues towards the east of block 24. Subsoil and topsoil respread continues in an easterly direction along block 24 from stockpiles located in block 17.	

13. Overburden placement in dieback infested area on the eastern end of block 24 commences. Subsoil and topsoil respread continues in dieback free areas of block 24 from stockpiles located in block 17.	
14. Subsoil from dieback infested stockpiles located in block 15 is respread over dieback infested area of block 24. Subsoil respread of dieback free areas of block 24 is completed.	
15. Topsoil respread for block 24 is complete in dieback and dieback free areas.	

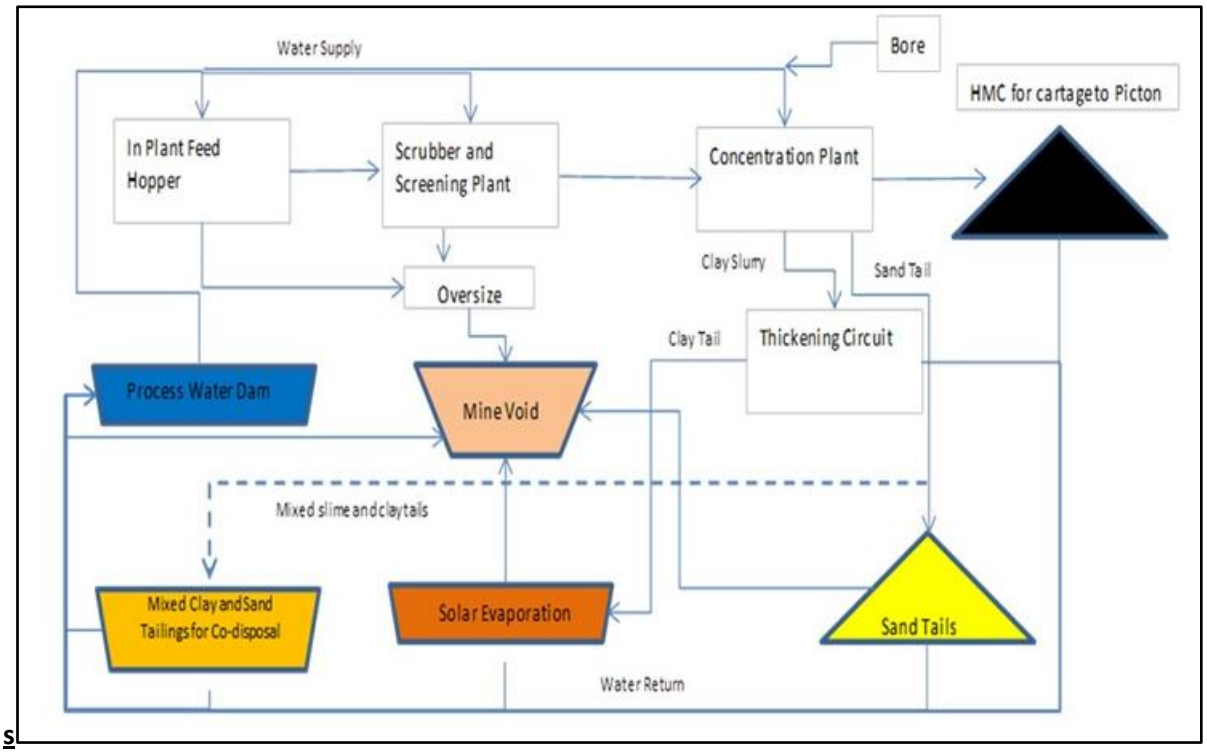
2.4.5 Ore Processing

Ore will be mined from the face using a Front End Loader in a series of lifts, and fed into the in-pit hopper, and screened and slurried using a mobile in-pit screening unit. The screened slurry will then be pumped to the feed preparation plant where it will move through a trommel and scrubber for removal of material greater than 3 mm. Oversize materials (i.e. > 3 mm) will be returned to the pit void or used to sheet internal minesite roads.

From the feed preparation plant, the ore will be transported via pumps and pipelines to the wet concentration plant where the process requires all particles >2.4 mm to be removed from the ore. It is anticipated the wet concentrator plant will operate at a nominal throughput rate of 200 TPH to produce 256,000 t of HMC over the life of mining the Yoongarillup Mineral Sands Deposit. The HMC is stockpiled on site, and remains saturated, prior to transportation to the Picton Dry Separation Plant

Two waste streams will be produced from the wet concentration plant; sand tails and clay slurry (Plate 2-3). The clay slurry is directed to the thickening circuit, where flocculent agglomerates clay fines, producing clay tails.

PLATE 2-3 FLOWCHART OF MINING OPERATION



S

Clay tails are pumped into SEPs to allow settlement and drying. Dried clay tails is then removed from the SEPs (during dry months) and placed in mine voids. The co-disposal of clay tails with the sand tails into pit voids is also conducted.

Clay tails will be piped to SEPs to allow settlement and drying. Dried clay tails will then be removed from the ponds (during the dry months) and placed in-pit with sand tails. Where possible co-disposal of tailings will be undertaken during mining whereby the clay tails is disposed with the sand tails into the pit voids. This provides a more heterogeneous distribution of soil particle sizing and improves the hydraulic conductivity and permeability of the returned soil profile. The majority of the water will be decanted from the SEPs and pumped back to the PWP for use as process water.

2.4.6 Ancillary Infrastructure

Infrastructure

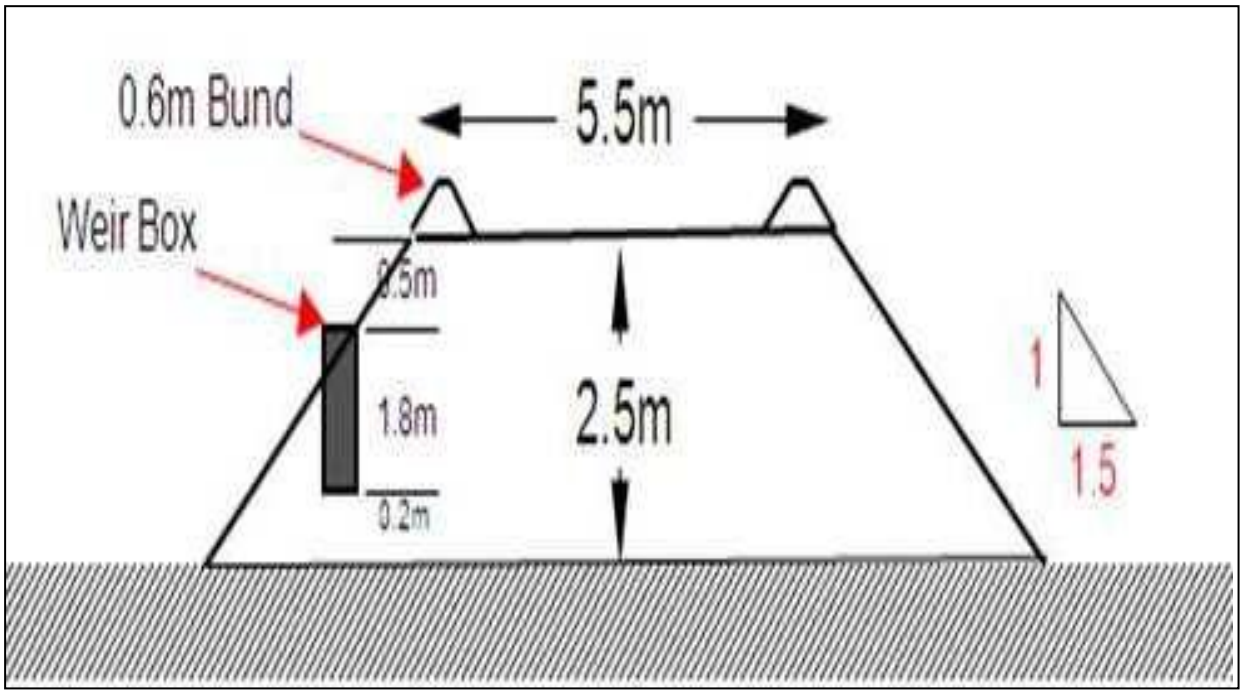
Infrastructure to support mining will include:

- Mobile in-pit screening plant, comprising feed hopper and screens and conveyors;
- Feed preparation plant, comprising a scrubbing unit to remove rock and clay from the ore;
- Wet concentration plant, comprising gravity separation spirals for heavy mineral separation, a thickening unit and other ancillary equipment;
- Mine offices, workshops and associated hardstand area;
- Internal haul roads and access roads.

Solar Evaporation Ponds (SEPs)

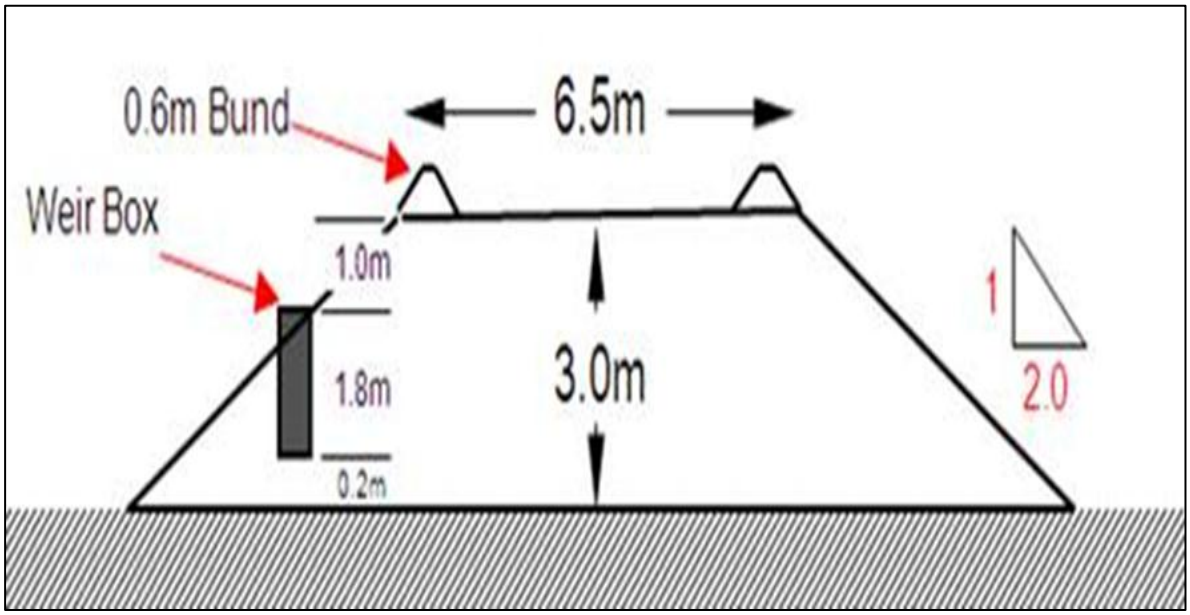
Doral propose to construct nine SEPs (28.23 ha) as shown on Figure 2-3, to receive clay tailings during mining. SEPs will be constructed in accordance with best practice as outlined within Code of Practice: Tailings Storage Facilities in Western Australia (DMP, 2013) and shown in Plate 2-4 and Plate 2-5.

PLATE 2-4 SOLAR EVAPORATION POND DESIGN CLAY AND OVERBURDEN STRUCTURES



(Note: NOT TO SCALE)

PLATE 2-5 SOLAR EVAPORATION POND DESIGN TAILINGS SAND STRUCTURES



(Note: NOT TO SCALE)

The following standard design and operating practices for the management of SEPs will be implemented over the life of the mine in order to maintain the structural integrity of the embankment walls and to prevent over topping:

- All SEP floors are constructed to design slope using laser levels prior to pouring. The SEP floors are designed with a slope of 1:300 to 1:400 to assist with even and homogenous fills and the prevention of free water pools unable to flow to the weir box;
- SEP wall height must be at least 2.5 m above the floor for clay and overburden structures and at least 3.0 m above the floor for tailing sand structures;
- SEPs constructed with dry clay material or overburden is track rolled using a D7 bulldozer. The angle of repose for the outer pond wall is 1.0 vertical: 1.5 horizontal;
- Only light vehicles have access to standard pond walls following construction. If SEP walls are to be modified as haul roads the running width must be at least 6.5 m for one-way traffic and 14 m for two-way traffic.

Process Water Pond

A 1.08 ha pond will be constructed in mine voids created from the removal of overburden and ore from blocks 10 and 12 (Figure 2-3). The PWP will be unlined and will supply water to the plant for processing of ore. The capacity of the PWP will be 113ML.

Drop Out Pond

The drop out pond of 0.76 ha will be constructed adjacent to the PWP. The purpose of this pond is to receive all return water from the site and act as a settling pond to settle out suspended solids from water prior to it entering the PWP.

2.4.7 Water and Power Supply

Water Source

Water required for the wet concentrator plant process will be sourced entirely from the PWP. Water for the PWP will be sourced from two production bores screened within the Yarragadee aquifer and supplemented with rainfall runoff, mine dewater and return water from the SEPs. The process to apply for an abstraction licence from the Yarragadee aquifer has been initiated by Doral in consultation with the DoW (refer to Section 5). A simple site water balance for the mine is described below.

Site Water Balance

The simple site water balance was developed to establish a monthly water balance for the life of mine (PB, 2014a; Appendix C). The wet concentration plant processing operations have the highest demand for water; based on an average mining rate of 200 TPH, a net water demand of 180 TPH per 200 TPH of ore is required over the life of mine. This equates to a water demand of 4.32 megalitres (ML) per day, approximately 131 ML per month and approximately 1577 ML (1.6 GL/yr).

Water will be drawn directly from the PWP. The main inputs of water to the PWP will include:

- Recycled process water;
- Groundwater inflows pumped from the active mining cells (i.e. pit dewatering);
- Site runoff from impervious areas, including access road, building/structures and hardstands;
- Direct rain that falls over the surface of the PWP;
- Abstraction from production bores screened in the Yarragadee aquifer.

The outputs from the PWP are:

- Use of water in the wet concentration plant process;
- Evaporation;
- Emergency discharge.

The PWP will be constructed to hold a maximum of 113 ML. This will allow approximately 21 days of water demand to be held at any time during the life of mine, therefore water will be secure for this period at all times.

Based on the simple water balance (PB, 2014a; Appendix C) 2 ML (1.5%) per month of the site water demand will be met from groundwater inflows and site runoff in a wet year. It is likely that in a dry year there will be little or no water available from site, as any rainfall that occurs will be lost to evaporation (PB, 2014a).

Therefore production bores screened in the Yarragadee aquifer, will be relied upon to provide up to 100% of the site water demands over the life of mine. Doral propose to secure water for the proposed Yoongarillup Mine though the legislative instruments of the RIWI Act. An application for a licence to abstract 1.6 GL/yr from the Yarragadee aquifer has been submitted to the DoW.

Power Supply

Power requirements will be sourced from the Western Power grid via a 2MVA 22kV power line. Consultation with Western Power has indicated that Western Power will utilise existing infrastructure

and upgrade where required to provide a three phase power supply to the processing plant. The power demands of the Proposal are estimated at 1,819kW with the major consumption areas being:

- 534kW: Feed Preparation Plant;
- 794kW: Wet Concentration Plant;
- 61kW: Clay tailings disposal system;
- 430kW: Mine Services.

2.4.8 Workforce

Workforce requirements will fluctuate between summer months, when clay tails are removed from SEPs and winter where the workforce will generally be focused on mining activities.

The permanent workforce levels are expected to be:

- Summer 32 people;
- Winter 25 people.

This includes:

- Mine Coordinator;
- Mine Engineer;
- Surveyor;
- Environmental Officer;
- Operators;
- Maintenance Staff.

Sub–contractors will be utilised for specific task as required. Specific workforce induction and training commitments will be implemented for the Proposal as outlined in the Environmental Management System and Safety Manual. Mining of this mineral resource will provide direct and indirect employment opportunities for the local community.

2.4.9 Ground Disturbance and Rehabilitation

A summary of disturbance and rehabilitation is provided in Table 2-7 and the proposed rehabilitation schedule is illustrated in Figure 2-5.

2.5 FIGURES

The following figures are provided in Appendix A

Figure 2-1 Regional Location

Figure 2-2 Land Ownership

Figure 2-3 Mine Site Layout

Figure 2-4 Proposed Sues Road Deviation – Preliminary Concept Alignment

Figure 2-5 Yoongarillup Mine Rehabilitation Schedule

TABLE 2-7: AREA DISTURBED AND REHABILITATED

TENEMENT AND AREA DISTURBED / REHABILITATED	2015		2016		2017		2018		2019		2020		TOTAL	
	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)	Disturbed (ha)	Rehabilitated (ha)
M70/548														
Pits														
SEP														
Mine Infrastructure														
Temporary SEP/Backfill														
M70/458 TOTAL														
M70/549														
Pits														
SEP														
Mine Infrastructure														
Temporary SEP/Backfill														
M70/459 TOTAL														
TOTAL														

This page left blank intentionally.

3 CLOSURE OBLIGATIONS AND COMMITMENTS

Mine closure is subject to the requirements that arise from State and Commonwealth legislation, mining tenement conditions, commitments made in Mining Proposals, commitments made in environmental approval application documents, conditions on environmental approvals (such as Ministerial Statements, pollution licences and clearing permits) and any other commitments given to external stakeholders. The closure requirements known to date for the Yoongarillup Mine are identified in the following sections.

3.1 LEGISLATIVE REQUIREMENTS

Doral has identified a number of general legislative obligations relevant to closure of the proposed Yoongarillup Mine which are presented in Table 3-1.

TABLE 3-1: STATE LEGISLATION CLOSURE OBLIGATIONS

LEGISLATION	SECTION REFERENCE	REQUIREMENT RELEVANT TO CLOSURE
Aboriginal Heritage Act 1978	Part IV	Heritage sites are not to be altered, excavated, damaged, concealed or any portion of the site removed in anyway, unless relevant approvals are obtained via Section 16 or 18 under the *Aboriginal Heritage Act 1978*.
Agriculture and Related Resources Protection Act 1976	Part V, Division IV (47)	The occupier of any private land shall control declared plants and declared animals on and in relation to that land.
Contaminated Sites Act 2003 *Contaminated Sites Regulations 2006*	Part I, Section 11 Part II (6)	The proponent or individuals are to report known or suspected areas of contaminated sites.
Contaminated Sites Act 2003	Part III, (23)	Sites classified as Contaminated - Remediation Required as described under the *Contaminated Sites Act 2003* are to be remediated.
Environmental Protection (Controlled Waste) Regulations 2004		Disposal of asbestos is to be separated, wrapped and labelled and disposed in accordance with Part III,(6)(44)
Environmental Protection (Controlled Waste) Regulations 2004		The proponent is to treat all products listed in schedule 1 of the Environmental Protection (Controlled Waste) Regulations 2004 as a controlled waste.
Environmental Protection Act 1986	Part V, (49)	Proponent shall not cause pollution or an unreasonable emission of noise, odour or electromagnetic radiation.
Environmental Protection Act 1986	Part V, (51)	The proponent shall not clear native vegetation without the relevant approval (e.g. clearing permit) in place.
Health Act 1911	Part IV (2) (87)	The proponent shall ensure (stagnant) pools, ponds, open ditches, and drains do not become offensive to the public or allow these areas to become prejudicial to human health.

LEGISLATION	SECTION REFERENCE	REQUIREMENT RELEVANT TO CLOSURE
Health Act 1911. *Environmental Protection (Controlled Waste) Regulations 2004*	Part IV (3) (95) Part III	Removal of sewerage systems is to be conducted in accordance with Local Government Law and by a licensed contractor in accordance with the Environmental Protection (Controlled Waste) Regulations 2004.
Mines Safety and Inspection Regulations 1995	Part III, (2)(3.11)	Notification of suspension of mining operations must be in writing and include the requirements specified in Section 3.14 of the regulations.
Mines Safety and Inspection Regulations 1995	Part III, (2)(3.16)	At notification of abandonment the proponent is required to notify the department how the following has been achieved: • Secure the site against inadvertent public access. • Prevent and mitigate mine subsidence. • Plant and equipment removed or secured and left in a safe condition. • Hazardous substances removed or properly disposed.
Mines Safety and Inspection Regulations 1995	Part XVI, (2)(16.35)	The proponent shall submit a plan with the notification which shows: (a) the specific locations in which radioactive waste has been buried; and (b) the absorbed dose rates in air one metre above the final surface.
Mines Safety and Inspection Regulations 1995	Part XVI, (2)(16.35)	After the mine is abandoned, rehabilitation sites are to be inspected and monitored at such intervals and in such a way as is approved by the State Mining Engineer.
Mines Safety and Inspection Regulations 1995	Part XIII, (13.8)	The principal employer at, and the manager of, a mine must ensure that geotechnical aspects are adequately considered in relation to the design, operation and abandonment of quarry operations.
Mining Act 1978	Part IV (84AA)	A mine closure plan is required to be approved by the DMP and reviewed every 3 years, or as specified by the DMP.
Mining Act 1978	Part III (1)(20)(3a)	Make safe all holes, pits, trenches and other disturbances on the surface of the land which are likely to endanger the safety of any person or animal.
Mining Act 1978	Part III (1)(20)(3b)	Take all necessary steps to prevent fire and damage to trees or other property.
Mining Regulations 1981	Part V, (6)(97)	Avoid activity that obstructs any public thoroughfare or undermines any road, railway, dam or building in such manner as to endanger the public safety.

LEGISLATION	SECTION REFERENCE	REQUIREMENT RELEVANT TO CLOSURE
Mining Regulations 1981	Part V, (6)(98)	The proponent shall not allow detritus, dirt, sludge, refuse, garbage, mine water or pollutant from the tenement to become an inconvenience to the holder of any other mining tenement or to the public, or in any way injure or obstruct any road or thoroughfare or any land used for agricultural purposes.
Soil and Land Conservation Act 1945	Part V (32)	The proponent shall take adequate precautions to prevent or control soil erosion, salinity or flooding; or the destruction, cutting down or injuring of any tree, shrub, grass or any other plant on land where land degradation is occurring or likely to occur.
Wildlife Conservation Act 1950	(16 and 23F)	A person may not take for any purpose protected fauna or flora without a licence, or rare and endangered flora without the written consent of the Minister.

3.2 MINING TENEMENT CONDITIONS

The proposed Yoongarillup Mine will operate on Mining Tenements M70/458 and M70/459. The current conditions of each of these tenements have been reviewed and the conditions relevant to closure are included within Table 3-2. It should be noted that at this stage there are no specific mine closure conditions as a mining proposal has not yet been submitted to the DMP.

It also should be noted that there is an error contained in Tenement Condition 21 for both M70/458 and M70/459 in that the condition refers to State Forest 13 and not State Forest 33. Tenement Conditions have been accessed via the DMP's Mineral Titles Online database.

TABLE 3-2: MINING TENEMENTS MINE CLOSURE CONDITIONS

TENEMENT NO.	CONDITION NO.	CONDITIONS RELEVANT TO MINE CLOSURE
M70/458	Consent to Mine on State Forest No. 13 granted by the Minister for Mines subject to:	
	21 (v1)	The lessee at his expense rehabilitating all areas affected by mining or operations associated with mining conducted during the term of the lease, including the rehabilitation enrichment of dieback or other forest disease affected areas, resulting from the lessees mining or operations associated with mining. Rehabilitation being to the satisfaction of the Regional Mining Engineer and in agreement with the Regional Manager CALM.
M70/459	Consent to Mine on State Forest No. 13 granted by the Minister for Mines subject to:	
	21 (v1)	The lessee at his expense rehabilitating all areas affected by mining or operations associated with mining conducted during the term of the lease, including the rehabilitation enrichment of dieback or other forest disease affected areas, resulting from the lessees mining or operations associated with mining. Rehabilitation being to the satisfaction of the Regional Mining Engineer and in agreement with the Regional Manager CALM.

3.3 MINISTERIAL STATEMENT CONDITIONS

The proposed Yoongarillup Mine will be formally assessed by the EPA in accordance with the provisions of Part IV of the EP Act and if approved will be subject to a number of conditions and procedures. The specific conditions relevant to closure of the proposed Yoongarillup Mine will be contained within Table 3-3.

TABLE 3-3: MINISTERIAL STATEMENT CLOSURE CONDITIONS

NO.	CONDITIONS RELEVANT TO CLOSURE
	TBC

3.4 CONDITIONS OF LICENCES AND PERMITS

The proposed Yoongarillup Mine is likely to be subject to the following licences and permits that have conditions pertinent to closure:

- Licence to Take Water for the purposes of dewatering;
- Licence to Take Water to abstract water from the Yarragadee aquifer;
- Licence to Operate issued under Part V of the EP Act.

These conditions are listed in Table 3-4.

TABLE 3-4: YOONGARILLUP LICENCE AND PERMITS CLOSURE CONDITIONS

CONDITION	CONDITION RELEVANT TO CLOSURE.
TBC	e.g. The groundwater bore monitoring program *(and reporting)* shall be maintained for a period covering at least two winters' rainfall seasons after cessation of dewatering extraction

3.5 ENVIRONMENTAL COMMITMENTS

In the process of gaining environmental approval for the Yoongarillup Mineral Sands Project, Doral has made commitments to undertake specific actions related to closure within the following documents:

- Public Environmental Review Yoongarillup Mineral Sands Project;
- Mining Proposal Yoongarillup Mineral Sands Project (in preparation).

These commitments are listed in Table 3-5.

TABLE 3-5: PROJECT CLOSURE COMMITMENTS

NO.	COMMITMENTS RELEVANT TO CLOSURE
1	Doral will implement a Rehabilitation Management Plan for the Proposal which will include the following key aspects: • A surface profile reconstruction plan; • A topsoil management plan; • A seed bank management plan.
2	In addition Doral will implement a Mine Closure Plan (this MCP) which has been developed in accordance with EPA and DMP (2011) and EPA (2006b) guidance and a Dieback Management Plan.

3.6 OTHER STAKEHOLDERS COMMITMENTS

Doral has an open process for engaging with local and affected stakeholders (See Section 5 for more information). During this engagement process and through processes to secure land access for the Yoongarillup Mineral Sands Project a number of commitments have been made that are relevant to closure of the Yoongarillup Mine. These are listed in Table 3-6.

TABLE 3-6: OTHER STAKEHOLDER COMMITMENTS

STAKEHOLDER	PROPERTY REFERENCE	COMMITMENTS RELEVANT TO CLOSURE
TBC		

This page left blank intentionally.

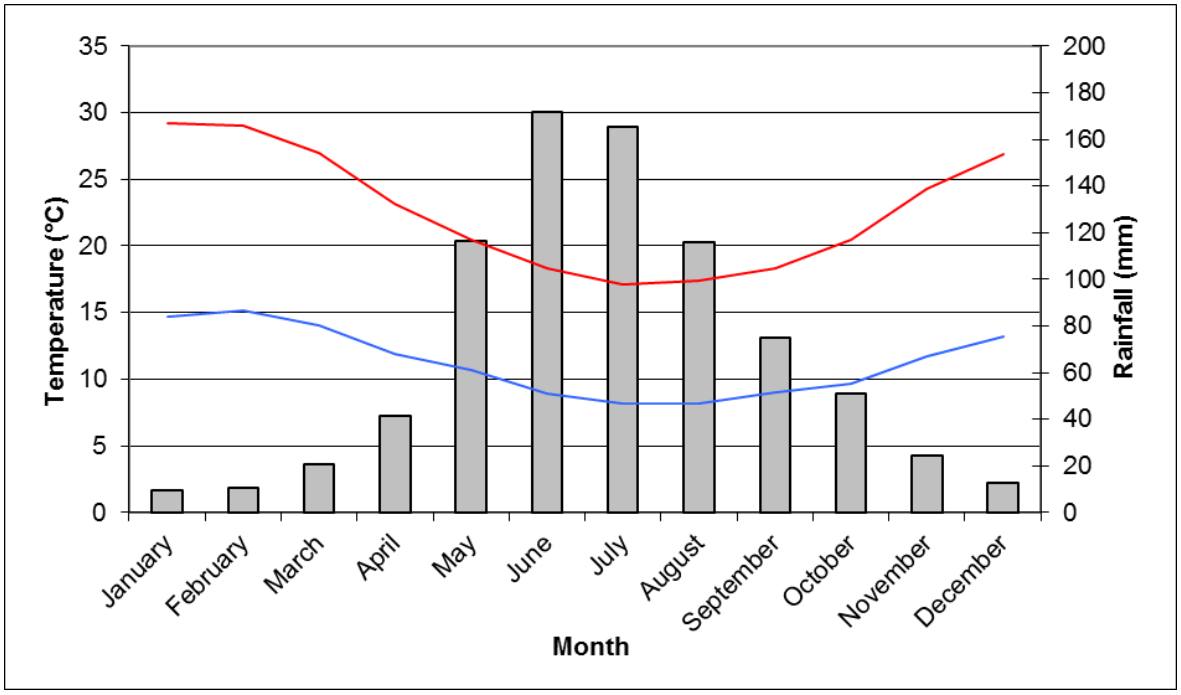
4 CLOSURE DATA

4.1 CLIMATE

The Geographe-Naturaliste coastline experiences a Mediterranean climate with warm to hot dry summers, and mild wet winters. High pressure cells dominate climatic patterns during summer, and the passage of cold fronts and associated low pressure cells dominate during winter. Strong sea breezes occur from late November to early March.

The annual rainfall averages between 800mm and 1000mm, peaking in June and July, as shown in Table 4-1. In summer the average maximum temperature is 28°C with an average minimum temperature of 12°C. In winter the average maximum temperature is 16°C with an average minimum temperature of 5°C (Bureau of Meteorology, 2013).

PLATE 4-1 ANNUAL AVERAGE CLIMATE DATA



Source: Bureau of Meteorology Busselton Station (Weather Station 009515)

4.2 BIOREGION

The Yoongarillup Mine is located on the lower/mid slopes of the Whicher Scarp which is an arcuate north facing scarp formed during the late Tertiary and early Pleistocene by marine erosion of underlying sedimentary rocks and in this area marks the southern limit of the Swan Coastal Plain.

The Whicher Scarp is referred to as being entirely within the Southern Jarrah Forest (JAF02) Biogeographic Sub-region of the Jarrah Forest Bioregion as defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Australian Government, 2013) and reported in EPA (2009a).

It should also be noted however that the Whicher Scarp has been mapped by the EPA (EPA, 2004a, Map 1) as occurring over the boundary of the Swan Coastal Plain (Perth Sub-region SWA02) and the Southern Jarrah Forest (JF02) Biogeographic Sub-regions. Given that the location of the Proposal is

situated on the foothills of the Whicher Scarp, it could be considered that the Proposal area is part of the Swan Coastal Plain (SWA02) Biogeographical Sub-region. This is consistent with the Department of Parks and Wildlife's (DPaW) assessment (Mitchell et al. 2002), EPA Guidance Statement 10 (EPA, 2003), accepted geological interpretations by Baxter (1977) (i.e. the targeted mineral sand deposits are units of the Swan Coastal Plain) and soil mapping by DAWA (2003).

4.3 GEOLOGY

The proposed Yoongarillup Mine is located in the southern part of the Perth Basin (Figure 4-1). The Perth Basin is a deep linear trough containing sedimentary rocks (Permian to Quaternary) extending north-south for some 1,000 km in the southwest of Western Australia and covers an area of 45,000 km2 onshore and 55,000 km2 offshore (GSWA 1976). The Perth Basin is essentially a half-graben structure bounded on the east by north-trending Darling Fault, 1000 km long, which separates the Basin from the Archean rocks of the Yilgarn Block (GSWA, 1976).

The regional geology associated with the mine site is dominated by a sedimentary sequence deposited within the graben in the southern Perth Basin (Schafer *et al.,* 2008). This part of the Basin comprises two main geological structures: the Bunbury trough and the Vasse Shelf. The major north-south trending Busselton Fault subdivides the graben structure into two major structural units: the deep Bunbury Trough to the east and a relatively shallow fault block, known as the Vasse Shelf, to the west (Schafer *et al.,* 2008). The mine site is situated on the eastern side of the graben structure, entirely within the Bunbury Trough (Figure 4-1).

The geological setting of the area comprises:

- The Yarragadee Formation.
- The Leederville Formation:
- Vasse Member;
- Mowen Member.

The Superficial Deposits:

- Yoganup Formation;
- Guildford Clay;
- Bassendean Sand.

The Yarragadee Formation comprises Jurassic aged laterally discontinuous interbedded feldspathic sandstone, siltstone and shale deposits that are up to two km in thickness (Varma, 2009).

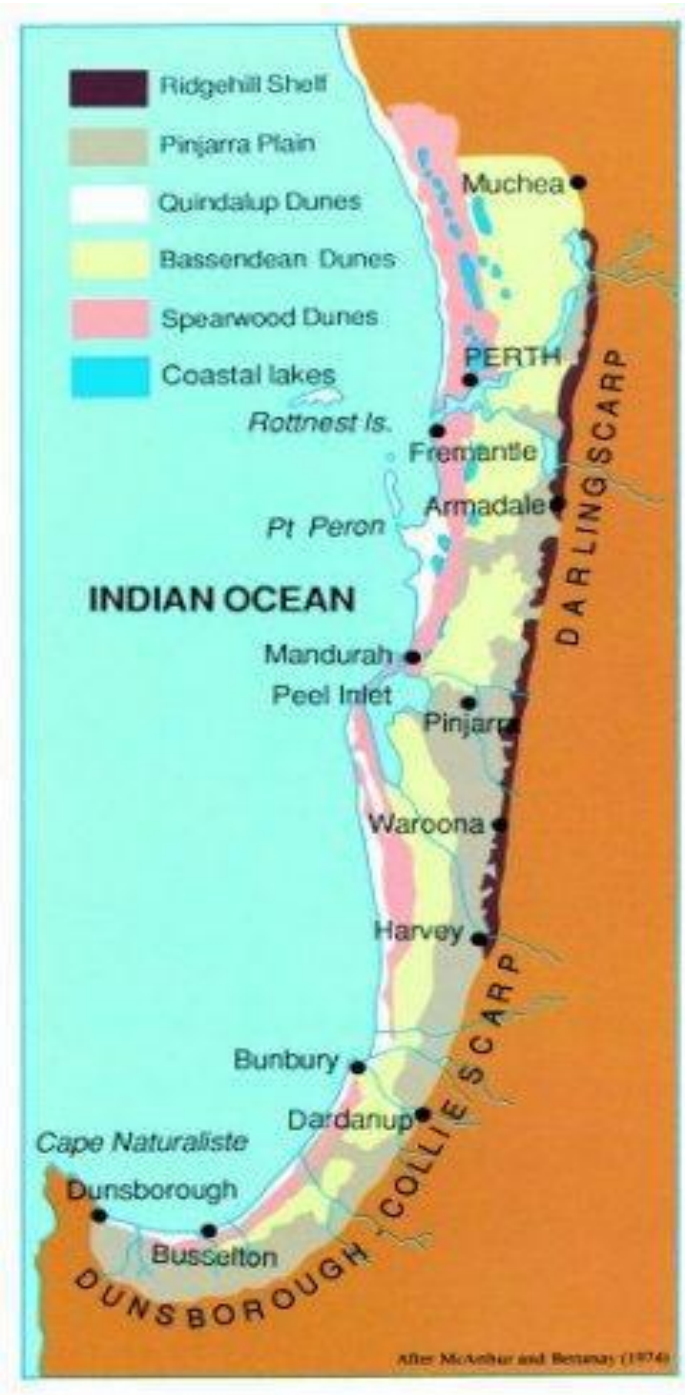
The Cretaceous aged Leederville Formation unconformably overlies the Yarragadee Formation and comprises discontinuous interbedded sandstone and shales. The sediments are essentially flat-lying with a gentle slope to the north and have a weathering profile, up to 150 m thick, where outcropping occurs mainly along the Whicher Scarp and the Blackwood Plateau (Schafer *et al.,* 2008). Based on the studies east of the mine site, the Leederville Formation has been divided into Vasse and Mowen Members (Schafer *et al.,* 2008). The Vasse Member is the aquifer and the Mowen Member is a confining layer (aquitard) (Schafer *et al.,* 2008).

The Pliocene-Quaternary aged superficial deposits overlie the Leederville Formation and collectively comprise the Yoganup Formation, Guildford Formation and the Bassendean Sand (Schafer *et al.,* 2008). The maximum thickness of Quaternary deposits in the Perth Basin amounts to about 150 m, but in most areas they are less than 20 m thick (Geological Survey Western Australia, 1976). The superficial deposits form a relatively thin cover sequence over most of the coastal plain. The oldest superficial deposit is the Yoganup Formation, which occurs along the base of the Whicher Scarp. It comprises leached and ferruginous beach sand with localised concentrations of heavy minerals (Schafer *et al.,* 2008) and consists of white coarse sand rich in heavy metals and sandy silt and clay respectively. The Guildford Clay covers much of the coastal plain and is a composite unit of interfingering alluvial clay and sand. The Bassendean Sand consists of quartz-rich dunal sand that generally overlies or abuts the Guildford Clay.

The Yoganup Formation dominates the area, whilst the Guildford Clay is observed mainly towards the northern boundaries. In these superficial deposits, a lateritic hardpan has developed due to water table fluctuation in many areas (Schafer *et al.,* 2008).

The mine site is geologically situated within the Swan Coastal Plain which is bound by the Indian Ocean on the west and the Whicher Scarp on the east (Plate 4-2). The Yilgarn Craton lies to the east of this sedimentary basin and the surface geology is dominated by materials that are of alluvial or fluvial origin. A series of parallel dune systems runs the length of the Swan Coastal Plain with the youngest (Quindalup) dunes fringing the ocean, with the Spearwood (~40,000BP), and the Bassendean (~800,000BP) dunes located inland of the Quindalup dunes. Further inland still is the Pinjarra Plain which is a low lying area of deposited alluvial sediment originating from eroded scarp material to the east. The Pinjarra Plain abuts the foothills of the Darling and Whicher scarps (McArthur and Bettenay 1974; Salma et al. 2001; Moore 2004).

PLATE 4-2 MAP OF THE REGIONAL GEOLOGY OF THE YOONGARILLUP MINERAL SAND MINE, SOUTHEAST OF BUSSELTON
(After Bolland 1998)



The proposed Yoongarillup Mine resides on the flank of the Whicher Scarp as demonstrated by the digital elevation model of the proposed Yoongarillup Mine site surrounds (Plate 4-3) (Landloch 2014: Appendix D).

The localised geology is aeolian grey sands over deep yellow sands on the low lying areas, with sections of colluvial sands and gravels over the laterite (Plate 4-4).

PLATE 4-3 DIGITAL ELEVATION MODEL OF THE YOONGARILLUP MINE SURROUNDS

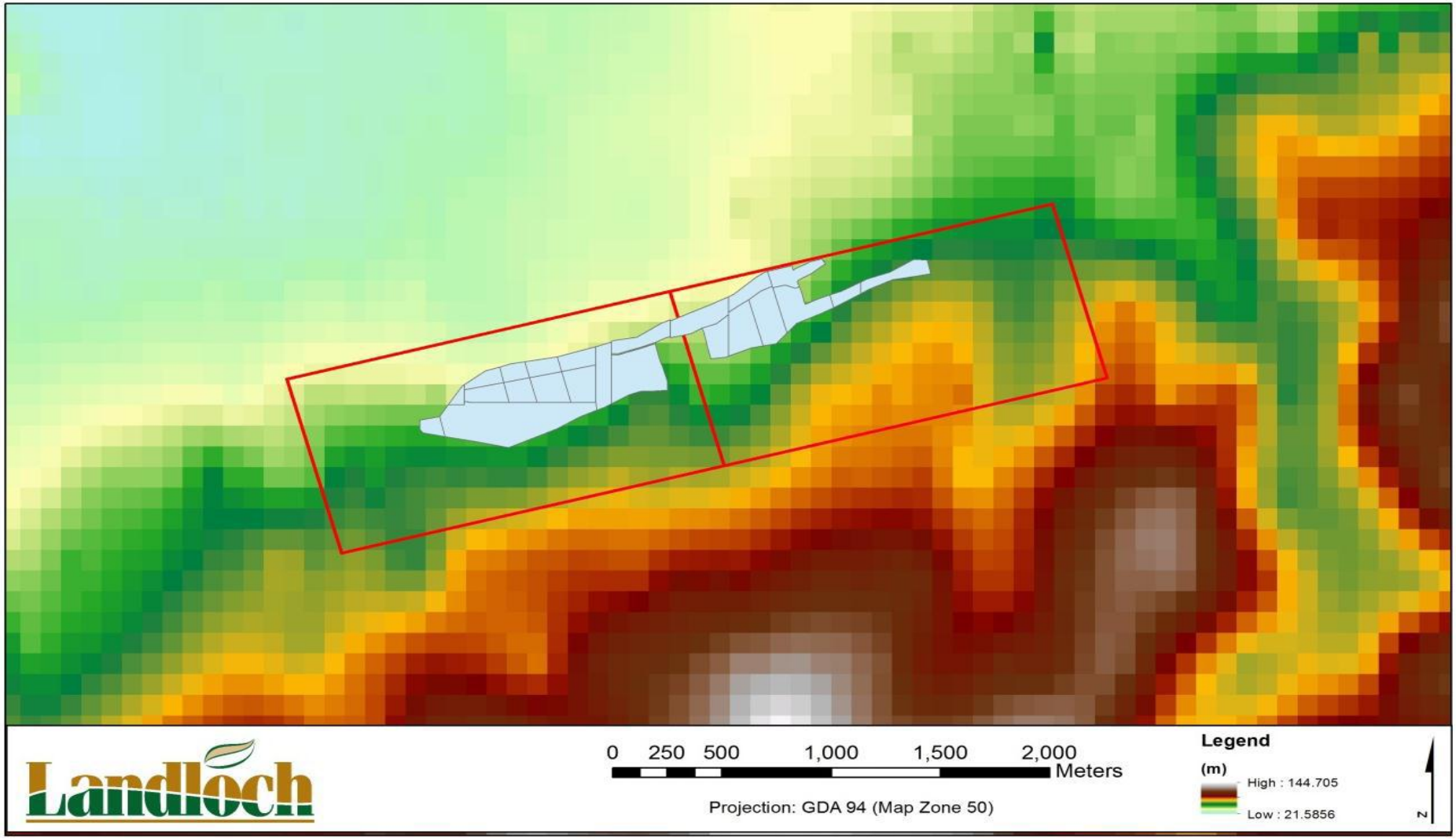
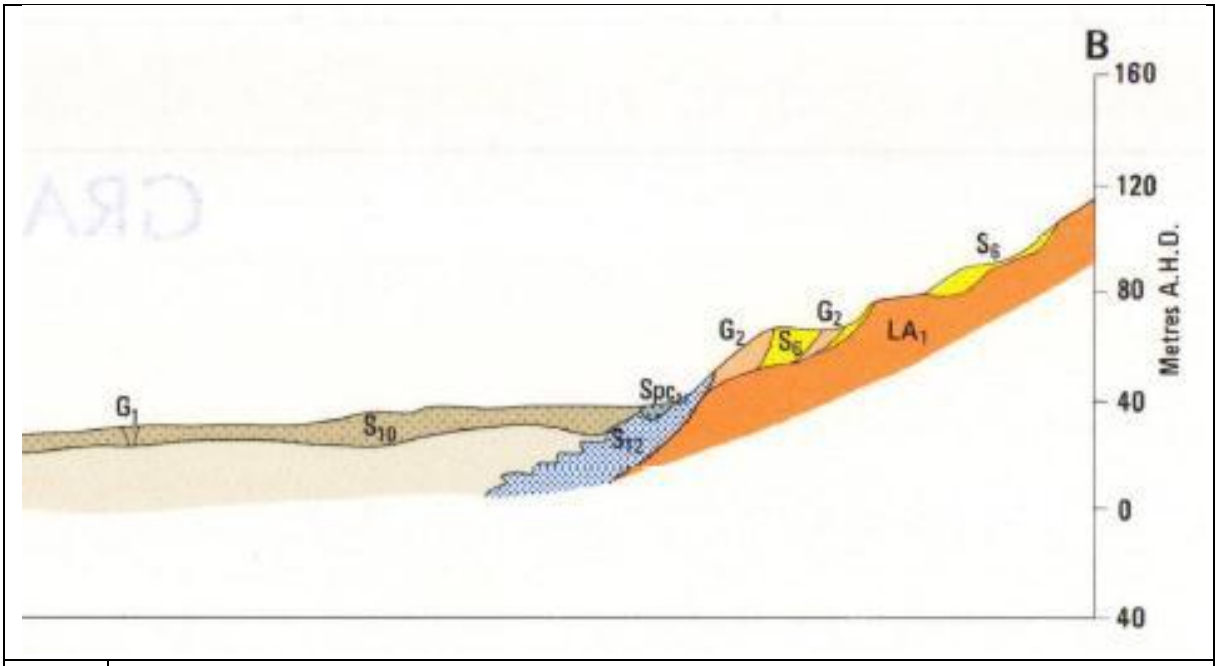


PLATE 4-4 CROSS SECTION OF THE DUNE-SCARP LOCAL GEOLOGY OF THE BUSSELTON AREA
(After Belford 1987)



S10	Sand over silt and sandy silt. Sand is very light grey at surface, yellow at depth, fine to medium grained sub-rounded quartz, local concentrations of heavy minerals, local development of coffee rock, moderately well sorted, of aolian origin
Spc	Clayey peaty sand, Grey to black with variable organic content
S12	Sand. Yellow, fine to medium grained, sub-angular to rounded quartz with some feldspar, local concentrations of heavy minerals, well sorted, overlying boulder and cobble conglomerates, of alluvial and marine origin
G2	Gravel, Brown and reddish brown, ferrunginous, pisolitic, occasionally cemented in a clay silt matrix, moderately sorted, of colluvial origin
S6	Sand. Light grey, fine to course, angular to sub-rounded quartz with some feldspar, moderately sorted, loose, of elluvial origin modified by colluvial processes
LA1	Laterite. Massive and cemented, occasionally vesicular, up to 4 m thick. Sometimes overlain by a ferrunginous gravel set in a clay-sand matrix

4.4 CONCEPTUAL HYDROLOGY

Groundwater investigations conducted by Parsons Brinckerhoff Pty Ltd (PB) (2014b) indicate three aquifers are recognised locally, which are hosted within the local stratigraphy; the Superficial aquifer, the Leederville aquifer and the deeper Yarragadee aquifer. A generalised lithostratigraphical and hydrostratigraphical description of the proposed Yoongarillup Mine is provided in Table 4-1 and shown on Figure 4-2.

TABLE 4-1: GENERALISED STRATIGRAPHY AND ASSOCIATED AQUIFERS OF THE PROPOSED YOONGARILLUP MINE

AGE	STRATIGRAPHY	MAXIMUM THICKNESS (M)	LITHOLOGY	AQUIFER SYSTEM
Quaternary – late Tertiary	Superficial Formation:			
	Bassendean Sand	80*	Fine to medium sub-rounded quartz sand.	Superficial aquifer
	Guildford Formation	35*	Brown to dark grey clays with isolated lenses of silt and sand towards the base.	Local aquitard
	Yoganup Formation	10*	White to yellowish brown unconsolidated, poorly sorted sand, gravel and pebbles with local subordinate clay, ferruginised grains and heavy minerals.	Superficial aquifer
Cretaceous	Leederville Formation	600*	Interbedded units of sand and shales. Generally divided in to upper, predominantly shaly section (Mowen Member) and lower sandy section (Vasse Member).	Leederville aquifer
Mid to Late Jurassic	Yarragadee Formation	2000*	Weakly consolidated sandstone, siltstone and shales.	Yarragadee aquifer
Early Jurassic	Cockleshell Gully Formation		Angular to sub angular, weakly cemented quartz Sandstone containing accessory pyrite and garnet, and weakly consolidated siltstone and shale.	

Source: PB (2014b) *Davidson (1995)

The following description of the hydrogeology has been taken from PB (2014b; Appendix C).

The Superficial Aquifer is an unconfined aquifer comprising Bassendean Sand towards the top and Yoganup Sand towards the base. The Guildford Clay is locally present between the two aquifers. The hydraulic conductivity of the Superficial Aquifer is likely to be variable.

The Leederville Aquifer is a multi-layered aquifer system comprising discontinuous interbedded sequences of sandstone and clay. The horizontal hydraulic conductivity of sandstone beds in the Leederville aquifer, derived from pumping tests (Davidson, 1995), is about 10 metres per day (m/d), and that of the siltstone and shale beds is assumed to be about 1 x 10-6 m/d. If the interbedded sandstones, siltstones and shales are laterally extensive, the average horizontal hydraulic conductivity of the aquifer will approach 5 m/d (as the sandstones constitute approximately half the aquifer thickness). Sandy beds that comprise the Vasse Member constitute the main aquifer. The sandy beds underlie the Mowen Member which comprises an aquitard. The Mowen Member is assumed to be present in the entire modelled area. The Leederville Aquifer becomes more consolidated with depth resulting in permeability decrease with depth.

The Leederville Aquifer extensively outcrops throughout the Blackwood Plateau (Schafer *et al.,* 2008). The Yarragadee Aquifer is composed primarily of non-marine fluvial feldspathic, poorly sorted sandstones which are porous and poorly cemented and, hence, allow for considerable groundwater reserves. It grades from a shale-siltstone dominated base to a cleaner sandstone in the upper portions

of the Formation, probably representing increased subsidence or filling of the basin during the late Jurassic (Varma, 2009). The Yarragadee Formation is divided into four units. Unit 3, which underlays the Vasse Member in the mining area is reported to be the most transmissive unit (Baddock *et al.,* 2005). However, isotopic dating of groundwater indicates an average hydraulic conductivity of 8 m/d.

4.5 WATER QUALITY

Doral recognise the importance of the collection of background or 'pre-mine' water quality data given the area has previously been modified by agricultural uses since the 1830s (DoW, 2010) and has the potential to be further impacted by mining. Background data collected will be used for comparison with data collected during mining and post-mining to monitor and identify any impacts.

Nine bores (six screened within the Mowen Member, two screened within the Superficial and Mowen Member, and one screened in the Mowen and Vasse Members) have been monitored for water quality parameters since 2012. Six groundwater monitoring events have been conducted on certain bores, with at least two events conducted on all bores. Bores will continue to be monitored regularly until the mine is approved and commences pre-mine construction and operation, to expand the background dataset. Further groundwater monitoring bores will be installed into the Superficial aquifer for collection of data during mining.

Based on the collected data, the pre-mine water quality across the area is characterised as:

- Slightly acidic, pH ranges between 4.17 and 6.85;
- Salinity ranges between 110 and 320 mg/L, which is at the lower end of the scale for the Leederville aquifer within the Busselton-Capel groundwater area (DoW, 2009a) and is more similar to the salinity found in the Donnybrook groundwater area, which is generally <500 mg/L (DoW, 2009a);
- Generally suitable for irrigation, as the majority of metal concentrations are lower than long term irrigation trigger values (LTV) (ANZECC & ARMCANZ 2000). The exceptions are:
    - All bores have higher concentrations of iron than the LTV;
    - Bore YMB2 has higher nickel concentrations than the LTV;
    - Bores YMB1, YMB3, YMB4 and YMB5 have higher nitrogen concentrations than the LTV;
    - Bores YMB1, YMB6D and YMB7 have higher phosphorus concentrations than the LTV.

Generally the background data describes the values associated with a 'slightly to moderately disturbed' ecosystem (ANZECC & ARMCANZ, 2000). These values include freshwater systems with slightly to moderately cleared catchments and rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism.

4.6 WATER MANAGEMENT AREAS

4.6.1 Superficial and Leederville Aquifers

The proposed Yoongarillup Mine is within the Busselton-Capel Groundwater Area (BCGA). The majority of the mining operation will be conducted within the Busselton-Capel subarea of the BCGA. However a small portion of the mine pit located within the State Forest sub-area is within the Blackwood Plateau North sub-area of the BCGA (Figure 4-3).

The Busselton-Capel subarea covers 757.3 km2 and is predominantly used by the service sector, mining and industry, and for horticulture. Currently the Superficial and Leederville aquifers in the subarea are fully allocated. The Blackwood Plateau North subarea covers 1056.9 km2 and is used for stock, domestic and garden supply (DoW, 2009a).

4.6.2 Yarragadee Aquifer

The proposed Yoongarillup Mine is within the Busselton-Yarragadee Groundwater Area (Yarragadee aquifer). The Busselton-Yarragadee subarea covers 2021.4 km2 and is fully allocated (Figure 4-3). The predominant use of this aquifer is for public water supply, mining and industry (DoW, 2009a).

Surface Water

The proposed Yoongarillup Mine is within the Busselton Coast surface water management area, within the Vasse Diversion subarea. Part of the Vasse Diversion subarea is a proclaimed surface water area known as the 'Geographe Bay Rivers'. A portion of the proclaimed surface water area overlaps the proposed Yoongarillup Mine (Figure 4-3) (DoW, 2009b).

4.6.3 Hydrology

The proposed Yoongarillup Mine is within the catchment of the Vasse River (Figure 4-3). The majority of the catchment (80%) is cleared for agricultural use, and many drainage lines have previously been created across the landscape (PB, 2014c: Appendix C).

The Vasse River begins at the northern edge of the Blackwood Plateau in the Whicher Ranges, 149 m above sea level, and traverses north for approximately 24 km, across mixed farming and horticulture land uses on the Swan Coastal Plain before discharging into the Vasse-Wonnerup Estuary or the Vasse Diversion Drain, which subsequently discharges into Geographe Bay (Paper Daisy Environmental Services, 2000). The Vasse River is located approximately 6 km northwest of the western boundary of M70/459.

The Vasse River's only tributary is the Sabina River which similarly flows into the Vasse-Wonnerup Estuary (PB 2014c). The Sabina River, located 590 m to the east of the eastern boundary of M70/458, flows northerly for approximately 18 km into the Vasse-Wonnerup Estuary (Figure 4-3 and Figure 2-1). Both rivers are seasonal, flowing in winter and dry in summer (DoW, 2010). The Vasse Diversion Drain was constructed to divert water from the Vasse River. It accepts water from 65% of the Sabina River Catchment and 90% of the Vasse River catchment, diverting it away from the Vasse-Wonnerup Estuary (Paper Daisy Environmental Services, 2000). The Vasse Diversion Drain begins just north of the Busselton Golf Course, approximately 9 km north of the Proposal.

There are no local waterways within the proposed Yoongarillup Mine. Sheet flow or flow in small gullies is likely to occur seasonally based on aerial observations (PB, 2014c; Appendix C).

Based on local rain gauge stations (9771 and 9971) operated by the Bureau of Meteorology (BOM) average annual rainfall for the proposed mining operation is likely to be in the order of 700 mm per year (PB, 2014c; Appendix C).

4.7 SOIL AND LANDFORMS

4.7.1 Regional Soils and Landforms

Soils and landforms of the region have been described and mapped by Churchward and McArthur (1980), Tille and Lantzke (1990), most recently by the Department of Agriculture Western Australia

(DAWA, 2003). The mapping shows the proposed Yoongarillup Mine lies within two soil landscape systems:

- Whicher Scarp System (214Ws);
- Abba System (213Ab).

Within these two systems, four Soil Mapping Units occur within the proposed Yoongarillup Mine as shown in Table 4-2 and Figure 4-4.

TABLE 4-2: SOIL MAPPING UNITS OCCURRING WITHIN THE PROPOSED YOONGARILLUP MINE

SOIL MAPPING UNIT	DESCRIPTION	SUPPORTS REMNANT VEGETATION YES/NO
213AbAbw	Winter wet flats and slight depressions with sandy grey brown duplex (Abba) and gradational (Busselton) soils	No
213AbAB1	Flats and low rises with sandy grey brown duplex (Abba) and gradational (Busselton) soils	No
214WsYLv	Narrow v-shaped minor valleys cutting through the shelf. Soils are brown deep sands and brown loamy earths.	No
214WsYL1	Raised flats. Duplex sandy gravels, semi-wet soils, yellow deep sands and sandy earths and loamy gravels.	Yes

4.7.2 Soils of the Yoongarillup Mine

Landloch (2014; Appendix D) undertook a baseline soil assessment of mining tenements M70/458 and M70/459 (targeted to within the mine pits) to provide information on the properties of the undisturbed soil resource for the proposed Yoongarillup Mine.

Results of this assessment indicate that wind-blown and reworked sands make up most of the parent material for the soils within the proposed Yoongarillup Mine, associated with Bassendean Sands (S_{10}). The entire proposed Yoongarillup Mine pit area consists of this one soil type. There are smaller areas of shallow gravels on the laterite geology to the south of the proposed Yoongarillup Mined pits. In the eastern sections of the assessment area are zones of disturbed soil from previous sand mining and gravel quarrying by others.

Consequently, three soil types were identified and mapped by Landloch (2014; Appendix D) as listed and described below and shown on Figure 4-5.

- Deep Pale Sands;
- Shallow Gravels;
- Disturbed soils.

4.7.2.1 Deep Pale Sands

The Deep Pale Sands are the dominant soil type across the assessment area and occupy all of the proposed pit area. Typical soil profiles consist of a shallow grey organic A horizon over deep yellow sandy B horizons (Plate 4-5 and Plate 4-6).

PLATE 4-5 TYPICAL GREY SANDY TOPSOIL OVER DEEP YELLOW SAND

PLATE 4-6 DETAIL OF GREY A1 HORIZON

One soil pit assessed had a lighter coloured B horizon and this is most likely attributable to a variation in parent material with differing levels of iron oxide content (Plate 4-7).

PLATE 4-7 PIT DL4 SHOWING PALE SANDY B HORIZON

The horizonation of the Deep Pale Sands is ~10-15cm of A1 over >1.5m B2. The surface horizon is hydrophobic, as indicated by water beading on the surface in the field (Plate 4-8).

PLATE 4-8 EVIDENCE OF HYDROPHOBICITY IN SURFACE SOILS

Overall, the Deep Pale Sands are dark brown loamy sands over yellow to grey sands and sandy loams with an acid pH (Table 4-3). Soil pH does decrease with depth and the coastal areas are known zones of acid sulfate soils, but does not exceed pH <4 which would indicate potentially acid forming soil material. Previous mapping and reports have stated that the mine has a low risk for the presence of acid sulfate soils (Soilwater 2012: 0). The soil is poorly structured (massive). The soil has very low salinity levels throughout the profile (EC1:5<0.05dS/m). Surface coarse fragments were largely absent and some charcoal fragments were observed in the subsurface, most likely from the agricultural clearing practices.

TABLE 4-3: CHARACTERISTICS OF DEEP PALE SAND SOILS

PROPERTY	INSPECTION SITE DESCRIPTION

PROPERTY	INSPECTION SITE DESCRIPTION
Brief description	Deep yellow/grey sand to loamy sands
Extent	27.9ha
Soil samples	DL_1 to DL_5
Gradient	Gently undulating
Soil Landscape	Swan Coastal Plain – Whicher Scarp
Soil classification	Bleached Orthic Tenosol
Surface coarse fragments	<5%
Surface condition	Soft
*Permeability**	Moderate
*Water repellent**	Yes
*Drainage**	Sheet wash

4.7.2.2 Shallow Gravels

It is noted that there is a change in surface geology in the forested southern sections of the mining lease (Plate 4-9). Exposed outcrops appeared to be massive and cemented yellow to red laterite rocks. The associated soil was shallow gravel that was very pale in colour. Coarse surface fragments were present, and approximately 20% of the loamy sand soil profile contained gravel (Plate 4-10). The field pH was 6 and hand augering the material to depths of greater than 30cm was difficult. This soil type was not examined by soil pits as it was not within the cleared farm area and thus access with machinery was difficult. Boundaries of this soil were inferred from a low intensity reconnaissance of the area, and the typical soil condition and boundary should not be regarded with a high level of confidence.

PLATE 4-9 LATERITE OUTCROP

PLATE 4-10 SHALLOW GRAVEL MATERIAL WITH SURFACE COURSE FRAGMENTS AND EXPOSED UNDERLYING ROCK IN FORESTED AREAS

4.7.2.3 Disturbed Soils

Sections of the proposed pit on M70/458 have been previously used as a sand quarry (construction base materials), as well as a gravel quarry as undertaken by the landowner (N. Haddon pers. comm) (Plate 4-11). The sand quarried areas have been rehabilitated and the surface condition is variable. On the elevated areas the vegetation cover consists of crops or weeds and there is evidence that builders' rubble has contaminated the reapplied topsoil (Plate 4-12). The light grey sandy surface soil is in a loose condition and there are many areas of bare soil. On the low lying areas the surface vegetation is pasture species, or waterlogging-tolerant species. The surface soil of some of the low lying areas is darker in colour due to a higher organic content and there are areas of standing water.

It was not possible to map the variety and spatial diversity of soils within this area, and these soils have been grouped together under the Disturbed soil type.

PLATE 4-11 ABANDONED GRAVEL PIT AND LAKE

PLATE 4-12 DETAIL OF REHABILITATED SURFACE SOIL WITH BUILDING RUBBLE, WEEDS AND BARE SURFACES

4.7.3 Soil Analysis Results

Laboratory results are shown in Table 4-4, and are interpreted against industry standards using references such as Interpreting Soil Test Results (Hazelton and Murphy, 2011) for soil chemistry. For reference, an agricultural guide has been included in Appendix 3 of the Landloch Soil Assessment report included as 0.

It should also be noted that since the proposed disturbance footprint for the proposed Yoongarillup Mine is relatively small, only a few soil pits were analysed. It is therefore prudent to consider the results as an indication of the nature of the undisturbed soils, adequate at the proposal stage. Further testing will be required to gain a more detailed understanding of the soils for long term storage and use to rehabilitate mine infrastructure at closure.

TABLE 4-4: SOIL ANALYSIS RESULTS FOR THE YOONGARILLUP MINERAL SANDS PROJECT

ANALYSES		UNIT	SAMPLE ID					
			DL1_1	*DL1_2*	*DL1_3*	*DL4_1*	*DL4_2*	*DL4_3*
		Depth	*10cm*	*30cm*	*100cm*	*10cm*	*30cm*	*100cm*
pH		*pH units*	6.24	5.63	5.79	5.46	5.24	4.73
Electrical Conductivity		*dS/m*	0.05	0.02	0.02	0.04	0.02	0.03
Total Nitrogen		*mg/kg*	1894	1433	<10.0	3105	605	145
Total Phosphorus		*mg/kg*	425	330	39.6	287	52.3	28.8
Organic Carbon		*%*	2.77	2.4	0.1	4.33	1.32	0.33
Plant Available Nutrients	*Phosphorus - Colwell*	mg/kg	81.5	60.6	18.8	67.7	24.6	18.1
	Potassium - Colwell	mg/kg	94.2	76.9	73.5	89.9	77.8	65.9
	Sulphur - KCl	mg/kg	32.3	24	32	3.5	2.9	16.9
	Copper – DTPA	mg/kg	0.68	0.44	<0.25	0.4	<0.25	<0.25
	Iron – DTPA	mg/kg	48.1	56.3	32.7	52.9	44.7	16.4
	Manganese – DTPA	mg/kg	1.8	0.5	<0.25	0.6	<0.25	<0.25
	Zinc – DTPA	mg/kg	2.5	0.5	<0.25	1.2	0.3	0.3
Exchangeable Cations	*Calcium*	meq/100g	4.525	2.82	0.4925	3.66	0.71	0.4215
	Magnesium	meq/100g	0.44	0.21	0.11	0.30	0.11	0.09
	Potassium	meq/100g	0.13	0.05	0.03	0.06	0.02	0.01
	Sodium	meq/100g	0.08	0.11	0.02	0.06	0.03	0.03
	Aluminium	meq/100g	0.02	0.06	0.08	0.15	0.27	0.25
	Effective Cation Exchange Capacity	meq/100g	5.19	3.25	0.73	4.24	1.12	0.80
	Exchangeable Sodium Percentage	%	1.45	3.35	3.29	1.50	2.28	3.20
Particle Size Distribution of Fine Fraction	*Coarse Sand 0.2-2.0mm*	%	53.8	57.8	49.8	27.0	21.1	30.7
	Fine Sand 0.02-0.2mm	%	40.9	35.8	47.5	62.8	67.7	57.8
	Silt 0.002-0.02mm	%	0.0	1.9	0.0	2.8	1.9	0.0
	Clay <0.002mm	%	5.3	4.5	2.6	7.4	9.3	11.4
Dispersion Index		*Class*	5	5	5	5	5	5

4.7.4 Available Soil Resources

There will be a number of soil resources that are available for use within rehabilitation and closure of the Yoongarillup Mine. A description of the characteristics and quantities of soil resources available is provided below.

Soil management strategies are based on the assumptions that:

- Pit areas in the State Forest sub area south of Goulden Road will be returned to native vegetation;
- Pit areas in the existing farmland will be returned to an agricultural land use;
- The topsoil/subsoil stripped from the forest, the agriculture area, and the disturbed area will be stripped and stored separately.

The intention in the forested area will be to harvest topsoil to ensure the greatest amount of seed store and fertility, and subsoil for plant growth medium. The aim in the agricultural area will be to harvest topsoil for the greatest fertility level and subsoil for plant growth medium.

Topsoil

Doral strips and stores topsoil at locations close to where it will be required for future rehabilitation. Topsoil is stripped from all locations and is distinguished from subsoil by colour and depth. Where different qualities of topsoil are identified topsoil is stockpiled separately. Qualities that will be used to segregate topsoil into separate stockpiles are:

- Vegetation type: native or pasture;
- Dieback presence;
- Noxious weed infestation.

Topsoil in the State forest sub-area should be stripped to a depth of 150 mm (taken in two 75 mm layers) so as to selectively harvest the zone containing the highest amounts of seed, biological activity, and fertility. The two layers shall be stockpiled separately to ensure the seed bank is not diluted.

Topsoil in the agricultural area, should be stripped to a depth of 150 mm as this is the average depth of the A horizon and also corresponds to the soils with the highest levels of plant nutrients and organic material.

The estimation of recoverable soil materials is made with the following assumptions:

- Topsoil and subsoil will be stripped within the disturbance footprint only;
- A planar surface was used to calculate the soil type areal extents.

Therefore the soil extents from the disturbance pit are:

- Deep Pale Sand soil (agriculture) – 19.2 ha;
- Deep Pale Sand soil (forest) – 8.9 ha;
- Disturbed soil – 10.4 ha.

The recoverable topsoil volumes are:

- 28,800 m^3 of Deep Pale Sand soil (agriculture);
- 13,350 m^3 of Deep Pale Sand soil (forest);
- 15,600 m^3 of Disturbed soil.

Subsoil

Subsoils in the State forest sub-area should be stripped to an average depth of 300 mm and average depth of 1000 mm in the agricultural areas to provide a growth medium for both native and agricultural species as well as a barrier for the overburden and tailings likely deposited under the respread soils.

No subsoil volume is given for the Disturbed soil type (as described in Section 4.7.2.3). There may be a potentially useful subsoil resource in this area, but this will require further investigation to assess the nature of the material that has been placed in this area by previous extractive industries.

The recoverable subsoil volumes are:

- 279,321 m^3 of Deep Pale Sand subsoil.

Overburden

Overburden is the material that lies above the heavy mineral ore. Overburden materials are typically well structure clays (or sandy clays) with or without gravel. These soils are strongly to moderately acidic with very low salinity. Structural stability of these materials are variable with macro and micro stability ranging from very good through to very poor, which is consistent with the moderate to high sodicity rating of these materials. These materials have slow to very slow permeability.

The current (2014) mine schedule indicates approximately 478,000 BCM of overburden will be generated by mining.

Dried Clay Fines

Clay fines generated from the wet concentration plant process are dried in SEPs. Once dried sufficiently to be transported by machinery these materials are available for use to backfill mined pits.

Industry experience indicates that this material can be useful to apply at low rates to mix with sandy soils, particularly in the foothill landforms, where they can improve the soils plant available water content. Application rates must be carefully managed as these materials if placed at the soil surface and not mixed with sand to a loamy texture can become hard setting. Furthermore if placed on top of sandy materials and a sharp textural boundary exists, loamy and clayey surface soils can form a hydraulic break over the sandy soils and prevent water infiltration.

Tailings Sand

Tailings sand generated from the wet concentration plant process are typically disposed of directly to mine voids. These materials contain very low proportions of clay (typically less than 1 or 2%) and no gravel, as this was removed as oversize.

These materials are single grain sands, with very rapid permeability.

Co-disposed Tailings (Sand/Clay Mix)

Co-disposal occurs when clay fines are mixed with sand tailings. This mix is then pumped to fill pit voids. The benefits of co-disposal are:

- It results in a reduction of the area outside the pit boundaries required for SEPs;
- It returns deeper soil horizons with fines content similar to pre-mining levels.

Co-disposal is the preferred method of disposal, and occurs wherever it is practical to do so.

Oversize/Gravel

At the feed preparation plant, gravel and oversize is removed from the trommel. It is typically disposed to mine voids with overburden material.

4.7.5 Acid Sulfate Soils

An Acid Sulfate Soil assessment was conducted by Soilwater Consultants (2012; 0) in consultation Department of Environment and Conservation (DEC) (2012) guidance. Comparison of the field screening results to the DEC (2012) assessment criteria (i.e. more than 10% of sample locations with pH_F <4, or more than 10% of samples with pH_{FOX} >3) show that the results do not exceed the assessment criteria. It is therefore considered that a significant risk of sulfide oxidation hazard does not exist at the site. Consequently, it is not necessary to complete the additional risk assessment measures detailed in Steps 2-5 of DEC (2012). Although the ASS hazard has a low risk and does not exceed the DEC (2012) assessment criteria, a groundwater monitoring and contingency plan will be prepared and implemented as required by DEC (2012).

4.7.6 Post-mining Soil Profiles

Records will be retained of what type of material has been used to backfill the pits and of what type of materials have been used to establish the post-mining soil profile, as shown in Table 4-5. This table will be updated once the pit has been rehabilitated.

TABLE 4-5: MINE VOID BACKFILL MATERIAL AND SOIL PROFILE DESCRIPTION

BLOCK ID	REHAB YEAR	BLOCK DESCRIPTION	MINING DEPTH	BACKFILL	SOIL PROFILES
Block 2	2019	Haddon East Sub- Area		e.g. Clay Overburden sand tails	e.g. 150 mm topsoil, 1000mm subsoil, 4000mm overburden, 5000mm co-disposed tails etc.
Block 4	2019	Haddon East Sub- Area			
Block 5	2019	Haddon East Sub- Area			
Block 6	2019	Haddon East Sub- Area			
Block 7	2019	Haddon East Sub- Area			
Block 8	2019	Haddon East Sub- Area			
Block 9	2019	Haddon East Sub- Area			
Block 10	2018	Haddon East Sub- Area			
Block 11	2018	Haddon East Sub- Area			
Block 12	2018	Haddon East Sub- Area			
Block 13	2018	Haddon East Sub- Area			
Block 14	2020	Haddon West Sub- Area			
Block 15	2020	Haddon West Sub- Area			
Block 16	2020	Haddon West Sub- Area			
Block 17	2020	Haddon West Sub- Area			
Block 18	2020	Haddon West Sub- Area			
Block 19	2020	Haddon West Sub- Area			
Block 20	2020	Haddon West Sub- Area			
Block 21	2020	Haddon West Sub- Area			
Block 22	2020	Haddon West Sub- Area			
Block 23	2020	Sues Road			
Block 24	2018	Forest sub Area			
Block 25	2018	Forest sub Area			
SEP 01	2020	Haddon West Sub Area			
SEP 02	2020	Haddon East Sub- Area			
SEP 03	2020	Haddon East Sub- Area			
SEP 04	2020	Haddon East Sub- Area			
SEP 05	2020	Haddon East Sub- Area			
SEP 06	2020	Haddon East Sub- Area			
SEP 07	2020	Haddon East Sub- Area			
SEP 08	2020	Haddon East Sub- Area			
SEP 09	2020	Haddon East Sub- Area			
Infrastructure area	2020	Haddon West Sub Area			

4.8 WETLANDS AND GROUNDWATER DEPENDANT ECOSYSTEMS

4.8.1 Wetlands

The Vasse-Wonnerup System is listed as a Wetland of International Importance (under the Ramsar Convention) and is located approximately 14 km north of the Yoongarillup Mine. Hydrogeological investigations and hydrology assessments undertaken by PB (refer to Appendix C) investigated the potential hydrological and physico-chemical impacts of the Yoongarillup Mine on the Vasse-Wonnerup System Ramsar wetland.

Groundwater Drawdown

PB prepared a numerical groundwater flow model (PB, 2014b; Appendix C) to assess the dewatering requirements and groundwater drawdown associated with the development of the Yoongarillup Mine. Results of PB (2014b) showed that during the short-term dewatering of mine pits the maximum extent of drawdown to the north of the proposed Yoongarillup Mine is predicted to be 350 m. Given the Vasse-Wonnerup System Ramsar wetland is over 14 km away from the proposed Yoongarillup Mine the system will not be affected by dewatering of mine pits

Emergency Discharge

The proposed locations for emergency discharge of water are shown on Figure 2-3. Emergency discharge of water will not occur until strict water quality criteria are met. Once discharged, water will move through paddock drains north of the mine, where water is likely to sit until it evaporates. Paddock drains are separate to major diversion drains in the region therefore there is no pathway for the discharged water to move into the Vasse-Wonnerup System Ramsar wetland.

4.8.2 Groundwater Dependant Ecosystems

The risk of indirect impacts to native vegetation within the State Forest sub-area and the Whicher National Park has been assessed through detailed numerical groundwater flow modelling by PB (2014b). 'Worst-case scenario' groundwater flow modelling by PB (2014b; Appendix C) predicts that:

- A maximum drawdown of one metre will occur within the Superficial Aquifer (Figure 4-6);
- No drawdown of the Superficial Aquifer south of the mine (i.e. in the State Forest sub-area).

The drawdown depends on the intersection of saturated material. The modelled steady state water table suggests that the Superficial Aquifer south of the mine is mainly unsaturated; therefore, no drawdown will result;

- Drawdown of the Mowen Member will be less than one metre within the State Forest sub-area (Figure 4-7);
- Drawdown will not extend beyond the boundary of the mine pits (Figure 4-6);
- No drawdown of the Vasse Member (Figure 4-8).

No adverse impacts to groundwater dependent vegetation within the State Forest sub-area or Whicher National Park are expected from groundwater drawdown during short-term dewatering of mine pits as: The Whicher National Park is located a minimum of 300 m from any drawdown impacts;

- Vegetation within the State Forest sub-area is likely to access water via the Leederville aquifer and not the Superficial aquifer (Figure 4-2). The Leederville aquifer is predominantly hosted by the sandy beds of the Vasse Member which will not be affected by drawdown;
- Fluctuations of less than one metre in the water table as a result of mine dewatering are similar to the seasonal fluctuation the forest experiences naturally. Monitoring of groundwater levels within and adjacent to the State Forest sub-area show seasonal fluctuations between 0.6 m and 5.5 m (Appendix C).

4.9 FLORA AND VEGETATION

4.9.1 Flora and Vegetation Surveys Undertaken

Flora and vegetation surveys specifically undertaken for the proposed Yoongarillup Mine are provided as Appendix E and include the following:

- Level 2 Flora and Vegetation Survey at Yoongarillup (Ecoedge Environmental, 2014);
- Flora and Vegetation Survey of Yoongarillup Resource Zone Survey Area (Mattiske, 2012a);
- Threatened and Priority Species Survey of Drill Lines within the Millbrook State Forest (Mattiske, 2012b).

During the feasibility stage of the proposed Yoongarillup Mine Doral conducted an exploration drilling program in the State Forest sub-area. As required by tenement conditions, a CMP was prepared to address the conservation impacts of the proposed drilling activities within the State Forest sub-area. To assist in the preparation of the CMP, findings of the flora and vegetation survey conducted by Mattiske (2012a) and a subsequent threatened and priority species survey of the proposed drill lines (Mattiske, 2012b) were utilised. During the review of the CMP by the Environmental Management Branch and South West Region of the Department of Environment and Conservation (now DPaW), it was identified that several items relating to the Mattiske (2012a) survey required further response. These responses were incorporated into the final CMP (Aurora Environmental, 2012) and approved by DPaW on 19 September 2012.

DPaW's review of the draft CMP and the Mattiske (2012a) survey, also identified differences in the survey effort in comparison with Keighery *et al.,* (2008) and it was recommended by DPaW that:

- 'Should exploration or any future proposal require soil disturbance, further quadrat based floristic surveys will be carried out to DPaW standards to address current deficiencies'.

Doral engaged Ecoedge Environmental to conduct an additional flora and vegetation survey in accordance with EPA Guidance Statement No. 51 (EPA, 2004b), for the State Forest sub-area. Findings of this survey (Ecoedge Environmental, 2014) have been used as the primary document to conduct the environmental impact assessment of flora and vegetation within the State Forest sub-area, however data collected during the previous surveys by Mattiske (2012a and 2012b) has also been considered.

Findings of Mattiske (2012a) have been used to assess impacts to flora and vegetation within the Haddon West and Haddon East sub-areas. No vegetation surveys were undertaken for the Piggott sub-area, as this area does not contain any native vegetation, with the exception of scattered trees/shrubs. Table 4-6 summarises the relevant flora and vegetation survey used for the environmental impact assessment for each corresponding sub-area of the proposed Yoongarillup Mine.

TABLE 4-6: FLORA AND VEGETATION SURVEYS CONDUCTED IN EACH SUB-AREA

SUB-AREA	FLORA AND VEGETATION SURVEY
State Forest	Ecoedge Environmental (2014) Mattiske (2012a) Mattiske (2012b)
Haddon West	Mattiske (2012a)
Haddon East	Mattiske (2012a)
Piggott	Not assessed

4.9.2 Whicher Scarp Soil-Landscape System

The proposed Yoongarillup Mine is located within the Whicher Scarp soil-landscape system (unit 214Ws) which includes the DPaW managed lands of the Whicher Forest Block and Whicher Reference Area (Keighery *et al.,* 2008) and is immediately adjacent to the Whicher National Park. The soil-landscape system covers an area of 20,709 ha (Maps 1 and 2 after DAFWA, 2007) and is 0.7% of the Southern Jarrah Forest Biogeographic region of which around 46% (approximately 9,200 ha) remains naturally vegetated leading to unusual relictual habitats of plant communities and flora (EPA, 2009) (refer to Table 4-7, Figure 4-4). Consequently this remnant vegetation meets the six criteria for regionally significant natural areas (EPA, 2006b). Of this remaining area, 64% (approximately 5,800 ha) is found on public lands. The majority of the public lands are DPaW managed lands located in nine forest areas. Only 3.4% of the Whicher Scarp Soil-Landscape System is protected in formal reserves. The proposed Yoongarillup Mine contains a total of 56.38 ha of native vegetation that occurs within the Whicher Scarp soil-landscape system (Figure 4-4).

TABLE 4-7: WHICHER SCARP SOIL-LANDSCAPE SYSTEM

SOIL-LANDSCAPE SYSTEM	PRE-EUROPEAN EXTENT(HA)	AREA REMAINING (HA)	PERCENTAGE REMAINING (%)	DEVELOPMENT AREA WITHIN SOIL-LANDSCAPE SYSTEM (HA)	PERCENTAGE OF PROPOSED YOONGARILLUP MINE WITHIN SOIL-LANDSCAPE SYSTEM (%)
Whicher Scarp	20,709	9,200	46	56.38	0.61

4.9.3 Vegetation Complexes within the Proposed Yoongarillup Mine

Utilising the Regional Forest Agreement (RFA) vegetation complex mapping (Mattiske and Havel, 1998), the Swan Coastal Plain (SCP) mapping (Heddle *et al.,* 1980) and the South West Biodiversity Project (SWBP) Mapping and Information Instalment 2 (Molloy *et al.,* 2007), the native vegetation within the proposed Yoongarillup Mine (56.38 ha) is mapped as Yelverton vegetation complex. Vegetation complexes occurring within the proposed Yoongarillup Mine are described in Table 4-8 and shown on Figure 4-9.

TABLE 4-8: VEGETATION COMPLEXES WITHIN THE PROPOSED YOONGARILLUP MINE

VEGETATION COMPLEX	VEGETATION COMPLEX CODE	DESCRIPTION	PRE-EUROPEAN VEGETATION EXTENT (HA)	CURRENT AREA REMAINING (HA)	PERCENTAGE OF PRE EUROPEAN COMPLEX REMAINING (%)	AREA OF PROPOSED YOONGARILLUP MINE WITHIN VEGETATION COMPLEX (HA)
Abba	AB	Woodland and open forest of *Corymbia calophylla* on flats and low rises in the humid zone.	12,450	578	5%	0
Abba	Aw	Mosaic of tall Shrubland of *Melaleuca viminea* and woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* with occasional *Corymbia calophylla* on broad depressions in the humid zone.	15,863	508	3%	0
Yelverton	Y	Woodland of *Eucalyptus marginata* subsp. *marginata-Corymbia calophylla-Allocasuarina fraseriana-Agonis flexuosa* and open woodland of *Corymbia calophylla* on low undulating uplands in the humid zone	9,046	3477	38%	55.87
Yelverton	Yw	Woodland of *Allocasuarina fraseriana-Nuytsia floribunda-Agonis flexuosa-Banksia attenuata* on slopes and open forest of *Corymbia calophylla-Eucalyptus patens-Eucalyptus marginata* subsp. *marginata* on the lower slopes and woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* on valley floors in the humid zone.	4,216	1,116	26%	0.51

4.9.4 Vegetation Communities within the Proposed Yoongarillup Mine

Vegetation communities within the proposed Yoongarillup Mine have been mapped by Ecoedge Environmental (2014) and Mattiske (2012a) as shown on Figure 4-10. Table 4-6 (refer to Section 4.9.1) shows the corresponding flora and vegetation survey used to map vegetation communities for each sub-area within the proposed Yoongarillup Mine.

The proposed Yoongarillup Mine (total project area of 151.97 ha) comprises predominantly cleared pasture/area (95.59 ha), with native vegetation (56.38 ha) being confined to the following areas:

- State Forest sub-area: The portion of Mining Tenement M70/459 that is located within State Forest No. 33 (excludes the 0.22 ha of previously cleared area);
- Haddon East sub area: The southwest corner of Lot 1873 and the southeast corner of Lot 1874.

The following sections describe the vegetation communities that occur within each of the sub-areas of the proposed Yoongarillup Mine.

State Forest Sub-Area

The following sections have been sourced from Ecoedge Environmental (2014), unless otherwise stated.

Ecoedge Environmental (2014) mapped the vegetation within the State Forest sub-area by placing twenty-one 10m x 10m quadrats in areas not previously sampled by Mattiske (2012a). A quadrat installed during the previous survey by Mattiske (2012a) (F 5-2) and a quadrat installed during the Whicher Scarp Survey (Keighery *et al.,* 2008) (WHICH03) were also re-surveyed. Quadrats were sighted in relatively undisturbed vegetation and were surveyed twice on 19-25 September 2012 and 11-12 October 2012. In addition to the 21 quadrats, recording of species composition and soil type was collected at 50 assessment points to assist with delineating boundaries for soil and vegetation type mapping. Locations of quadrats are shown on Figure 4-11.

Plant communities were defined and mapped by Ecoedge Environmental (2014) primarily on a floristic basis, derived from the clustering of quadrats into groups by multivariate analysis. Multivariate analysis of the floristic quadrat data (in the form of 21 quadrats by 194 plant taxon matrix) was undertaken using PATN (Belbin, 2003) to compare quadrats within the State Forest sub-area. All taxa occurring within the 21 quadrats were used for the analysis

Ecoedge Environmental (2014) identified and mapped four vegetation communities (A, B, C and D) based on the quadrat groups derived from the multivariate analysis. In addition observations of surface soils (0-5 cm) taken during the survey were used to assist with the interpretation of vegetation community boundaries. The vegetation communities are summarised below and shown on Figure 4-10. The most frequent species within each vegetation community are shown in Table 4-9.

- **A**: *Eucalyptus marginata, Corymbia calophylla* open forest/woodland over *Banksia grandis* low open woodland over *Acacia pulchella, Adenanthos barbiger, Dasypogon hookeri, Hakea amplexicaulis, H. ruscifolia, Hibbertia hypericoides, Hypocalymma robustum, Labichea punctata, Melaleuca thymoides, Podocarpus drouynianus, Synaphea whicherensis, Xanthorrhoea gracilis,* shrubland/low shrubland over *Anarthria prolifera, Loxocarya cinerea, Mesomelaena tetragona, Tetraria octandra* open sedgeland and *Conostylis setigera subsp. setigera, Dampiera linearis, Hypochaeris glabra, Lomandra hermaphrodita, Patersonia umbrosa* var. *umbrosa* and *Trachymene pilosa* open herbs on grey-brown, yellow or yellow-brown ('orange') loamy sand.

Ecoedge Environment (2014) comments: There is an area of grey-brown sandy loam in the western portion of vegetation community A, otherwise soils are mainly yellow-brown ('orange') loamy sand that is up to 2 m deep near the northern boundary. A small area of red-brown loam occurs along a shallow drainage line on the northern boundary within which quadrat YOONG25 is located. The southern limit of vegetation community A is demarcated in places by a low slope of exposed laterite and gravel. A variant of this vegetation unit is found on the grey-brown sandy loam near the western boundary of the State Forest sub-area where species such as *Boronia crenulata*, *Tetraria* sp. Jarrah Forest (R. Davis 7391) and *Banksia dallanneyi* are a more frequent than they are on the yellow-brown loamy sands. Conversely species such as *Banksia attenuata*, *Mesomelaena tetragona* and *Synaphea whicherensis* are found on the yellow-brown loamy sands but are uncommon or absent from the grey-brown sandy loams

- **B**: *Eucalyptus marginata, (Corymbia calophylla, C. haematoxylon)* woodland over *(Banksia grandis), (Xylomelum occidentale)* open low woodland over *Acacia pulchella, Banksia dallanneyi subsp. dallanneyi, Conostephium pendulum, Dasypogon bromeliifolius, Hibbertia hypericoides, Hypocalymma robustum, Leucopogon pulchellus, Stirlingia latifolia, Xanthorrhoea gracilis* shrubland/low shrubland over *Desmocladus fascicularis, Mesomelaena tetragona* very open sedges and *Arctotheca calendula, Burchardia congesta, Caladenia flava, Elythranthera brunonis, Hypochaeris glabra, Quinetia urvillei, Rhodanthe citrina, Stylidium calcaratum* and *Trachymene pilosa* open herbs on grey-brown loamy sand to light grey sand.

  Ecoedge Environmental (2014) comments: This is the most widespread vegetation community in the State Forest sub-area and is in places separated from vegetation community A by a fringe of gravel and exposed laterite sloping to the north. Grey-brown sandy loam predominates in the western third and light grey sands in the eastern two thirds of this vegetation community. The small tree *Corymbia haematoxylon* is largely confined to the western portion of this vegetation community.

- **C**: *Eucalyptus marginata, Corymbia calophylla* open forest over *Banksia dallanneyi* var. *dallanneyi, Hakea amplexicaulis, Hibbertia cunninghamii, H. commutata, H. hypericoides, Hovea chorizemifolia, Hypocalymma robustum, Labichea punctata, Leucopogon conostephioides, Xanthorrhoea preissii, X. gracilis* shrubland/low shrubland over *Desmocladus fasciculatus, Tetraria octandra, T.* sp. Jarrah Forest very open sedges and *Conostylis setigera subsp. setigera, Lagenophora huegelii, Lomandra sericea, L. hermaphrodita, Opercularia apiciflora, Patersonia umbrosa* var. *xanthina* and *Thelymitra crinita* open herbs on gravelly sand or grey brown loamy sand.

  Ecoedge Environmental (2014) comments: This vegetation community is found in the south western portion of the State Forest sub-area and is situated on gravel and exposed laterite or grey-brown loamy sand over laterite

- **D**: *Eucalyptus marginata, Corymbia haematoxylon, Allocasuarina fraseriana* open forest over *Banksia grandis, (Persoonia elliptica)* open low woodland over *Dasypogon hookeri, D. bromeliifolius, Hibbertia hypericoides, H. glomerata, Labichea punctata, Stirlingia latifolia, Xanthorrhoea preissii, X. gracilis* shrubland/low shrubland over *Patersonia umbrosa* var. *xanthina* very open herbs on grey-brown or yellow-brown loamy sand and sandy clay loam.

  Ecoedge Environmental (2014) comments: This vegetation unit differs from the others in the State Forest sub-area in having a substantial representation of *Allocasuarina fraseriana* in the

overstorey. There is also a small area of clay loam soils with dampland species such as *Kunzea recurva* and *Mirbelia dilatata* within this vegetation community. As only one quadrat from the current study was situated within this vegetation community, the vegetation description was derived with the assistance of information from Mattiske (2012a).

TABLE 4-9: MOST FREQUENT SPECIES OCCURRING WITHIN EACH VEGETATION COMMUNITY

SPECIES	**Group A**	**Group B**	**Group C**	**Group D**
Number of Quadrats	**9**	**6**	**4**	**1**
	PERCENTAGE OCCURENCE WITHIN QUADRATS (%)			
Acacia extensa		**57**		
Acacia nervosa			50	
Acacia pulchella	67	71		
Adenanthos barbiger	89	57		*100*
Adenanthos meisneri		57		
Allocasuarina fraseriana				*100*
Amphipogon turbinatus				*100*
Anarthria prolifera	78	57	50	*100*
Arctotheca calendula		71		
Astroloma ciliatum			50	
Babingtonia camphorosmae		57	50	
Banksia dallanneyi var. *dallanneyi*	56	71	100	*100*
Banksia grandis	67	57		
Billardiera variifolia			50	
Boronia crenulata subsp. *pubescens*	56		50	
Burchardia congesta	67	86	50	
Caladenia flava		71	75	
Calothamnus sanguineus		57	50	
Chamaescilla corymbosa			50	
Conostephium pendulum		86		

Conostylis setigera subsp. *setigera*	67		100	*100*
Corymbia calophylla	78	57	100	
Corymbia haematoxylon		57		*100*
Dampiera linearis	67	57	50	
Dasypogon bromeliifolius	56	86	50	*100*
Dasypogon hookeri	78			*100*
Daviesia physodes		57		
Desmocladus fasciculatus		86	100	*100*
Drosera pallida		57	50	
Drosera pulchella			50	
Drosera stolonifera	56		50	
Elythranthera brunonis		71	50	
Eucalyptus marginata subsp. *marginata*	100	86	100	*100*
Gompholobium knightianum	100	57	50	
Gompholobium preissii	78		50	
Hakea amplexicaulis	67		50	
Hakea lissocarpha			50	
Hakea ruscifolia	78			
Hibbertia cunninghamii			100	*100*
Hibbertia commutata			75	
Hibbertia glomerata subsp. *glomerata*	56		75	
Hibbertia hypericoides	100	86	100	
Hovea chorizemifolia			75	
Hypocalymma angustifolium			50	
Hypocalymma robustum	89	86	100	*100*
Hypochaeris glabra	89	86	50	
Hypolaena exsulca		57	50	*100*
Kennedia coccinea			50	

** Taxa occuring in more than 75% of quadrats ('typical taxa') are highlighted green. All species are listed for vegetation community D as only one quadrat was placed and therefore are not shaded green*

The area of each vegetation community occurring within the State Forest sub-area as mapped by Ecoedge Environmental (2014) is shown in Table 4-10. Ecoedge Environmental (2014) included the (0.22ha) cleared area (sand pit and Goulden Road track) within vegetation community A. This area has been subtracted from the total area of vegetation community A.

TABLE 4-10: VEGETATION COMMUNITIES WITHIN THE STATE FOREST SUB-AREA

VEGETATION COMMUNITY	TOTAL AREA (HA)
A	16.74
B	19.17
C	7.36
D	1.46
TOTAL	**44.73**

Haddon West Sub-Area

Mattiske (2012a) mapped the Haddon West sub-area as Cleared (CL) as shown on Figure 4-10. Within the CL area approximately 22 scattered trees/shrubs also occur.

Haddon East Sub-Area

Mattiske (2012a) mapped the Haddon East sub-area based on the Structural Forms of Australian Vegetation (Beard, 1990), cluster analysis of recording sites, permanent plots and interpretation of aerials. Approximately 46.63 ha of the Haddon East sub-area was mapped as CL. The CL area contains approximately 26 scattered trees/shrubs. Vegetation communities occurring in the Haddon East sub-area are summarised below and shown on Figure 4-10:

- W1: Open Woodland of *Eucalyptus marginata – Corymbia calophylla – Corymbia haematoxylon – Allocasuarina fraseriana* over introduced herbs and grasses on disturbed flats and lower slopes with leached or brown sandy-loams and sandy-gravels.
- F1: Open Forest of *Eucalyptus marginata – Corymbia calophylla – Banksia grandis - Corymbia haematoxylon – Xylomelum occidentale* over *Xanthorrhoea preissii, Podocarpus drouynianus, Hakea amplexicaulis, Hakea ruscifolia, Hibbertia hypericoides, Dasypogon hookeri, Dasypogon bromeliifolius* and *Kingia australis* over low herbs and grasses on lower and mid slopes with leached grey/brown sandy to sandy-loam soils.
- F2: Open Forest of *Eucalyptus marginata – Allocasuarina fraseriana – Corymbia calophylla – Corymbia haematoxylon – Xylomelum occidentale* over *Podocarpus drouynianus, Hibbertia hypericoides, Xanthorrhoea gracilis, Hypocalymma robustum* and *Hakea amplexicaulis* over *Hypolaena exsulca* and *Loxocarya striata* low subshrubs and herbs on slopes with leached grey sands to sandy-gravels.
- F3: Open Forest of *Corymbia calophylla - Eucalyptus marginata – Banksia grandis - Allocasuarina fraseriana* over *Hibbertia hypericoides, Xanthorrhoea preissii, Xanthorrhoea gracilis, Dasypogon*

hookeri, Dasypogon bromeliifolius, Kunzea recurva and *Podocarpus drouynianus* on flats with leached grey and brown sands and sandy loams.

- CL: Cleared

Table 4-11 lists the area of each vegetation community mapped by Mattiske (2012a) that occurs within the Haddon East sub-area.

TABLE 4-11: VEGETATION COMMUNITIES WITHIN THE HADDON EAST SUB-AREA

Vegetation Community	Total Area (ha)
W1	5.83
F1	0.39
F2	5.16
F3	0.27
CL	46.63
TOTAL	**58.28**

Piggott Sub-area

The Piggott sub-area contains no native vegetation and is considered to be CL, with the exception of 24 scattered trees/shrubs.

4.9.5 Vegetation Condition within the Proposed Yoongarillup Mine

State Forest Sub-Area

Vegetation condition within the State Forest sub-area was mapped by Ecoedge Environmental (2014; Appendix E) using the vegetation condition ratings according to Keighery (1994) as shown on Figure 4-12. The Keighery (1994) condition ratings are shown in Table 4-12.

TABLE 4-12: VEGETATION CONDITION RATINGS (KEIGHERY, 1994)

SCORE	DESCRIPTION
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely	The structure of the vegetation is no longer intact and the area is completely or

Degraded (6)	almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Vegetation within the State Forest sub-area (44.73 ha) was rated as Very Good (32.74 ha) or Excellent (11.99 ha) condition by Ecoedge Environmental (2014) using the condition ratings of Keighery (1994). A small totally cleared area (0.08 ha) on the northern boundary of the State Forest sub-area, previously used as a sand pit is rated as Completely Degraded by Ecoedge Environmental (2014). In addition the Goulden Road track is considered to be Completely Degraded. The portion classified as Very Good rather than Excellent (approximately 73% of the State Forest sub-area), has been partly cleared as evidenced by old windrows of fallen trees scattered throughout (Ecoedge Environmental, 2014). Based on the size of the regrowth eucalypts, Ecoedge Environmental (2014) estimates that the clearing was probably conducted during the period 1950-1965, perhaps in readiness for pine planting that did not eventuate.

Parts of the previously cleared area are relatively species poor and there is evidence of heavy kangaroo grazing through the State Forest sub-area. A strip around the east and north sides of the State Forest sub-area shows no signs of previous clearing which resulted in the vegetation being classified as Excellent condition. Phytophthora disease is present along the eastern boundary and part of the western boundary, evidenced by scattered deaths of Eucalyptus marginata and Xanthorrhoea species (Moore Mapping, 2014). Scattered deaths of Banksia grandis, particularly near the southern boundary of the State Forest sub-area are a result of drought, and dumping of domestic and farm refuse has been carried out in various places along the tracks in the northern and western parts (Ecoedge Environmental, 2014). The proportion and cover of introduced species is generally low throughout.

Haddon West Sub-area

Mattiske (2012a; Appendix E) mapped the Haddon West sub-area as Completely Degraded using the vegetation condition ratings according to Keighery (1994) as shown on Figure 4-12.

Haddon East Sub-area

The Haddon East sub-area was also mapped by Mattiske (2012a; Appendix E) as predominantly Completely Degraded due to the absence of native vegetation. The small area of native vegetation in the south east corner of Lot 1874 was mapped as a combination of Degraded, Good and Very Good (Figure 4-12).

Piggott Sub-area

Piggott sub-area contains no native vegetation and is considered to be all CL, with the exception of 26 scattered trees/shrubs. The condition of the Piggott sub-area is therefore considered to be Completely Degraded (Figure 4-12).

4.9.6 Vegetation of Conservation Significance

Threatened and Priority Ecological Communities

Ecoedge Environmental (2014; Appendix E) undertook a DPaW database search for threatened or priority ecological communities known to occur within a 5 km radius of the proposed Yoongarillup Mine (DEC, 2013a). A Protected Matters Search was undertaken for communities listed under the EPBC Act occurring within a 10 km radius of the proposed Yoongarillup Mine. Results of these searches are presented in Table 4-13. The complete Protected Matters Search results are included as Appendix 1 of Ecoedge Environmental (2014) (Appendix E).

TABLE 4-13: THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES DATA SEARCH RESULTS

COMMUNITY NAME	COMMUNITY DESCRIPTION	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Shrublands on dry clay flats SCP10a	Rapidly drying clay flats that generally have shallower microtopography than other clay pan community types or else have thin skeletal soils.	EN	CR
Herb rich saline shrublands in clay pans SCP07	Community occurs on heavy clay soils that are generally inundated from winter into mid-summer. This community is dominated by either *Melaleuca viminea*, *Melaleuca uncinata, Melaleuca cuticularis* or *Casuarina obesa* or a mixture of these species.	VU	CR
Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) SCP10b	Rapidly drying clay flats, occurring on small areas of ironstone with thin skeletal soils in the Busselton area.	CR	EN
Southern wet shrublands, Swan Coastal Plain SCP02	Shrublands or open low woodlands restricted to small remnants of Busselton. These occur on seasonally inundated sandy clay soils.	EN	-
Eucalyptus calophylla woodlands on heavy soils of the southern Swan Coastal Plain SCP1b	Consists largely of *Eucalyptus* (*Corymbia*) *calophylla* forests and woodlands of bushland remnants on the plain south of Capel.	VU	-
Eucalyptus haematoxylon - *E. marginata* woodlands on Whicher foothills ('community type 1a')	Community occurs along the northern edge of State Forest along the base of the Whicher Range and is composed of *Eucalyptus* (*Corymbia*) *haematoxylon* – *Corymbia calophylla* - *Eucalyptus marginata* forests and woodlands. Taxa virtually restricted to the type include *Acacia varia* subsp. *varia*, *Agonis grandiflora* and *Xanthosia pusilla*.	P3	-
Central Whicher Scarp Mountain Marri woodland (Whicher Scarp woodlands of grey/white sands community A1)	Located on Whicher Scarp mid slopes. The taxa that identify the group include: *Ricinocarpos aff. cyanescens*, *Hibbertia ferruginea*, *Platysace filiformis*, *Conospermum capitatum* subsp. *glabratum*, *Thysanotus arbuscula*, *Schoenus brevisetis*, *Phlebocarya filifolia*, *Leucopogon glabellus*, *Pimelea rosea* subsp. *rosea*, *Adenanthos obovatus*, *Stylidium carnosum* and *Gompholobium capitatum*.	P1	-
Central Whicher Scarp	Occurs on coloured sands on moderate to gentle	P1*	-

COMMUNITY NAME	COMMUNITY DESCRIPTION	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Jarrah woodland (Whicher Scarp woodlands of coloured sands and laterites community C1)	slopes of the Central Whicher Scarp. The community has strong representation of a less common group of southern taxa including: *Podocarpus drouynianus*, *Loxocarya cinerea*, *Allocasuarina fraseriana*, *-Drosera stolonifera*, *Amperea ericoides*, *Thysanotus triandrus*, *Cyathochaeta equitans*, *Hibbertia quadricolor*, *Comesperma calymega*, *Lepidosperma pubisquameum*, *Conospermum paniculatum*, *Acacia preissiana* and *Hybanthus debilissimus*.		
Sabina River Jarrah and Marri woodland (Whicher Scarp community F1)	Community in Sabina River alluvial fan where the Sabina River meets the Swan Coastal Plain. It is characterised by a suite of wetland taxa of restricted occurrence in the Whicher Scarp: *Mirbelia dilatata*, *Lomandra pauciflora*, *Tremandra diffusa*, *Tremandra stelligera*, *Trymalium floribundum* subsp. *trifidum* and *Clematis aristata* var. *occidentalis*. Other significant taxa in the community are: *Hovea elliptica*, *Leucopogon verticillatus*, and *Darwinia citriodora*.	P1*	-
Swan Coastal Plain Paluslope Wetlands	These wetlands are very wet all year round and are associated with areas of groundwater seepage from the sandy low hills at the base of the Whicher Scarp. At times these wetlands are contiguous with areas of Pinjarra Plain wetlands, and the wetlands of the two landforms merge. Combinations of the following species are typically found in the type: *Melaleuca preissiana*, *Taxandria linearifolia*, *Taxandria fragrans*, *Melaleuca incana*, and *Cyathochaeta teretifolia*. Other species include: *Eucalyptus patens*, *Homalospermum firmum*, *Gahnia decomposita*, *Callistachys lanceolata*, *Hakea linearis*, *Melanostachya ustulata*, *Evandra aristata*, *Beaufortia sparsa*, *Callistemon glaucus* and *Pultenaea pinifolia.*	P1*	-

* Indicates Whicher Scarp Floristic Community Types (Keighery *et al.,* 2008).

Priority Ecological Communities within the Proposed Yoongarillup Mine

Vegetation community A shares approximately 65% of its typical (>75% frequency) and common (50-75%) taxa with the Priority 1 ecological community; Central Whicher Scarp Jarrah woodland (FCT C1) (Ecoedge Environmental, 2014). Moreover, a total of 46 species recorded within at least one of the nine quadrats within vegetation community A is a 'typical' or 'common' species of FCT C1. This provides strong evidence to infer that vegetation community A, which is based on the vegetation community A quadrats, represents an occurrence of FCT C1 and that the extent of this Priority 1 ecological community within the State Forest sub-area is in fact larger than that mapped by DPaW (totalling 4.4ha) and at least

as large as the area mapped as 'yellow-brown sandy loam' (Figure 4-13). FCT C1 typically occurs on 'coloured' or 'yellow' sands (Keighery *et. al.,* 2008).

The floristic composition of vegetation community C, which includes an area mapped by DPaW as the Priority 1 ecological community; Central Whicher Scarp Mountain Marri woodland (FCT A1) was compared to both FCT A1 and FCT C4, which is also known to occur in the State Forest sub-area (refer to Ecoedge Environmental, 2014). Quadrat WHI03, which was surveyed as part of the Whicher Scarp Survey (Keighery *et. al.,* 2008) and designated as FCT C4, is located within the area mapped as vegetation community C.

Based on this comparison, vegetation community C is closer in composition to FCT C4 than FCT A1. Vegetation community C shares 16 'typical' or 'common' taxa with FCT A1 compared to 25 'typical' or 'common' taxa shared with FCT C4. Furthermore, vegetation community C contained in at least one of its quadrats 88% of the 'typical' or 'common' taxa of FCT C4, compared to only 55% of those for FCT A1. Based on this analysis, vegetation in the area mapped as vegetation community C, is more likely to be FCT C4 other than the Priority 1 ecological community, FCT A1. However, as vegetation community C is based on only four quadrats, surveying of more quadrats within this area is likely to confirm the presence of FCT A1 as mapped by DPaW (Figure 4-13).

4.9.7 Flora within the Proposed Yoongarillup Mine

A total of 353 species of vascular flora from 49 plant families, including 34 introduced species were recorded within the proposed Yoongarillup Mine (Ecoedge Environmental, 2014; Mattiske 2012a: Appendix E).

Flora of Conservation Significance

Desktop Assessment

Ecoedge Environmental (2014) conducted a DPaW database search for Threatened and Priority flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act 1950 (WC Act), occurring within 5 km radius of the State Forest sub-area (DEC, 2013b) and a Protected Matters Search for flora listed as Threatened pursuant to Schedule 1 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) occurring within 10 km radius of the State Forest sub-area. Mattiske (2012a; Appendix E) also undertook a DPaW database search and Protected Matters Search for flora within or adjacent to the State Forest sub-area. Results of these searches are summarised below in Table 4-14.

TABLE 4-14: THREATENED AND PRIORITY FLORA POTENTIALLY OCCURRING WITHIN OR ADJACENT TO THE PROPOSED YOONGARILLUP MINE

FAMILY	SPECIES	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Ericaceae	*Andersonia gracilis*	-	E
Proteaceae	*Banksia mimica*	T	E
Proteaceae	*Banksia nivea subsp. uliginosa*	-	E
Proteaceae	*Banksia squarrosa* subsp. *argillacea*	T	V
Apiaceae	*Brachyscias verecundus*	-	CE

FAMILY	SPECIES	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Orchidaceae	*Caladenia hoffmanii*	-	E
Orchidaceae	*Caladenia procera*	-	CE
Orchidaceae	*Caladenia winfieldii*	-	E
Centrolepidaceae	*Centrolepis caespitosa*	-	E
Myrtaceae	*Chamelaucium sp.* C Coastal Plain (R.D. Royce 4872)	T	V
Myrtaceae	*Darwinia foetida*	-	CE
Myrtaceae	*Darwinia whicherensis*	-	E
Fabaceae	*Daviesia elongata* subsp. *elongata*	T	V
Orchidaceae	*Diuris micrantha*	-	V
Orchidaceae	*Drakaea elastica*	-	E
Droseraceae	*Drosera fimbriata*	-	V
Myrtaceae	*Eucalyptus phylacis*	-	E
Fabaceae	*Gastrolobium papilio*	-	E
Proteaceae	*Lambertia echinata* subsp. *occidentalis*	-	E
Proteaceae	*Petrophile sp. Whicher Range* (G.J.Keighery 11790) WA Herbarium	-	E
Epacridaceae	*Sphenotoma drummondii*	-	E
Proteaceae	*Synaphea stenoloba*	-	E
Myrtaceae	*Verticordia plumosa* var. *vassensis*	T	E
Orchidaceae	*Caladenia busselliana*	T	-
Orchidaceae	*Diuris drummondii*	T	-
Cyperaceae	*Eleocharis keigheryi*	T	-
Cyperaceae	*Bolboschoenus medianus*	P1	-
Rutaceae	*Boronia humifusa*	P1	-
Fabaceae	*Gastrolobium sp. Yoongarillup* (S.Dilkes s.n. 1/9/1969)	P1	-
Loganiaceae	*Logania wendyae*	P1	-
Apiaceae	*Actinotus whicheranus*	P2	-

FAMILY	SPECIES	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Euphorbiaceae	*Amperea micrantha*	P2	-
Rutaceae	*Boronia capitata* subsp. *gracilis*	P2	-
Myrtaceae	*Eucalyptus relicta*	P2	-
Ericaceae	*Leucopogon sp.* Busselton (D. Cooper 243) PN	P2	-
Elaeocarpaceae	*Platytheca anasima*	P2	-
Proteaceae	*Synaphea petiolaris* subsp. *simplex*	P2	-
Asteraceae	*Blennospora doliiformis*	P3	-
Rutaceae	*Boronia tetragona*	P3	-
Cyperaceae	*Caustis sp*. Boyanup (G.S. McCutcheon 1706)	P3	-
Asparagaceae	*Chamaescilla gibsonii*	P3	-
Restionaceae	*Chordifex gracilior*	P3	-
Proteaceae	*Conospermum paniculatum*	P3	-
Apiaceae	*Eryngium sp.* Ferox (G.J. Keighery 16034)	P3	-
Apiaceae	*Eryngium subdecumbens*	P3	-
Proteaceae	*Grevillea brachystylis* subsp*. brachystylis*	P3	-
Proteaceae	*Isopogon formosus* subsp. *dasylepis*	P3	-
Fabaceae	*Jacksonia gracillima*	P3	-
	Lasiopetalum membranaceum	P3	-
Restionaceae	*Lepyrodia heleocharoides*	P3	-
Restionaceae	*Meeboldina decipiens* subsp. *decipiens*	P3	-
Loganiaceae	*Mitreola minima*	P3	-
Haloragaceae	*Myriophyllum echinatum*	P3	-
Cyperaceae	*Schoenus benthamii*	P3	-
Proteaceae	*Synaphea hians*	P3	-
Proteaceae	*Synaphea polypodioides*	P3	-
Elaeocarpaceae	*Tetratheca parvifolia*	P3	-
Orchidaceae	*Thelymitra variegata*	P3	-
Malvaceae	*Thomasia laxiflora*	P3	-

FAMILY	SPECIES	CONSERVATION STATUS (WC ACT)	CONSERVATION STATUS (EPBC ACT)
Myrtaceae	*Verticordia attenuata*	P3	-
Fabaceae	*Acacia flagelliformis*	P4	-
Fabaceae	*Acacia semitrullata*	P4	-
Myrtaceae	*Aponogeton hexatepalus*	P4	-
Orchidaceae	*Caladenia speciosa*	P4	-
Myrtaceae	*Calothamnus quadrifidus* subsp. *teretifolius*	P4	-
Myrtaceae	*Chamelaucium sp.* Yoongarillup (G.J. Keighery 3635)	P4	-
Proteaceae	*Franklandia triaristata*	P4	-
Proteaceae	*Lambertia rariflora* subsp. *rariflora*	P4	-
Asparagaceae	*Laxmannia jamesii*	P4	-
Menyanthaceae	*Ornduffia submerse*	P4	-
Myrtaceae	*Verticordia lehmannii*	P4	-

Results of Threatened and Priority Flora Surveys

Threatened and Priority flora species were recorded within the proposed Yoongarillup Mine during surveys undertaken by Mattiske (2012a), Mattiske (2012b) and Ecoedge Environmental (2014), all three of these reports are located in Appendix E. Details of each survey are provided in Table 4-15.

TABLE 4-15: DETAILS OF THREATENED AND PRIORITY FLORA SURVEYS CONDUCTED WITHIN THE PROPOSED YOONGARILLUP MINE

SURVEY	SUB-AREA	METHODOLOGY/SEARCH AREA	TIMING
Mattiske (2012a)	State Forest Haddon West Haddon East	100 m x 100 m grid pattern with 75 sites being surveyed in total. Nine 10 m x 10 m quadrats within less disturbed vegetation.	November 2011
Mattiske (2012b)	State-Forest	Nine drill lines approximately 6 m wide and 100 m long.	March 2012
Ecoedge Environmental (2014)	State Forest	Grid pattern along transects 30 m-40 m apart. Previous locations of Threatened and Priority species recorded by Mattiske (2012a and 2012b)	September/October 2012

Two Threatened flora species, *Daviesia elongata* subsp. *elongata* and *Verticordia densiflora* var. *pedunculata were* recorded within the State Forest sub-area. Both of these species are listed as Threatened pursuant to subsection (2) of Section 23F of the WC Act. *D. elongata* subsp. *elongata* is listed as vulnerable and *V. densiflora* var. *pedunculata* is listed as endangered pursuant to section 179 of the EPBC Act.

Two Priority listed species pursuant to subsection (2) of section 23F of the WC Act; *Conospermum paniculatum* (P3) and *Acacia semitrullata* (P4) were also recorded within the State Forest sub-area. A species previously recorded by Mattiske (2012a and 2012b) as potentially the Priority 3 species *Jacksonia gracillima* was subsequently identified by Ecoedge Environmental (2014) to be a Whicher Range variant of the common species *Jacksonia horrida*. J. Horrida (referred to as Jacksonia sp. Whicher (G. J. Keighery 9953)) is considered to have regional conservation significance (Keighery *et al.,* 2008).

Ecoedge Environmental (2014) recorded three species within the State Forest sub-area which are considered to be regionally significant by either Keighery *et. al.,* (2008) or DEC (2012a). These include the Whicher variant *Crowea angustifolia* var. *angustifolia* and populations of *Hemiphora bartlingii* and *Petrophile serruriae*. Mattiske (2012a) also recorded *Hemiphora bartlingii* and *Petrophile serruriae* as well as *Hibbertia lasiopus.* In addition, DPaW has a record of *Schoenus* sp. Whicher (G. J. Keighery and B. J. Keighery 901) within the State Forest sub-area but this species was not observed by Mattiske (2012a) or Ecoedge Environmental (2014), although it is possible that *Schoenus brevisetis* (recorded by Ecoedge Environmental, 2014) is in fact *Schoenus* sp. Whicher (G. J. Keighery and B. J. Keighery 901).

The locations of Threatened and Priority flora are shown on Figure 4-14 and regional conservation significant flora are shown on Figure 4-15.

Introduced Species

A total of 34 introduced species were recorded within the proposed Yoongarillup Mine (Mattiske, 2012a; Ecoedge Environmental, 2014: Appendix E). Of these taxa, *Zantedeschia aethiopica* (Arum Lily) is

a Declared Plant species pursuant to section 37 of the Agriculture and Related Resources Protection Act 1976. This species is listed as a Priority 1 (P1) and Priority 4 (P4) for all of Western Australia. Locations of this Declared Plant are shown on Figure 4-16.

Strict weed hygiene measures will be implemented to reduce the risk of weed introduction into adjacent uncleared areas and areas that are largely weed-free. Measures will be implemented to target the control of the Declared Plant *Zantedeschia aethiopica*. Weed management will be implemented as per Doral's Flora and Vegetation Management Plan.

4.10 DIEBACK

The plant disease known as 'dieback' is caused by infestation of an introduced pathogen Phytophthora species, with the most common (and perhaps the most devastating) species being *P. cinnamomi.* It affects a vast and diverse range of plant species in the southwest region of Western Australia. The disease enters through the plant roots, eventually causing them to rot, affecting the plants ability to transport water and nutrients throughout the plant. Some species which are susceptible to dieback (such as Jarrah) may show some resistance to the disease and appear to gradually die back (hence the name). However, most species susceptible to *P. cinnamomi* experience a 'sudden death' where all of the plant dies at once (Glevan, 2011).

There is a risk that dieback could spread from potentially infested paddock areas (mapped as dieback uninterpretable) and/or infested bush areas to the east of the State Forest Sub-area (west of Sues Road) to un-infested areas within the State Forest sub-area. The paddocks are uninterpretable and therefore to follow the precautionary principle, these areas are therefore assumed to be infested. To manage the risk of dieback spreading into the disease-free areas of State Forest sub-area, Doral will prepare and implement a Dieback Management Plan.

4.11 FAUNA

4.11.1 Existing Environment

Studies Undertaken

A detailed fauna investigation was undertaken by Greg Harewood (Harewood, 2014; Appendix F) to quantify the fauna values of the proposed Yoongarillup Mine (Figure 4-17) and identify the potential presence, distribution and abundance of specific fauna species of conservation significance. The fauna survey was undertaken included Lots 1870, 1871, 1872, 1873, 1874 and State Forest No. 33. The fauna assessment included the following:

- Level 1 fauna assessment;
- Level 2 seasonal Fauna Survey undertaken in December 2011 and March 2012;
- Chuditch Trapping Program;
- Western Ringtail Possum Targeted Surveys;
- Black Cockatoo Habitat Survey;
- Terrestrial Invertebrate Survey for Short Range Endemic (SRE) taxa (Phoenix Environmental Services, 2012).

Field survey techniques included opportunistic surveys, trapping, call playback, habitat surveys, acoustic bat recordings, infrared cameras and bird surveys. Previous Fauna surveys in the area were consulted

prior to field investigations and used to determine the potential fauna assemblage for the general area. The methodology and full results of the fauna survey are provided in Appendix F.

The following description of fauna and fauna habitats within the proposed Yoongarillup Mine is adapted from Harewood (2014) unless otherwise stated.

Terrestrial Fauna Habitats

Nine Fauna Habitats were mapped within the proposed Yoongarillup Mine (Figure 4-17). These fauna habitats were based on the vegetation units of Ecoedge Environmental (2014) and Mattiske (2012a) and are described in Table 4-16. Most of the proposed Yoongarillup Mine is cleared of native vegetation and is used for livestock grazing. Remnant native vegetation is dominated by woodlands or forests of Jarrah and/or Marri with variation occurring with respect to the subdominant mid and lower storey species.

Most of the vegetation within the State Forest sub-area is rated by Ecoedge Environmental (2014) as Very Good to Excellent condition despite appearing to have regenerated after past historical disturbances. Adjacent vegetation within the Whicher National Park is generally in better condition with a higher density of groundcover vegetation.

Fallen logs (some hollow) and trees with hollows were relatively common within the (vegetated) areas of the proposed Yoongarillup Mine. The location of trees containing hollows is shown in Figure 4-18.

TABLE 4-16: FAUNA HABITATS WITHIN THE PROPOSED YOONGARILLUP MINE

BROAD FAUNA HABITAT TYPE	FAUNA HABITAT MAPPING (Harewood, 2014)	SOURCE	DESCRIPTION
Open Forest	Jarrah/Marri open forest on yellow or yellow brown loamy sand	Ecoedge (2014)	Vegetation Unit A: *Eucalyptus marginata*, *Corymbia calophylla* open forest/woodland over *Banksia grandis* low open woodland over *Acacia pulchella*, *Adenanthos barbiger*, *Dasypogon hookeri*, *Hakea amplexicaulis*, *H. ruscifolia*, *Hibbertia hypericoides*, *Hypocalymma robustum*, *Labichea punctata*, *Melaleuca thymoides*, *Podocarpus drouynianus*, *Synaphea whicherensis*, *Xanthorrhoea gracilis*, shrubland/low shrubland over *Anarthria prolifera*, *Loxocarya cinerea*, *Mesomelaena tetragona*, *Tetraria octandra* open sedgeland and *Conostylis setigera* subsp. *setigera*, *Dampiera linearis*, *Hypochaeris glabra*, *Lomandra hermaphrodita*, *Patersonia umbrosa* var. *umbrosa* and *Trachymene pilosa* open herbs on grey-brown, yellow or yellow-brown ('orange') loamy sand.
Woodland	Jarrah Woodland on light grey sand or grey-brown loamy sand	Ecoedge (2014)	Vegetation Unit B: *Eucalyptus marginata*, (*Corymbia calophylla*, *C. haematoxylon*) woodland over (*Banksia grandis*), (*Xylomelum occidentale*) open low woodland over *Acacia pulchella*, *Banksia dallanneyi* subsp. *dallanneyi*, *Conostephium pendulum*, *Dasypogon*

BROAD FAUNA HABITAT TYPE	FAUNA HABITAT MAPPING (Harewood, 2014)	SOURCE	DESCRIPTION
			bromeliifolius, *Hibbertia hypericoides*, *Hypocalymma robustum*, *Leucopogon pulchellus*, *Stirlingia latifolia*, *Xanthorrhoea gracilis* shrubland/low shrubland over *Desmocladus fascicularis*, *Mesomelaena tetragona* very open sedges and **Arctotheca calendula*, *Burchardia congesta*, *Caladenia flava*, *Elythranthera brunonis*, **Hypochaeris glabra*, *Quinetia urvillei*, *Rhodanthe citrina*, *Stylidium calcaratum* and *Trachymene pilosa* open herbs on grey-brown loamy sand to light grey sand
Open Forest	Jarrah/Marri open forest on gravelly sand or grey brown loamy sand	Ecoedge (2014)	Vegetation Unit C: *Eucalyptus marginata*, *Corymbia calophylla* open forest over *Banksia dallanneyi* var. *dallanneyi*, *Hakea amplexicaulis*, *Hibbertia cunninghamii*, *H. commutata*, *H. hypericoides*, *Hovea chorizemifolia*, *Hypocalymma robustum*, *Labichea punctata*, *Leucopogon conostephioides*, *Xanthorrhoea preissii*, *X. gracilis* shrubland/low shrubland over *Desmocladus fasciculatus*, *Tetraria octandra*, *T.* sp. Jarrah Forest very open sedges and *Conostylis setigera* subsp. *setigera*, *Lagenophora huegelii*, *Lomandra sericea*, *L. hermaphrodita*, *Opercularia apiciflora*, *Patersonia umbrosa* var. *xanthina* and *Thelymitra crinita* open herbs on gravelly sand or grey brown loamy sand.
Open Forest	Jarrah/Mountain Marri/Sheoak open forest on grey-brown or yellow-brown loamy sand and sandy loam	Ecoedge (2014)	Vegetation Unit D: *Eucalyptus marginata*, *Corymbia haematoxylon*, *Allocasuarina fraseriana* open forest over *Banksia grandis*, (*Persoonia elliptica*) open low woodland over *Dasypogon hookeri*, *D. bromeliifolius*, *Hibbertia hypericoides*, *H. glomerata*, *Labichea punctata*, *Stirlingia latifolia*, *Xanthorrhoea preissii*, *X. gracilis* shrubland/low shrubland over *Patersonia umbrosa* var. *xanthina* very open herbs on grey-brown or yellow-brown loamy sand and sandy clay loam.
Open Woodland	Jarrah/Marri/Mountain Marri/Sheoak Open Woodlands over weeds	Mattiske (2012a)	W1. Open Woodland of *Eucalyptus marginata* - *Corymbia calophylla* - *Corymbia haematoxylon* - *Allocasuarina fraseriana* over introduced herbs and grasses on disturbed flats and lower slopes with leached or brown sandy-loams and sandy-gravels.
Open Forest	Jarrah/Marri/Banksia/Mountain Marri/Woody Pear	Mattiske (2012a)	F1. Open Forest of *Eucalyptus marginata Corymbia calophylla Banksia grandis* - *Corymbia haematoxylon Xylomelum occidentale* over *Xanthorrhoea preissii,*

BROAD FAUNA HABITAT TYPE	FAUNA HABITAT MAPPING (Harewood, 2014)	SOURCE	DESCRIPTION
	open forest over Shrubland over low herbs and grasses on leached grey/brown sandy to sandy-loam soils		*Podocarpus drouynianus, Hakea amplexicaulis, Hakea ruscifolia, Hibbertia hypericoides, Dasypogon hookeri, Dasypogon bromeliifolius* and *Kingia australis* over low herbs and grasses on lower and mid slopes with leached grey/brown sandy to sandy-loam soils.
Open Forest	Marri/Mountain Marri/Banksia/Woody Pear open forest over shrubland	Mattiske (2012a)	F2. Open Forest of *Eucalyptus marginata - Corymbia calophylla -Banksia grandis - Corymbia haematoxylon – Xylomelum occidentale* over *Xanthorrhoea preissii, Podocarpus drouynianus, Hakea amplexicaulis, Hakea ruscifolia, Hibbertia hypericoides, Dasypogon hookeri.*
Open Forest	Marri/Jarrah/Banksia/Sheoak open forest over Shrubland on leached grey and brown sands and sandy loams	Mattiske (2012a)	F3. Open Forest of *Corymbia calophylla - Eucalyptus marginata Banksia grandis - Allocasuarina fraseriana* over *Hibbertia hypericoides, Xanthorrhoea preissii, Xanthorrhoea gracilis, Dasypogon hookeri, Dasypogon bromeliifolius, Kunzea recurva* and *Podocarpus drouynianus* on flats with leached grey and brown sands and sandy loams.
Cleared	Cleared paddocks	Mattiske (2012a)	CL. The majority of the proposed Yoongarillup Mine is cleared farmland. Some of the cleared areas are low lying and subject to seasonal inundation/waterlogging in the winter months. Some sections contain various densities of scattered individual and groups of trees, principally Marri (*C. calophylla*) and Jarrah (*E. marginata*) over a mixture of introduced pasture grasses, clovers, weeds and degraded sedgelands. A variety of non-endemic trees and shrubs have been planted in some locations as windbreaks and screens.

Occurrence of Vertebrate Fauna

In total, evidence of 95 species of native vertebrate fauna was obtained during the level 2 survey (captured, sighted, heard, recorded, signs) comprising of 52 native bird species, fourteen native mammal species, 25 reptile species and four amphibian species. This is approximately 53% of the total number of potential native species (based on previous fauna surveys in the area and desktop investigations).

Fish

No freshwater fish were recorded.

No listed threatened or priority native fish species were recorded and none of the species known from the general area are considered likely to occur in the area under any circumstances given the lack of suitable habitat.

Native Non-Volant Mammals

Eight native non-flying mammals were captured and/or observed during the field surveys. Based on desktop study results another six species may occur in the general area. Three species of conservation significance were observed or noted as utilising the proposed Yoongarillup Mine:

- Quenda (*Isoodon obesulus fuciventer*) listed as a P5 (DPaW Priority Species);
- Southern Brush-tailed Phascogale (*Phascogale tapoatafa* spp) listed as Schedule 1 under the WC Act;
- Western Brush Wallaby (*Macropus Irma*) listed as P4 (DPaW Priority Species).

Other specially protected/priority species that may utilise the Yoongarillup area at times but which were not sighted are the Chuditch (*Dasyurus geoffroii*) and the Western Ringtail Possum (*Pseudocheirus occidentalis*) which are both listed as Schedule 1 under the WC Act and Vulnerable under the EPBC Act. Although some areas of suitable habitat occur within the proposed Yoongarillup Mine, these species were absent during the survey.

Bats

Six bat species were recorded during all stages of the fauna survey. Based on the desktop study results another three species of bat may occur in the general area.

No bat species recorded are listed as conservation significant species. The Western false pipistrelle (*Falsistrellus mackenziei*) is listed as P4 and has been recorded nearby and may utilise habitat within the proposed Yoongarillup Mine despite its apparent absence during the survey period.

Introduced Mammals

Six introduced mammals were observed during the field survey; the House Mouse (Mus musculus), Black Rat (*Rattus rattus*), Red Fox (*Vulpes vulpes*), Rabbit (*Oryctolagus cuniculus*), Pig (*Sus scrofa*) and European Cattle (*Bos taurus*).

Birds

A total of 53 bird species (one introduced) were recorded. A comprehensive list of these species is provided in Appendix F. Another 55 species may occur in the general area. The higher number of potential bird species (based on fauna surveys at Gwindinup/Happy Valley (Bancroft and Bamford, 2008), Tutunup (Biota, 2009), Yoganup (Biota, 2007a) and Tutunup South (Biota, 2007b) compared to the proposed Yoongarillup Mine can in part be explained by the larger size of the survey area, a wider range of habitats and in the case of Gwindinup/Happy Valley repeated surveys over several years.

Four species of avifauna assigned conservation significance were recorded within the proposed Yoongarillup Mine;

- Baudin's Black-Cockatoo (*Calyptorynchus baudinii*) listed as Schedule 1 under the WC Act and Vulnerable under the EPBC Act;
- Carnaby's Black-Cockatoo (*Calyptorynchus latirostris*) listed as Schedule 1 under the WC Act and Endangered under the EPBC Act;
- Forest Red Tailed Black-Cockatoo (*Calyptorynchus banksia naso*) listed as Schedule 1 under the WC Act and Vulnerable under the EPBC Act;

- Rainbow Bee-eater (*Merops ornatus*) listed as Schedule 3 under the WC Act and Migratory under the EPBC Act.

Other specially protected/migratory/priority species that may utilise habitats within the proposed Yoongarillup Mine at times but which were not sighted are the Peregrine Falcon (*Falco peregrinus*) listed as Schedule 4 of the WC Act, the Masked Owl (*Tyto n. novaehollandiae*) listed as P3, the Great Egret (*Ardea alba*) and the Cattle Egret (*Ardea ibis*) both listed as Migratory under the EPBC Act.

Reptiles

A total of 25 species of reptile were captured and/or observed during the field surveys. Based on the desktop study results another 11 species may occur in the general area. These results are comparable with those recorded elsewhere on the Whicher Scarp. Bancroft and Bamford (2008) recorded a combined total of 25 reptile species from Gwindinup and Happy Valley. Biota recorded 19 species at Tutunup (Biota, 2009) and 20 species at Yoganup and at Tutunup South (Biota 2007a, 2007b). Hart *et al.,* (1997) recorded 21 species further out on the coastal plain within vegetation bordering Tutunup Road. One species of conservation significance was recorded, the Coastal Plains Skink (*Ctenotus ora*) which is a P1 species. The only other likely species of conservation significance that may occur within the proposed Yoongarillup Mine and its surrounds is the Southern Carpet Python (*Morelia spilota imbricata*) which is listed as Schedule 4 under the WC Act.

Amphibians

Four species of frog were captured and/or observed during the field survey. Desktop study results indicate that another seven species may occur in the general area. None of the identified or potential amphibian species that may occur in the area are listed as Threatened or Priority species.

Vertebrate Species of Conservation Significance

Based on previous surveys, database and literature searches from within 20 km of the proposed Yoongarillup Mine, there is the potential for 29 species of conservation significance to occur in the area (Table 4-17). Seven of these species have been recorded within the proposed Yoongarillup Mine (Either directly or through secondary evidence).

TABLE 4-17: POTENTIALLY OCCURRING CONSERVATION SIGNIFICANT VERTEBRATE FAUNA SPECIES

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Carter's Freshwater Mussel *Westralunio carteri*	-	P4	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Salinity tolerance quite low (Morgan *et al,.* 2011)	Unlikely. No suitable habitat.
Margaret River (Hairy) Marron *Cherax tenuimanus*	CR	S1	Information on the current distribution of the hairy marron indicates that the species requires relatively good quality water and a diversity of habitat structure and may struggle to persist in disturbed habitats.	Unlikely. No suitable habitat.
Mud Minnow *Galaxiella munda*	-	S1	Typically found in small flowing streams near submerged vegetation, occasionally in still water of ponds, swamps and roadside drains. Water is usually darkly tannin stained and acidic (pH 3.0-6.0) (Allen *et.al*., 2003).	Unlikely. No suitable habitat.
Balston's Pygmy Perch *Nannatherina balstoni*	VU	S1	Acidic, tannin stained freshwater pools, streams and lakes within 30 km of the coast, typically situated amongst peat flats. Prefers shallow water and is commonly found in association with tall sedge thickets (Allen *et al*., 2003). Morgan (1996) found them most common in shallow pools and creeks that often dry up in summer. Lower numbers were observed in the permanent major rivers surveyed.	Unlikely. No suitable habitat.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Perth Lined Lerista *Lerisita lineata*	-	P3	This small species of skink inhabits white sands (Storr *et al*., 1999) under areas of shrubs and heath where it inhabits loose soil and leaf litter (Nevill, 2005) particularly in association with Banksias (Bush *et al,*. 2002).	Unlikely. This species has not been found south of Bunbury in recent times. The single documented record south of Bunbury (West Busselton) is considered erroneous).
Coastal Plains Skink *Ctenotus ora*	-	P1	Sandy substrates with low vegetation (including heath) in open *Eucalyptus/Corymbia* woodland over *Banksia* (Kay and Keogh, 2012). Individuals have been found sheltering under *Banksia* logs on white sand, and trapped in eucalypt woodland with *Banksia* or peppermint mid-storey, or heath (Bamford *et al*., 2010). Habitat also includes open eucalypt woodland over *Banksia* and low vegetation on sandy coastal plain and coastal dunes (Wilson and Swan, 2013)	Known To Occur. Twenty eight specimens of what is assumed to be *Ctenotus ora* were collected during the survey period.
Southern Carpet Python *Morelia spilota imbricata*	-	S4, P4	This species has been recorded from semi-arid coastal and inland habitats, *Banksia* woodland, Eucalypt woodlands, and grasslands. Most often found utilising hollow logs in addition to the burrows of other animals for shelter. Often arboreal and will also use tree hollows for refuge.	Possible. Status on-site is difficult to determine. Habitat appears suitable with areas of dense groundcover and hollow logs/trees. Typically only occurs in low densities.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Short-nosed Snake *Elapognathus minor*	-	P2	Restricted to the humid coastal plains of the deep south west (Storr *et al.,* 2002). Inhabits heaths edging swamps though also known to inhabit wet sclerophyll forest. Shelters in low dense vegetation such as tussocks and sedges (Wilson and Swan, 2013).	Unlikely. Just outside of documented range. No suitable habitat.
Great Egret *Ardea alba*	Migratory	S3	Wetlands, flooded pasture, dams, estuarine mudflats, mangroves and reefs (Morcombe, 2004).	Possible. Likely to utilise the manmade dams and possibly paddocks for foraging at times, in small numbers. This species would be an infrequent, temporary visitor only. No potential for breeding on-site. Would not utilise forested areas for any purpose.
Cattle Egret *Ardea ibis*	Migratory	S3	Moist pastures with tall grasses, shallow open wetlands and margins, mudflats (Morcombe, 2004).	Possible. Likely to utilise the manmade dams and possibly paddocks for foraging at times, in small numbers. This species would be an infrequent, temporary visitor only. No potential for breeding on-site. Would not utilise forested areas for any purpose.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Malleefowl *Leipoa ocellata*	VU	S1	Mainly scrubs and thickets of mallee Eucalyptus sp., boree *Melaleuca lanceolata* and bowgada *Acacia linophylla*, also dense litter forming shrublands.	Unlikely. This species is locally and regionally extinct.
Australasian Bittern *Botaurus poiciloptilus*	EN	S1	Freshwater wetlands, occasionally estuarine; prefers heavy vegetation (Morcombe, 2004) such as beds of tall dense *Typha*, *Baumea* and sedges in freshwater swamps (Johnstone and Storr, 1998).	Unlikely. No suitable habitat
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Migratory	S3	They nest and forage usually near the coast over islands, reefs, headlands, beaches, bays, estuaries, mangroves, but will also live near seasonally flooded inland swamps, lagoons and floodplains, often far inland on large pools of major rivers. Established pairs usually sedentary, immatures dispersive (Morcombe, 2004). White-bellied Sea-Eagles build a large stick nest, which is used for many seasons in succession.	Unlikely. No suitable habitat
Peregrine Falcon *Falco peregrinus*	-	S4	Diverse from rainforest to arid shrublands, from coastal heath to alpine (Morcombe, 2004). Mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes (Johnstone and Storr, 1998). The species utilises the ledges, cliff faces and large hollows/broken spouts of trees for nesting. It will also occasionally use the abandoned nests of other birds of prey.	Possible. The species potentially utilises some sections of the proposed Yoongarillup Mine as part of a much larger home range. No actual nest sites observed.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Carnaby`s Black Cockatoo *Calyptorhynchus latirostris*	EN	S1	Forests, woodlands, heathlands, farms; feeds on *Banksia*, *Hakea* and Marri. Carnaby's Cockatoo has specific nesting site requirements. Nests are mostly in smoothed-barked eucalypts with the nest hollows ranging from 2.5 to 12 m above the ground, an entrance from 23-30 cm diameter and a depth of 0.1-2.5 m (Johnstone and Storr, 1998).	Known To Occur. Small flocks of this species observed flying over the proposed Yoongarillup Mine on occasions and foraging evidence attributed to this species found within proposed Yoongarillup Mine (chewed marri and jarrah fruits). All marri, mountain marri, jarrah, *banksia* trees and a range of other plant species within the proposed Yoongarillup Mine represents potential foraging habitat for this species. Larger trees (>50 cm Diameter at Breast Height (DBH)) are considered potential breeding habitat by DoE (DSEWPaC, 2012a). This species may also roost on site on occasions. Several trees with evidence of roosting activity were observed within the proposed Yoongarillup Mine.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Baudin`s Black Cockatoo *Calyptorhynchus baudinii*	VU	S1	Mainly eucalypt forests where it feeds primarily on Marri seeds, (Morcombe, 2004), *Banksia*, *Hakea* and *Erodium* sp. Also strips bark from trees in search of beetle larvae (Johnstone and Storr, 1998). This species of cockatoo nests in large tree hollows, 30–40 cm in diameter and more than 30 cm deep (Saunders, 1974).	Possible. Foraging evidence attributed to this species found within the proposed Yoongarillup Mine (chewed marri fruits). All marri, mountain marri, banksia trees and a range of other plant species within the proposed Yoongarillup Mine represents potential foraging habitat for this species. Larger trees (>50cm DBH) are considered potential breeding habitat by DoE (DSEWPaC, 2012a). This species may also roost on site on occasions. Several trees with evidence of roosting activity were observed within the proposed Yoongarillup Mine.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*	VU	S1	Eucalypt forests, feeds on marri, jarrah, blackbutt, karri, sheoak and snottygobble. The forest red-tailed black cockatoo nests in the large hollows of marri, Jarrah and Karri (Johnstone and Kirkby, 1999). In Marri, the nest hollows of the Forest Red-tailed Black Cockatoo range from 8-14 m above ground, the entrance is 12 – 41 cm in diameter and the depth is one to five metres (Johnstone and Storr, 1998).	Known To Occur. Heard calling on several occasions and foraging evidence attributed to this species found within the proposed Yoongarillup Mine (chewed jarrah fruits). All marri, mountain marri and jarrah trees and a range of other plant species within the proposed Yoongarillup Mine represents potential foraging habitat for this species. Larger trees (>50cm DBH) are considered potential breeding habitat by DoE (DSEWPaC, 2012a). This species may also roost on site on occasions. Several trees with evidence of roosting activity were observed within the proposed Yoongarillup Mine.
Masked Owl (SW population) *Tyto n. novaehollandia*	-	P3	Roosts and nests in heavy forest, hunts over open woodlands and farmlands (Morcombe, 2004). Probably breeding in forested deep south west with some autumn–winter wanderings northwards (Johnstone and Storr, 1998).	Possible. May occasionally reside in general area though status uncertain. May utilise forested areas for roosting and hunt over cleared paddocks.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Fork-tailed Swift *Apus pacificus*	Migratory	S3	Low to very high airspace over varied habitat from rainforest to semi desert (Morcombe, 2004).	Flyover Only. It is potentially a very occasional summer visitor to air space above the proposed Yoongarillup Mine but is entirely aerial and largely independent of terrestrial habitats. Not listed as a potential species as it is only likely to occur in the general area on very rare occasions.
Rainbow Bee-eater *Merops ornatus*	Migratory	S3	Open country, of woodlands, open forest, semi arid scrub, grasslands, clearings in heavier forest, farmlands (Morcombe, 2004). Breeds underground in areas of suitable soft soil firm enough to support tunnel building.	Known To Occur. Heard calling during field survey work in December 2011. May breed in some sections of the proposed Yoongarillup Mine where ground conditions permit.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Chuditch *Dasyurus geoffroii*	VU	S1	Chuditch are known to have occupied a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts. Riparian vegetation appears to support higher densities of Chuditch, possibly because food supply is better or more reliable and better cover is offered by dense vegetation. Chuditch appear to utilise native vegetation along road sides in the wheatbelt (CALM, 1994). The estimated home range of a male Chuditch is over 15 km^2 whilst that for females is 3-4 km^2 (Sorena and Soderquist, 1995). This species is rarely recorded on the coastal plain (Dell, 2000).	Possible. No evidence of this species found during the survey period. This species may however occur on some occasions as it has previously been recorded in state forest areas of the south west.
Southern Brush-tailed Phascogale *Phascogale tapoatafa* ssp	-	S1	This subspecies has been observed in dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover. A nocturnal carnivore relying on tree hollows as nest sites. The home range for a female Brush-tailed Phascogale is estimated at between 20 ha and 70 ha, whilst that for males is given as twice that of females. In addition, they tend to utilise a large number of different nest sites (~ 20) throughout their range (Soderquist, 1995). Rhind's 1998 study indicated a preference for hollows in older and senescent or dead trees and small hollow entrances (Rhind, 1998).	Known to occur. This species was recorded within the state forest area during the field survey (Camera site 1).

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Quenda *Isoodon obesulus fusciventer*	-	P5	Dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting jarrah and wandoo forests are usually associated with watercourses. Quendas can thrive in more open habitat subject to exotic predator control (DPaW information pamphlet).	Known To Occur. This species was recorded within the national park area (Trap Site 3) during the field survey. Appears to be favouring areas with the densest groundcover as it was not captured or observed in areas with relatively sparse groundcover.
Bilby *Macrotis lagotis*	VU	S1	Current habitat included *Acacia* shrublands, spinifex and hummock grassland (Menkhorst and Knight, 2011).	Unlikely. Regionally extinct.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Western Ringtail Possum *Pseudocheirus occidentalis*	VU	S1	The western ringtail possum was once located in a variety of habitats including coastal peppermint, coastal peppermint-tuart, jarrah-marri associations, sheoak woodland, and eucalypt woodland and mallee. Coastal populations mostly inhabit peppermint-tuart associations with highest densities in habitats with dense, relatively lush vegetation. In these areas the main determinants of suitable habitat for WRPs appears to be the presence of *Agonis flexuosa* either as the dominant tree or as an understorey component of eucalypt forest or woodland (Jones *et al.,* 1994a). Inland, the largest known populations occur in the upper Warren area east of Manjimup (Wayne *et al.,* 2005). In this area the peppermint tree is naturally absent and jarrah-marri associations constitute the species refuge and foraging habitat. In areas where peppermint is absent or rare WRPs have been observed feeding predominately on young jarrah, *Nuytsia floribunda* and *Allocasuarina fraseriana* (G Harewood pers. obs.).	Possible. No evidence of this species was found within the bounds of the proposed Yoongarillup Mine despite two repeat night surveys and extensive daytime transects across the site. Based on this information it is concluded to be absent from the site despite the presence of some areas of suitable habitat.
Western Brush Wallaby *Macropus irma*	-	P4	The species optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. It is also found in some areas of mallee and heathland, and is uncommon in karri forest (DPaW information pamphlet).	Known To Occur. A single individual of this species was seen within the national park area during the December 2011 survey period.

SPECIES	CONSERVATION STATUS (see Appendix 2 of Appendix F for code descriptions)		HABITAT	LIKELIHOOD OF OCCURRENCE
	EPBC ACT	WC Act		
Quokka *Setonix brachyurus*	VU	S1	Mainland populations of this species are currently restricted to densely vegetated coastal heaths, swamps, riverine habitats including tea-tree thickets on sandy soils along creek systems where they are less vulnerable to predation. The species is nocturnal.	Unlikely. A population of this species could not persist within the habitats present with the proposed Yoongarillup Mine.
Western False Pipistrelle *Falsistrellus mackenziei*	-	P4	This species of bat occurs in high forest and coastal woodlands. It roosts in small colonies in tree hollows and forages at canopy level and in the cathedral-like spaces between trees.	Possible. This species was not recorded during the two field survey periods and it appears based on this information to be currently absent from the area.
Water Rat *Hydromys chrysogaster*	-	P4	The water rat occupies habitat in the vicinity of permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen *et al.,* 1985).	Unlikely. No suitable habitat.

In summary the following species of conservation significance are likely or known to occur within the proposed Yoongarillup Mine:

- Western Brush Wallaby (*Macropus Irma*);
- Quenda (*Isoodon obesulus fusciventer*);
- Rainbow Bee-eater (*Merops ornatus*);
- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*);
- Carnaby`s Black Cockatoo (*Calyptorhynchus latirostris*);
- Coastal Plains Ctenotus (*Ctenotus ora*);
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*);
- Cattle Egret (*Ardea ibis*);
- Great Egret (*Ardea ibis*).

Possibly occurring due to suitable habitat, however little evidence to suggest the presence of these species:

- Western False Pipstrelle (*Falsistrellus mackenziei*);
- Western Ringtail Possum (*Pseudocheirus occidentalis*);
- Chuditch (*Dasyurus geoffroii*);
- Fork tailed Swift (*Apus pacificus*);
- Masked Owl (*Tyto n. novaehollandia*);
- Peregrine Falcon (*Falco peregrinus*);
- Southern Carpet Python (*Morelia spilota imbricate*).

4.11.2 Regional Endemism, Distribution Limits and Rare Assemblages

None of the recorded or potential bird, mammal, amphibian, fish or reptile species (excluding those listed in Table 4-17) can be regarded as of conservation significance due to regional or local endemism, being at the limit of their range or comprising a unique or rare assemblage. Most of the species recorded are common widespread species that could be found in similar habitats throughout the south west with assemblages also being typical of habitat of a similar type.

However several species/assemblages of reptile and one amphibian, although not restricted specifically to the Whicher Scarp could be regarded as locally significant. These are discussed below.

Species of local significance

Speckled Stone Gecko *Diplodactylus polyophthalmus*

At Yoongarillup this species was recorded once within the state forest area (though outside of the proposed works footprint). According to NatureMap (DPaW 2014) this record is at the extreme south west limit of this species range. The Speckled Stone Gecko does however appear to be relatively widespread along the Whicher Scarp having also been recorded at Gwindinup/Happy Valley (five individuals, Bancroft and Bamford 2008), Tutunup (two individuals, Biota 2009) and also within sections

of the coastal plain in close proximity to the Whicher Scarp where adequate habitat extent and connectivity remains (two individuals, Hart et al. 1997).

Recent investigation of the systematics of this species indicates that there is a deep genetic divergence between populations of *D. polyophthalmus* on the Swan Coastal Plain (around Perth) and the Darling Range (inland south of Perth) (Doughty and Oliver 2014). The Perth sandplain variant is considered to be threatened and at risk of extinction due to extensive and ongoing clearing (Doughty and Oliver 2014). The Darling range variant (*D. lateroides* sp. *nov*) which is what was found at Yoongarillup, is believed to be more secure than the Swan Coastal Plain variant owing to "relatively less clearing on poor agricultural land and rugged terrain where it occurs and the presence of many national parks in its range" (Doughty and Oliver 2014). The conservation status of these variants need to be considered (Doughty and Oliver 2014).

Black–backed Hooded Snake *Parasuta nigriceps*

At Yoongarillup this species was recorded twice within the state forest area (outside of the proposed works footprint). This species has disappeared from much of the southern Swan Coastal Plain due to clearing and habitat fragmentation. It has however been recorded along the Whicher Scarp at Yoganup (Biota 2007a) and also on a nearby section of the coastal plain where adequate habitat extent and connectivity remains (Hart et al. 1997).

Forest toadlet *Metacrina nichollsi*

This species was captured nine times during the two phase survey period, with eight of the records being from trap sites within the national park. This can in part be attributed to the generally denser ground vegetation present in these areas which provide better microhabitat for this ground dwelling species. According to NatureMap (DPaW 2014) this record is near to the northern limit of this species documented range. However, this species was also recorded at Tutunup (Biota 2009), approximately 20km north east of Yoongarillup along the Whicher Scarp, though not recorded by Biota at Yoganup (Biota 2007a) or by Bancroft and Bamford (2008) at Gwindinup/Happy Valley. These survey results suggest a northern range limit in this vicinity and that the species is likely to be present in suitable habitat within sections of the scarp (and areas inland) at least 20km further to the north east.

Rare Assemblages

West Coast Four-toed *Lerista Lerista elegans* and

Southwestern Four-toed *Lerista Lerista distinguenda*

These two closely related species are most commonly recorded on the coastal plain and the upper Darling/Whicher Scarps respectively so their apparent overlapping distributions at Yoongarillup is of some interest. Other surveys nearby have also recorded both species at the same location (Yoganup - Biota 2007a, Tutunup South – Biota 2007b and Tutunup - Biota 2009) and both species have also been recorded together on the far western section of the coastal plain (Ludlow Tuart Forest – Bamford 2001). These records would suggest the co-occurrence of these two species at Yoongarillup is not unique/rare and the presence of both species probably occurs at many locations along sand plain-scarp interzones from Busselton to Dongara where their documented distributions coincide.

West Coast Pale-flecked Morethia *Morethia lineoocellata* and Shrubland Pale-flecked Morethia *Morethia obscura*

These two closely related species do have significant overlapping distributions but typically are more common on the coastal plain and the upper Darling/Whicher Scarps respectively. Other surveys nearby have recorded both species at the same location (Yoganup - Biota 2007a, Tutunup South – Biota 2007b, Tutunup - Biota 2009 and Gwindinup/Happy Valley - Bancroft and Bamford 2008) which indicates this assemblage is not unique/rare and probably occurs at many locations where the documented distribution of both species overlaps (Busselton to Shark Bay).

Chain-striped Heath Ctenotus *Ctenotus catenifer*; Odd-striped Ctenotus *Ctenotus impar*; and

Coastal Plains Ctenotus *Ctenotus ora*

A single *Ctenotus catenifer* specimen was captured at Yoongarillup (within the National Park area). This represents one of the most northern records for this species across its documented distribution and its significance is supported by the fact that no observations of it have been made during other surveys carried out previously along the Whicher Scarp in recent times (Biota 2007a, Biota 2007b, Biota 2009 and Bancroft and Bamford 2008).

The presence of this southern Ctenotus along with the other two species *C. impar* and *C. ora*, both of which have been subject to declines on the coastal plain, makes this assemblage unique and possibly rare. This is despite the fact that both *C. impar* and *C. ora* (assuming all specimens of *C. labillardieri* collected in previous surveys are in fact the recently described *C. ora*) appear to be quite common along sections of the Whicher Scarp itself where suitable habitat remains, with several, sometimes numerous specimens of each species having been caught in previous nearby surveys (Hart et al. 1997, Biota 2007a, Biota 2007b, Biota 2009 and Bancroft and Bamford 2008).

It is possible that this assemblage occurs along the Whicher Scarp to the west and on the northern half of the Naturaliste ridge where the documented distributions of all three species overlap, though a lack of detailed fauna surveys in much of this area makes this difficult to assess.

Occurrence of Short Range Endemic (SRE) Invertebrate Fauna

Short Range Endemic (SRE) fauna (also known as narrow-range taxa) are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that also may be disjunct and highly localised (Harvey 2002; Ponder and Colgan, 2002).

One species of scorpion and three species of mygalomorph spiders were recorded during the field survey. None of these invertebrate species are considered to represent SRE's (Phoenix Environmental Services, 2012).

Biota (2009) conducted invertebrate field surveys nearby at Tutunup and Tutunup South and concluded that it was unlikely that any of the invertebrate taxa encountered would be restricted to the locality of the proposed Yoongarillup Mine due to the absence of geomorphological boundaries or subdivisions that may represent isolating mechanisms for potential SRE invertebrate species. Given the similar habitat types for the proposed Yoongarillup Mine (Jarrah/Marri Woodland on sand and/or laterite) these conclusions may also be applied.

4.12 AGRICULTURAL PRODUCTIVITY

Pre-mining Agricultural Assessments will be undertaken for the lots within the agricultural land of the proposed Yoongarillup Mine. As part of these assessments, soil profiles will be described, existing and historic land uses will be described, an expert subjective assessment of pasture yield will be made and pasture composition is described.

The soils of the Swan Coastal Plain have been formed on geologically recent dune sands of aeolian and alluvial origin. As such, they have low ECEC, clay and silt contents, and have a low base fertility status (Boland, 1998). However, this zone receives average annual rainfall amounts >600 mm per year and has been extensively cleared for agricultural production. The fertility results (Landloch 2014: 0) summarised in Table 4-18, show that apart from available K, were at medium to high levels which most likely reflects the addition of fertilisers as part of standard agricultural practices.

TABLE 4-18: SUMMARY OF FERTILITY RESULTS FOR THE TOPSOIL OF THE YOONGARILLUP MINE

PARAMETER	DEEP PALE SANDS
Total N (mg/kg)	1894-3105
Total P (mg/kg)	287-425
Avail P (mg/kg)	67.7-81.5
Avail K (mg/kg)	89.9-94.2
Organic C (%)	2.77-4.33

Rating	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH

Disturbance of these soils by mining is likely to reduce the nutrient status of the soils, and as such, it is likely that application of amendments will be required during rehabilitation activities to increase the success of pasture establishment.

Doral will implement a pasture productivity monitoring program.

4.13 GEOTECHNICAL STABILITY (SUBSIDENCE)

Doral will undertake subsidence monitoring of backfilled mine pits, utilising both surveyed ground surface markers and visual inspection. The survey method is considered accurate to within 10 mm.

Experience to date from the Dardanup Mine operated by Doral, has identified those deep pits (approximately 10 m) backfilled with clay overburden are subject to 100-200 mm of subsidence in the first year of rehabilitation. Pits backfilled with sand tails or co-disposed sand and clay mixtures have not subsided and maintain their constructed soil levels.

Inspections of rehabilitation areas will be conducted regularly and where localised subsidence occurs corrective measures will be implemented to reinstate the design surface profile (as described in Section 11).

4.14 RADIATION

The generally accepted upper limit value for the 'natural' environmental background gamma radiation level emitted from the earth is roughly 0.45 µGy/h. This will however, vary according to location. Generally the Southwest coastal plain has a range of between 0.1 to 0.3 µGy/h which is similar to the general earth background. These levels shall be maintained throughout post-mining rehabilitation works in comparison with the pre-mining gamma surveys.

Doral will undertake both pre-mining and post-mining ground level (1 m from surface) gamma radiation surveys prior to, and following the completion of mining and rehabilitation. This data is recorded to ensure that post-mining landforms are returned to acceptable background gamma radiation levels and similar to pre-mining levels.

In the case of the return of processing wastes to the mine void (e.g. sand tails, gravel, clay fines), the replacement of overburden and topsoil material should be such that the final background gamma radiation level shall also remain similar or below the pre-mining level. Post mining background surveys may be influenced by the return of materials such as gravel to the near surface, or by the replacement of topsoil and subsoil which was removed from a different area. Should post mining background gamma levels be unacceptable, then post rehabilitation earthworks may be required.

Since the commissioning of the Picton Dry Plant tails co-disposal unit in 2006, the tails from the Picton Dry Plant are returned to the mine as a damp material and blended via a purpose built hopper and injected into the outgoing mine sand tails for burial to the mine void. Controls incorporated into the tails hopper include a limited throughput of 10 tph as well as automatic shutdown if the mine tails output is reduced to ensure that the concentration of the outgoing monazite is conservatively kept below the maximum range of 140-180 ppm thorium (Th) and uranium (U). Monitored outgoing co-disposed tails indicate an average of levels of 85 ppm Th and 7 ppm U (0.43 Bq/g) which is well within acceptable levels.

4.15 HERITAGE

4.15.1 Ethnographic Survey

The survey area is wholly located within the South West Boojarah (SWB) # 2 (WC06/4 NT Claim which is represented by the South West Aboriginal Land and Sea Council (SWALSC).

Ethnosciences (2012: Appendix G) undertook an ethnographic survey within a sub-section of the proposed Yoongarillup Mine that included the State Forest, Haddon West and Haddon East sub-areas. The survey included a desktop investigation, consultation with the SWALSC regarding the survey and the selection of Aboriginal consultants from the SWB claim, interviews and site inspections with the SWB consultants and consultation regarding the results of the archaeological survey.

No other ethnographic Aboriginal sites or 'Other Heritage Places' were identified through desktop searches or by consultation with relevant Native Title groups.

4.15.2 Archaeological Survey

Tempus Archaeology (2012; Appendix G) undertook an archaeological survey within a sub-section of the proposed Yoongarillup Mine that included the State Forest sub-area, Haddon West sub-area and Haddon East sub-area. One minor artefact cluster (designated DYONG-001) and three finds of isolated stone artefacts (designated DYONG-ISO/001, DYONG-ISO/002 and DYONG-ISO/003) were identified and recorded (Figure 4-19).

The newly recorded artefact cluster and isolated finds of stone artefacts have been assessed by Tempus Archaeology (2012) and in their opinion; the finds do not constitute Aboriginal sites under the meaning of Section 5 of the Aboriginal Heritage Act 1972. To confirm this determination, Doral has commenced consultation with the Department of Aboriginal Affairs with regard to presenting the finds to the Aboriginal Cultural Material Committee (ACMC). Should the ACMC determine that the newly recorded Aboriginal cluster and isolated finds identified constitute Aboriginal sites (as defined under the

Aboriginal Heritage Act 1972), and disturbance of the sites cannot be avoided, Doral will seek Section 18 consent from the Minister for Aboriginal Affairs.

4.15.3 European Heritage

A search of the Heritage Western Australia database (2014), Australian Heritage database (2014), National Heritage database (2014) and Commonwealth Heritage database (2014) identified no heritage sites occurring within or near the proposed Yoongarillup Mine.

4.16 CLOSURE DATA GAPS

The following data gaps have been identified:

- An in depth understanding of the unsaturated zone hydrogeology for State forest sub area is required to inform the reconstruction of the soil profile.
- Soil characterisation for State forest sub area to gain a more detailed understanding of the soils for long term storage and use to rehabilitate mine infrastructure at closure;
- Stakeholder / Landowner consultation to develop agreed end land use or rehabilitation expectations which will be required to inform completion criteria for this mine closure plan;
- Characterisation of wastes e.g. tails etc. to ensure that a complete understanding of the potential composition of the reconstructed soil profile and the expected behaviour is understood by Doral prior to the reconstruction of the soil profiles especially in the State forest area.

4.17 FIGURES

The following figures are provided in Appendix A

Figure 4-1 Structural Geology
Figure 4-2 Hydrogeological Cross Sections
Figure 4-3 Water Management Areas
Figure 4-4 Soil Landscape Systems
Figure 4-5 Soil Mapping of the Proposal Area
Figure 4-6 Predicted Drawdown of the Superficial Aquifer
Figure 4-7 Predicted Drawdown of the Mowen Member (Aquitard)
Figure 4-8 Predicted Drawdown of the Vasse Member (Leederville Aquifer) From Production Bores
Figure 4-9 Vegetation Complexes
Figure 4-10 Vegetation Communities
Figure 4-11 Quadrat Locations
Figure 4-12 Vegetation Condition
Figure 4-13 Priority Ecological Communities
Figure 4-14 Locations of Threatened and Priority Flora
Figure 4-15 Conservation Significant Flora
Figure 4-16 Locations of Declared Plants
Figure 4-17 Fauna Habitats
Figure 4-18 Black Cockatoo Potential Breeding Trees
Figure 4-19 Location of Archaeological Finds

5 STAKEHOLDERS CONSULTATION

5.1 CONSULTATION OVERVIEW

Over the life of the project Doral will undertake a range of consultation exercises which will be both formal and informal discussions between a range of stakeholders and Doral.

Doral has identified the following key stakeholders that will be consulted regarding closure of the Yoongarillup Mine:

- EPA;
- DMP;
- DPaW (responsible for State Forest 33);
- City of Busselton;
- Main Roads WA (owner of Sues Road);
- Private landowners.

To date no land use agreements have been finalised. In-principle agreements have been obtained and formal agreements will be established in the near future. Doral have advised landholders affected by the mining operations that disturbed lands will be returned to the pre-mining land use. Doral will, where possible, accommodate landholder requests to change the final land use (e.g. establish additional water dams). Any changes to final land use will require approval from relevant regulatory bodies.

As part of ongoing discussions and negotiations regarding land access agreements for the forest sub area and the agricultural land, closure and rehabilitation practices and issues, including post-mining land use options, will be discussed.

The final land access agreements will formally document the agreed post-mining land use.

Doral will liaise with landowners in its immediate area of operation on a regular basis. These discussions will primarily be managed by the Mine Manager and typically involve discussions of how the daily mining operation may or could be impacting on individual landowners. A spreadsheet will be kept of these discussions to ensure any commitments made are honoured and this is stored in Doral's Environmental Management System. Specific commitments made to landowners that are relevant to closure will be documented within Table 3-6.

Stakeholder consultation undertaken to date is documented in Table 5-1.

To date issues surrounding mine closure have not been addressed but when addressed the stakeholder consultation table will be updated.

TABLE 5-1: STAKEHOLDER CONSULTATION

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
Office of the Environmental Protection Authority (OEPA) • P Tapsell • M Jeffries	21 Sep 2011	Project Briefing	Flora and vegetation survey to be undertaken as per EPA Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a). OEPA requested that that the Yoongarillup Project be referred under section 38 of the EP Act as a single Proposal, rather than separate areas (i.e. State Forest and paddock areas).	Flora and vegetation survey conducted by Mattiske (2012a) was undertaken in accordance with EPA (2004a). Proposal for the Yoongarillup Minerals Sands Project was referred under section 38 the EP Act on 22 March 2012 as a single Proposal.
	16 Mar 2012	Project Update	Doral were requested to submit a referral under section 38 of the EP Act by 22 March 2012 containing all available critical information (current at the time) to assist the OEPA in determining the level of assessment. Formal level of assessment was to be provided by the OEPA following the assessment of critical information (particularly flora and vegetation, dieback, and fauna).	Timelines agreed. Doral submitted referral on 22 March 2012.
	15 May 2012	Discussion of floristic issues related to the Yoongarillup referral	The importance of the Floristic Community Type (FCT) C1: Central Whicher Scarp Jarrah woodlands was discussed with Doral in relation to the percentage that occurred within the Proposal. Proposed National Park issue would not affect the Proposal. Dieback mapping issues discussed and OEPA requested a groundwater runoff map to be supplied. OEPA agreed Doral would receive an indication of the level of assessment by end of May.	The importance of FCT C1 was noted and all efforts to reduce the disturbance area within the State Forest were made. The Proposal was not located in an area identified as a Proposed National Park in the current Forest Management Plan 2014-2023. Doral engaged Moore Mapping (2012) to conduct further dieback mapping within the State Forest. Groundwater runoff map supplied to

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
				OEPA 17 May 2012. A PER level of assessment was set by the EPA on 27 August 2012, with a four week public review period (Assessment No. 1938).
Office of the Environmental Protection Authority (OEPA) • P Tapsell • K Taylor	26 Jul 2012	Meeting to outline OEPA recommendations to the EPA	The OEPA advised Doral that they will be recommending the Proposal be assessed as a streamlined PER with a 4 week public response period. The OEPA advised Doral that offsets will be critical to the approval process. Due to the need to provide offsets to satisfy the EPA and DoE, PER considered most timely assessment level. OEPA indicated that they did not believe a further flora and vegetation survey was required. EPA would consider recommendation on 2 August 2012	A PER level of assessment was set by the EPA on 27 August 2012, with a four week public review period (Assessment No. 1938). Discussions with DPaW regarding a suitable offset via land acquisition has commenced.
Department of Minerals and Petroleum (DMP) • E Bouwhuis • T Sudovic	21 Jul 2011	Project Briefing	DMP advised Doral that they will be required to prepare a Mining Proposal in accordance with DMP guidelines.	Noted
Department of Parks and Wildlife (DPaW) • C Bishop • K Williams • A Webb	15 Apr 2011	Project Briefing	DPaW advised Doral that the fauna survey should focus on Black-Cockatoo breeding sites, nesting hollows and ringtail possums. DPaW advised Doral that flora and vegetation surveys should identify Mountain Marri and Whicher Scarp FCT's within the state forest area of the proposal.	Doral provided DPaW's advice to the relevant consultant (Mattiske, 2012a, Ecoedge Environmental, 2014 and Harewood, 2014).

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
			DPaW advised that there is a requirement for a Conservation Management Plan (CMP) to be submitted to DPaW prior to submitting a Program of Works (POW) to the DMP for the exploration drilling within the State Forest.	Doral prepared and submitted a Draft CMP on 2 March 2012.
	1 Mar 2012	Pre-submission scoping meeting for Conservation Management Plan (CMP) for exploratory drilling	Doral to submit CMP to support the POW. Doral committed to undertaking targeted surveys of all drill lines for Threatened flora as detailed in the CMP. Doral to supply DPaW with results of the flora and vegetation survey (Mattiske, 2012a) for immediate review.	Doral submitted a Draft CMP on 2 March 2012. Doral supplied DPaW with relevant flora and vegetation surveys.
	26 Mar 2012	Update on CMP Progress and EPA Referral	Doral advised DPaW that a dieback assessment was to be undertaken on 27 March 2012. Doral to provide DPaW with the outcome of the targeted drill line survey and EPA referral when available.	Dieback assessment not available until the end of April 2012. Revised CMP will be provided to DPaW (communicated on the 12 April 2012).
Department of Parks and Wildlife (DPaW) • A Errington	31 Oct 2013	Offsets – land acquisition	Doral discussed acquiring a suitable piece of land as a direct offset for the residual impacts of the Proposal to meet the State and Commonwealth offset policies with DPaW. DPaW advised Doral that potential offset land was currently available. DPaW discussed the expectations and processes involved in acquiring land. DPaW advised Doral how other proponents have included land acquisition in their environmental approval documentation (i.e. PER) and what should be included in	Discussion with DPaW ongoing.

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
			the Yoongarillup Proposal (on-going consultation with DPaW) Doral advised DPaW that they cannot commit to providing funds to DPaW to acquire a suitable piece of land until the Proposal received conditional approval.	
Department of Parks and Wildlife (DPaW) • N Woolfrey • A Errington • D Coffey Office of the Environmental Protection Authority (OEPA) • T Gentle	2 May 2014	Offsets – land acquisition	Doral reiterated its commitment to acquiring suitable parcel(s) of land to use as direct offsets for the residual impacts of the Proposal, as required by the State and Commonwealth offset policies. DPAW acknowledged Doral's position of not being able to purchase specific land packages for the purpose of offsets until EPA approval had been obtained for the Proposal. EPA advised that the offset package will need to meet the requirements of the Commonwealth Offset Policy (including the "Commonwealth Offsets Calculator") and the EPA Offset Policy. DPAW acknowledged the amount of privately held native vegetation available on the Whicher Scarp for purchase was limited. Doral advised that they had a number of possible sites they were investigating, however further investigation, discussions with DPAW, DER and EPA, and landholders were required prior to finalising an offset package for the project.	Doral will continue to have on-going discussions with DPAW, the EPA and DER. Doral will undertake additional investigative studies on the sites that they have identified as potential offset sites. The information collected from these studies will be included in the final offset package submitted to the regulatory bodies for review and consideration.
Department of Environment Regulation (DER) • S Wong	16 May 2011	Proposed Acid Sulfate Soil Assessment	DER provided the following items that needed to be included in the Acid Sulfate Soil assessment: • Use a 0.005 detection limit for inorganic sulfur. • Undertake appropriate soil classification work when describing each of the soil profiles that occur onsite.	Information provided to Soil Water Consultants who are undertaking the ASS assessment.

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
			• Test the groundwater which collects in each of the bore holes for pH and electrical conductivity (EC). • Include an extra line of monitoring bores to the west of the proposed Haddon Pit to account for the potential dewatering zone. • Correctly log and conduct acid sulfate soil assessment for the bore holes which will be used as long term environmental monitoring bores.	
Department of Water (DoW) • R Watson	18 May 2011	Project Briefing	DoW advised Doral that the Yarragadee aquifer is fully allocated. Doral advised to procure water from businesses/ private allocation holders if possible. Doral advised DoW that approximately 1.5GL of water is required for the Proposal. If Doral are unable to procure a water allocation, a short term allocation can be requested. Once allocation has been traded Doral will still need to apply for a licence to take water.	Doral has contacted Iluka Resources Ltd and Cristal Mining Australia Ltd in an attempt to purchase/lease some unused portions of their water allocations. Doral unsuccessfully tendered on the Challenge Dairy water allocation.
	11 Dec 2013	Project Update	Project update was provided to DoW and new project manager introduced. The requirement of 1.6 GL/year for the proposal was confirmed with DoW. Doral had been unsuccessful in obtaining an existing allocation to date (through lease/purchase) but efforts were still being made in this area. Alternative allocations were discussed, including applying to access the "reserve" allocation as the Proposal is of a short term nature.	An application to abstract water from the Yarragadee aquifer has been applied for. Doral will continue to seek water allocation via purchase/lease from existing allocations.

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
	21 Jan 2014	Water Allocations	Email discussion seeking advice on process for submitting a 5C licence to take water. Advice was provided that application could be submitted, but would not be approved until all approvals for the Proposal were obtained.	Doral has submitted an application for a 5C licence to take groundwater.
Main Roads WA • P Bromley • P Davies • L Palandri	18 Dec 2013	Project Briefing Sues Road	Provided overview of the Proposal and discussed that a portion of the mineral reserve is located under Sues Road. Doral discussed the proposed road re-alignment of Sues Road and requested in-principle consent to mine Sues Road should the road re-alignment meet Main Roads requirements.	Doral are continuing discussions with Main Roads WA to finalise the re-alignment requirements. Main Roads provided in-principle consent to mine and temporarily re-align Sues Road.
Forest Products Commission • S Sawyer • T Sawyer • J Mak	23 Dec 2013	Project Briefing	Provided overview of the proposal. The Forest Products Commission manages a pine plantation east of Sues Road (south of the Proposal). Forest Products Commission advised that this plantation was to be thinned in 2014, and possibly again 5 years later. Concern was raised as to minesite dewatering operations and the stress this may place on the plantation. Forest Products Commission requested that Doral advise them when the PER was released for public comment.	Doral advised Forest products Commission that a detailed groundwater model (PB, 2014a) indicated that no drawdown outside of the mine pits will occur. And that this groundwater modelling would be available as part of the PER. Doral noted.
Landowner Lots 1872, 1873 and 1874 • N and E Haddon	9 Mar 2011	Project Briefing	Doral advised the Haddon's of upcoming drilling program. Discussions were held on what the mining operation may look like if the Project went ahead. The Haddon's advised that parts of adjoining State Forest have been cleared previously and in places has had sand and gravel excavated.	Regular update meetings and minutes provided to the Haddon's. As much timing information as possible supplied to minimise impact on farming operations. Paddock access requirements under

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
				development.
	23 Mar 2011	Project Update Exploratory Drilling Agreement	Doral discussed water sources for mining operations. Section 29 consent provided for exploratory drilling. The Haddon's requested as much timing information as possible be supplied to minimise impact on farming operations.	Meeting minutes forwarded to the Haddon's. Section 29 consent for exploratory drilling provided 23 March 2011.
	23 Jan 2012	Project Updates	Discussion of proposed compensation arrangements Timing impacts discussed – herding/cropping. Requirements for paddock access agreed – closing gates/ double gee inspection in areas. Changes to project staffing discussed as it occurred	Meeting minutes forwarded to the Haddon's.
	6 Aug 2012	Project Update	Doral provided advice that the Proposal was likely to be formally assessed as a PER by the OEPA which would delay the timing of implementing the Proposal. Doral discussed possible road relocation (Sues Road) to facilitate mining of existing road reserve, power supply for minesite, and engagement of consultant to undertake pasture monitoring and compensation arrangements. Doral discussed water requirements and protection of dam located east of Sues Rd (not located within Development Envelopment) Requested approval to undertake soil analysis in paddocks both sides of Sues Road to gain understanding of soil	Doral would continue liaising with the Haddon's and providing them with project updates.

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
			profile in pasture areas.	
	14 Feb 2013	Project Update	Discussion of proposed compensation arrangements. The Haddon's requested data on groundwater modelling.	Noted – Report to be forwarded when available.
	28 Feb 2013	Technical Studies	New Doral project staff introduced. Doral provided overview of the technical studies required to be undertaken to support the PER (noise, dust monitoring, flora and vegetation, fauna, hydrology, archaeology etc.).	Minutes of meeting forwarded to the Haddon's.
	28 Mar 2013	Discussed Upcoming Drilling Program	Section 29 consent provided for exploratory drilling.	Section 29 consent for exploratory drilling signed 4 April 2013.
	25 Oct 2013	Project Update	Advised that Doral had received board approval for the project. Advised that Doral were currently preparing the PER. Provided an update on the proposed project timing.	Minutes of meeting forwarded to the Haddon's.
	19 Dec 2013	Project Update	A Project Status update was provided.	Minutes of meeting forwarded to the Haddon's.
Landowner Lot 1870 • J and S Mildwaters	9 Mar 2011	Project Briefing	Susan Mildwaters attended the meeting with the Haddon's. The upcoming drilling program was discussed and information was provided on what the minesite operations may look like should the Proposal be implemented.	Regular update meetings and minutes to be provided. Susan Mildwaters provided advice to Doral that project update information and meeting minutes were able to be passed on to her via her parents, Neville

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
				and Elaine Haddon.
	23 Mar 2011	Project Update Upcoming Drilling Program	Doral discussed water sources for mining operations. Section 29 consent provided for exploratory drilling.	Section 29 consent for exploratory drilling signed 25 March 2011.
	29 Jan 2014	Phone Discussion to provide Project Update	Introduced new project staff. Discussed project status and PER process.	Provided minutes from previous meeting with the Haddon's.
Landowner Lots 101 and 102 • B and F Piggott	17 Mar 2011	Project Briefing	Doral provided advice of upcoming drilling program. Discussions were held on what any future mining operation may look like.	Section 29 consent for exploratory drilling signed 24 March 2011.
	10 Sep 2012	Project Update	Doral representatives provided update on Proposal. The Piggott's advised that they would prefer that Goulden Rd would not be used as a mine access road. Discussed environmental/technical studies that were required for the PER.	Minutes of meeting forwarded to the Piggott's. Doral advised that there is no current plan to utilise Goulden Road for this purpose.
	28 Mar 2013	Exploratory Drilling	Meeting to discuss upcoming drilling program. Section 29 consent provided for exploratory drilling. The Piggott's requested that survey stakes are removed after drilling. Requested information on drill hole water levels.	Section 29 consent for exploratory drilling signed 29 March 2013.

STAKEHOLDER	DATE	TOPIC	DISCUSSION POINTS/ISSUES RAISED	RESPONSE
	19 Dec 2013	Project Update	A Project Status update was provided.	Minutes of meeting forwarded to Piggott's.
Landowners Lot 1869 • E and S Chidgey • J and J George	28 Mar 2012	Project Briefing	Doral representatives provided a brief overview of the Proposal. Concern was shown by the landholders with regard to mining operations generating noise and dust. Concern was also expressed as to the potential impacts on their water supply, which was sourced from rainwater and groundwater and that mining operations would impact the groundwater table.	Doral noted concerns and advised that noise modelling would be undertaken as part of the environmental approval process.
	24 Apr 2013	Project Update	Doral representatives provided a Project Status update. Concern was again raised about noise and dust and the impact of the mining operations on their water supply. Doral advised landowner of PER process which would provide an opportunity for them to comment on the Proposal. Discussed upcoming exploratory drilling programs.	Committed to providing advice to landholders when the PER is released for public comment. Section 29 consent for exploratory drilling signed 16 May 2013.

This page left blank intentionally.

6 POST MINING LAND USE AND CLOSURE OBJECTIVES

6.1 POST-MINING LAND USE OBJECTIVES

The proposed Yoongarillup Mine is classified into three post-mining land uses, with specific objectives for each land use. The planned post-mining land use and their relevant objectives are described in the following sections.

6.1.1 Land Use: Agriculture

Post mining land use objective: To return the land to a condition capable of supporting diary and/or beef production with pasture production rates equivalent to or better than pre-mining production rates.

Within this land use type there is one primary sub-type for which specific rehabilitation parameters are customised – dryland pasture on Whicher Scarp landform. There may be scope, subject to landholder agreement, to establish native vegetation corridors/belts within the agricultural areas.

6.1.2 Land Use: Rehabilitated Native Vegetation

Post mining land use objective: To rehabilitate areas of environmental significance such that their environmental values are restored.

Areas of environmental significance - State Forest sub-area

6.1.3 Land use: Road and Road Reserve

Post mining land use objectives:

Primary: To re-establish roads to engineering and construction standards acceptable to Main Roads WA (Sues Road) and the City of Busselton (Goulden Road).

Secondary: To improve the quality of native vegetation in road reserves such that improved conservation outcomes are achieved through the connection of areas of remnant vegetation (i.e. wildlife corridors).

6.2 CLOSURE OBJECTIVES

The following closure objectives have been developed for the proposed Yoongarillup Mine. Many of these apply across the site, where the objective is different for different land uses this is identified.

6.2.1 Compliance

All legal and stakeholder obligations relevant to closure and completion of the site are met.

6.2.2 Landforms

Final landforms are returned to topography similar to pre-mining level and meeting landowner specifications.

Final landforms can support the designated post-mining land use, specifically:

- Agriculture land use: Top 1 m of soil profiles are consistent with pre-mining soil profiles and where different enable improved agricultural productivity (e.g. covering of rocky laterite surface with soil);
- Native vegetation land use: Created soil profiles and landforms are able to support native vegetation;

- Road Reserve land use: Backfilled mine pits do not subside over time and can support road construction.

Soils and landforms exhibit erosion rates consistent with surrounding areas and do not compromise post-mining land uses.

6.2.3 Radiation

Surface level radiation levels are similar or less than pre-mining levels.

6.2.4 Water

Surface and groundwater levels and quality are consistent with surrounding areas.

Surface and groundwater flows are consistent with surrounding areas.

6.2.5 Infrastructure

All mining equipment and structures are removed from site.

Waste generated during deconstruction is managed in a manner consistent with waste minimisation principles.

Re-established infrastructure is installed to standards accepted by key stakeholders.

7 IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

7.1 PROCESS FOR IDENTIFYING CLOSURE ISSUES AND MANAGEMENT RESPONSES

Consistent with Doral's Environmental Management System (EMS) a risk assessment has been undertaken to identify, assess and develop management responses for closure risk issues. The scope of this risk assessment has been to consider all aspects that affect effective closure and is not restricted to an assessment of environmental impacts.

The likelihood and consequence of each potential closure risk issue were categorised in accordance with Table 7-1 and Table 7-2.

A 5 x 5 risk assessment matrix (

Table 7-3) was then used to assess the overall risk associated with each potential risk issue. Once an initial risk ranking was documented additional control measures were identified (i.e. risks are treated) and the risk was then re-ranked to establish a target risk ranking. Management responses to target risk rankings are described in

Table 7-4.

The results of the risk assessment are presented in Appendix H and the issues and management responses identified are described Section 7.2.

TABLE 7-1: RISK ASSESSMENT LIKELIHOOD CRITERIA

DESCRIPTION	FREQUENCY	CRITERIA
Rare	Less once per five years	The environmental event may occur only in exceptional circumstances Practically impossible
Unlikely	Less than once per two years	The environmental event could occur at sometime Not expected to occur under normal circumstances
Possible	More than every two years	The environmental event should occur at some time Should occur under normal circumstances
Likely	More than once per year	The environmental event will probably occur in most circumstances Probably will occur under normal circumstances
Almost certain	More than once per month	It is expected to occur in most circumstances Common repeating occurrence

TABLE 7-2: RISK ASSESSMENT CONSEQUENCE CRITERIA

CONSEQUENCE	LEGAL AND REGULATORY	PUBLIC AND STAKEHOLDER RELATIONS	ASSET LOSS / COST	ENVIRONMENT
Insignificant	Insignificant regulatory penalty	Incidental environmental nuisance.	Low financial loss (<$2,000)	Possible incidental impacts to flora & flora in a locally affected environmental setting, no ecological consequences.

CONSEQUENCE	LEGAL AND REGULATORY	PUBLIC AND STAKEHOLDER RELATIONS	ASSET LOSS / COST	ENVIRONMENT
Minor	Minor regulatory penalty	Minor environmental nuisance to community.	Medium financial loss ($2,000-$20,000)	Reduction in abundance/biomass of flora/fauna in affected setting. No change to biodiversity or exposed ecosystem.
Moderate	Average regulatory penalty	Major environmental nuisance to affected community. Small scale media attention.	High financial loss ($20,000-$50,000)	Partial loss of ecosystem function in affected setting. Intervention required for recovery.
Major	Above average regulatory penalty	Regional media attention. Community relations impacts. Short term share price effects.	Major financial loss ($50,000-$500,000)	Substantial reduction of abundance/biomass in affected setting. Significant impact to biodiversity and ecological function, and requires intervention to recover. Can be ameliorated over medium to long term.
Catastrophic	Maximum regulatory penalty	National media attention. Long term community relations impacts. Major share price effects.	Huge financial loss (>$500,000)	Loss of biodiversity on a regional scale. Total loss of ecological function in affected setting with little prospect of recovery to pre-impact conditions. Requires massive intervention over long period of time.

TABLE 7-3: RISK ASSESSMENT RATING MATRIX

CONSEQUENCE	LIKELIHOOD				
	Rare	Unlikely	Moderate	Likely	Almost Certain
Catastrophic	H	H	E	E	E
Major	M	H	H	E	E
Moderate	L	M	H	E	E
Minor	L	L	M	H	E
Negligible	L	L	M	H	H

TABLE 7-4: RISK ASSESSMENT MANAGEMENT DESCRIPTION

SCORE	MANAGEMENT OF RISK
Extreme	Unacceptable risk, immediate action is required, with senior management intervention.
High	Approved action plan is required to reduce risks. Senior management attention is required.
Medium	Specific management with internal audit and review. Management responsibility must be specified.
Low	Management through routine procedures.

7.2 MANAGEMENT OF CLOSURE ISSUES

7.2.1 Compliance with Obligations and Requirements

Failure to understand and meet the relevant legal requirements and obligations to key stakeholders could result in significant cost impacts to Doral through rework and/or delays to completion and relinquishment. Section 3 of this document identifies all closure obligations and includes a reference to how obligations will be met.

7.2.2 Geotechnical Stability

Backfilled mine pits experience subsidence during the first couple of years of rehabilitation (see Section 4.13). This poses a risk to built structures if they are unknowingly built partially on consolidated unmined land and partially on backfilled mine pits which are still undergoing consolidation.

This risk is most significant for road infrastructure which will be constructed on back filled mine voids. This risk will be controlled through the application of civil engineering specifications and standards, including geotechnical compaction and stability testing, engineering supervision of the backfilling and compaction testing and process and use of tailings sand as the backfill material (rather than overburden or any other clay material which has a higher potential to subside).

Doral undertakes subsidence monitoring to identify and remedy areas of subsidence for at least three years prior hand back of the land. Where subsidence occurs it is remedied by:

- Pushing the topsoil to one side;
- Adding additional subsoil material to fill the subsidence void;
- Return of the topsoil.

Doral maintains a record of what type of material (i.e. overburden, sand tails, dry slime or co-disposed tailings) is used to backfill each mine pit block (refer to Table 4-5).

7.2.3 Land use

It is critical that Doral both understands the land use requirements that key stakeholders have for the site post-mining and can deliver on its commitments to deliver those agreed requirements.

Post-mining land uses will be discussed and agreed with landowners prior to entering agreements to access the land for mining and documented within the landowner agreements. Post-mining land uses will also be described and included within the mining proposal which will be submitted to DMP.

This MCP describes how Doral will meet the required outcomes for rehabilitation and closure commitments.

7.2.4 Landforms

Post-mining landforms are designed to be capable of supporting the agreed post-mining land use(s) as described below.

7.2.5 Agriculture

Unless otherwise agreed with landowners post-mining land surfaces will be returned to near pre-mining surface elevations.

Prior to stripping topsoil and subsoil, the soil profile is described within each specific mining block and recorded on a data sheet as shown in Appendix I.

The soil profile will be designed to recreate the pre-mining soil profile conditions. This design has been based on recommendations from pre-mining agricultural assessments and mineral sands industry knowledge and practice on the Swan Coastal Plain.

For the disturbed areas, mining infrastructure is removed, required agricultural infrastructure is reinstated (e.g. fences, water pipes) and topsoil is returned. Where the subsoils have been observed to be heavily compacted, these are ripped to approximately 300 mm in depth prior to topsoil being returned.

On the upland soils, which is primarily the area disturbed by SEPs which have been created by cut and fill of in situ soil materials, the dry clay is removed and the pond walls pushed back to create a surface level similar to pre-mining levels. There are areas where extra sand and/or clay material is present and these will be pushed to form slope angles and surface levels consistent with the surrounding areas.

In consultation with the landowner, the PWP will be dredged to remove clay fines material and will be profiled as agricultural dams in the finished landform. Soil surfaces are reshaped such that the slopes leading into the final dam landforms are consistent with natural landform slopes in the surrounding area. Alternatively the PWP will be backfilled and reinstated to pasture. Other agricultural dams will be replaced as they were prior to mining unless otherwise requested by the landowner.

State Forest Land

Doral understands that the critical stage in re-establishing a sustainable forest ecosystem is the reconstruction of soil profiles that are suitable to support the rehabilitated ecosystem in the long term. Therefore a comprehensive understanding of the undisturbed soil profile and characteristics is vital to the reconstruction of a ‘natural type’ soil profile that provides suitable rooting medium for the rehabilitated vegetation.

Roads

Within road reserves the final land surface is created to meet the engineered road and drainage design and to meet the City of Busselton and Main Roads WA road design and construction standards. Fill of mine voids in these areas is managed as described within Section 7.2.2 on geotechnical subsidence.

7.2.6 Weeds

Failure to identify, monitor and control weeds could have two adverse outcomes. Competition from weeds could result in revegetation failure (either native or agricultural). Failure to control declared plants (e.g. Arum Lily (*Zantedeschia aethiopica*), Apple of Sodom (*Solanum linnaeanum*), Cotton Bush (*Gomphocarpus fruticosus*)) could result in legislative prosecution, or more significantly local community reputational impact.

Doral maintains, educates and empowers its workforce to identify and physically remove declared plants found on the minesite. Weed control programs (implemented by professional weed control contractors) will be implemented on an as needed seasonal basis in conservation areas and areas of native rehabilitation. Pre-mining inspections are used to identify weed infestations in topsoil prior to stripping and if present infested topsoil is stockpiled and managed separately to non-infested topsoil.

7.2.7 Agricultural Productivity

Doral will enter into agreements with the landowners to rehabilitate disturbed land to agricultural productivity levels equal to or better than pre-mining levels. This is common practice in the mineral sands industry on the Swan Coastal Plain. Failure to deliver on this commitment could significantly affect Doral's ability to gain access for future deposits and/or result in significant costs associated with not being able to relinquish mining tenements. It may also impact the future productivity and sale of private land following cessation of mining.

Based on the pre-mining agricultural assessments undertaken there will be an opportunity to improve the soil profiles in some areas, by adding clay to the upper soil profile and improving the hydrophobic nature of the pre-mining soils.

The process for establishing soil profiles in mine voids, as described in Section 10.5, is designed to mitigate this risk. The key activities taken to mitigate this risk are:

- Topsoil and subsoils are stripped, stockpiled separately and utilised in rehabilitation;
- Soil profiles to at least one metre depth are created in mining voids as described inSection 10.5.

Pasture productivity will be measured pre-mining, in analogous areas and on rehabilitated sites.

7.2.8 Erosion

Inspections and subsequent correct actions will be undertaken to control erosion within rehabilitated areas to ensure minor erosion does not escalate to create significant damage to the landform. This will include, where required:

- Contour banking;
- Riptrap or rock protection in areas prone to erosion;
- Establishment of vegetation prior to winter flood events.

7.2.9 Groundwater

The nature of the materials backfilled into mining pits is described within Section 4.7.6 with the site consisting of a mosaic of sand, clay and co-disposed backfill materials.

When the mine pits are backfilled the same aquifer conditions are not necessarily returned. There is the potential that a section of the pit is backfilled with overburden (sandy clay) and clay fines and that no aquifer is returned (i.e. no sandy highly permeable material is returned). This has the potential to act as

a below ground dam with groundwater backing up behind the backfilled pit and with reduced recharge of the superficial aquifer.

Backfilling of mine pits may result in localised changes to the groundwater regime, however PB (2014a) predicts a 90% recovery of the groundwater table within 36 months of mine closure. No long-term (i.e. > 5 years) effects to the groundwater regime are expected.

Doral will undertake monitoring and investigation to understand any potential impacts to groundwater when the mine pits are backfilled.

7.2.10 Contaminated Sites

Doral have identified that the fuel storage areas present a risk that could result in some level of hydrocarbon (diesel) soil contamination around and underneath them. Controls will be put in place to minimise this risk including sealing floors of machinery workshop areas and bunding fuel storage areas in accordance with applicable Australian standards. A site contamination assessment will be implemented prior to closure so that the nature and extent of any contamination issues are understood and corrected during closure.

7.2.11 Decommissioning

Mining and processing infrastructure is required to be removed following completion of mining. Most of the infrastructure will be sold on site and removed for subsequent use (most likely at another mining operation), recycled, or disposed of at a licenced waste management facility.

Tasks required for decommissioning include but are not limited to:

- Disconnection, loading and removal of poly pipe;
- Dismantling and removal of overhead power lines installed within the mine (excluding Western Power assets);
- Dismantling concentrator, thickener, workshops, offices and associated footings;
- Dismantle and removal of field pumps and motor control centres;
- Dismantling feed preparation plant, workshops and associated infrastructure;
- Removal of hardstand areas;
- Excavation and removal of SEP weir boxes.

The following infrastructure will remain on site subject to regulatory approvals and landowner requirements:

- Three phase overhead power lines (owned by Western Power);
- Groundwater production bores;
- Farm buildings and sheds (e.g. current mine administration office);
- Internal access roads;
- Pre-existing farm sheds.

Road base and concrete footings from infrastructure will be disposed of onsite and will be covered with a minimum three metres of soil material.

7.2.12 Infrastructure reinstatement

Doral has requirements to reinstate the following infrastructure at closure, all of which has been costed within the cost estimate:

- Re-establishment of Sues Road along its original alignment;
- Re-establishment of the disturbed section of Goulden Road;
- Re-establishment of all cadastral boundaries by licensed surveying consultants.

7.2.13 Closure Provisioning

Doral recognises the risks to its reputation, the ability to continue operations and to secure access to future deposits that inadequate funding of closure activities may result in. To ensure that enough financial provision is provided for closure activities, Doral reviews and updates closure provision annually as part of the budget cycle. This allows for experience and learnings gained in progressive rehabilitation to be included within the provisioning process.

Doral's process for closure provisioning is described in Section 9.1.

7.2.14 Scheduling

Doral has a plan for completing decommissioning and rehabilitation activities at the proposed Yoongarillup Mine within approximately three years of cessation of mining. Delays in implementation of these activities pose the threat of escalating closure costs and deteriorating Doral's reputation within the local communities.

The closure implementation schedule is described within Section 10 and is reviewed and updated on an annual basis in alignment with the annual budgeting cycle.

This page left blank intentionally.

8 DEVELOPMENT OF COMPLETION CRITERIA

8.1 COMPLETION CRITERIA

Completion criteria have been developed for the Yoongarillup Mine as presented in Table 8-1.

TABLE 8-1: COMPLETION CRITERIA

CLOSURE OBJECTIVES	INDICATIVE COMPLETION CRITERIA	COMPLETION CRITERIA	MEASUREMENT TOOLS
Compliance			
All legal and stakeholder obligations relevant to closure and completion of the site are met	Completed checklist and evidence demonstrating compliance with all legal and stakeholder obligations	100% compliance with all legal and stakeholder obligations	Obligations Checklist Written landowner acceptance of rehabilitation outcome.
Safety and Public Health			
To leave the site in a condition where the risk of adverse effects to people, livestock and other fauna, and the environment in general, has been reduced to a level acceptable to all stakeholders.	Artificial barriers and sign are removed All excavations and voids are back filled to provide a safe and stable landform. All drill holes and bores are securely capped, filled or otherwise made safe Construction materials shall be is removed from the site or where approved to do so, material (e.g. concrete footings) shall be buried deep enough to eliminate risk of exposure.	All safety hazards are removed and all areas are safe for public access.	Visual Inspection
Landforms			
Final landforms are returned to topography as close as possible to pre-mining levels or to meet landowner specifications.	The post mining profile is integrated into the surrounding undisturbed landscape No slopes greater than 1:5 will remain unless required by landowner	Final topography is constructed.	Physical survey Landowner acceptance
Final landform can support agricultural post-	Agriculture land use: Top one metre of soil profiles	The measured agricultural productivity of each lot is	Pasture productivity measurement

CLOSURE OBJECTIVES	INDICATIVE COMPLETION CRITERIA	COMPLETION CRITERIA	MEASUREMENT TOOLS
mining land use	are consistent with pre-mining soil profiles and where different enable improved agricultural productivity.	equal to or more than either it's pre-mining yield assessment or an equivalent surrounding landform type. No subsidence maintenance required after 4 years.	Visual inspection
Final landform can support rehabilitated native vegetation land use	Created landforms are able to support native vegetation	No subsidence maintenance required after 4 years	Visual inspection and survey of topography.
Final landform can support Road and Road Reserve land use	Backfilled mine pits do not materially subside over time and can support road construction	Main Roads WA and City of Busselton sign off that Geotechnical and Engineering standards have been met.	Road construction technical reports and Main Roads WA and City of Busselton acceptance of compliance with standards.
Soils and landforms exhibit erosion rates consistent with surrounding areas and do not compromise post-mining land uses.	The ongoing management required to maintain the landform is no greater than would be required for similar properties in the area	There will be no active erosion rills greater than 10 m X 0.1 m	Visual inspection and photo monitoring
Native Vegetation (State Forest Sub-area)			
Soil properties are suitable to support the target ecosystem	Soil physical, chemical and biological characteristics will be consistent with those of the target landscape. Soil to the depth of reconstruction have similar pH and salinity as soils from the target ecosystem	Soil physical, chemical and biological specifications are still to be determined when baseline soil assessment for this area is completed.	Soil analysis using accredited laboratory, Field measurements
Vegetation in rehabilitated areas will have equivalent values as surrounding natural systems	Vegetation composition on the rehabilitated area is representative of the target ecosystem in species diversity and vegetation structure	Attainment of agreed species of ecosystem diversity targets The mean stem count of native species of at least 1200 stems per ha. Species richness is greater	Quantitative vegetation monitoring using recognised standard techniques acceptable to EPA and DMP. Quarterly monitoring of

CLOSURE OBJECTIVES	INDICATIVE COMPLETION CRITERIA	COMPLETION CRITERIA	MEASUREMENT TOOLS
		than 70% of the mean value recorded in all 20 m X 20 m reference plots in analogue sites in the target ecosystem. All species present in baseline environmental studies are present in rehabilitation area	permanent quadrats and photo monitoring points. Audit of rehabilitation records for sources of plant materials used in rehabilitation.
	Understand the recovery trends of the specific plant communities of the rehabilitated area	Defined relative cover is 60% of area rehabilitated.	
	Plants used in rehabilitation to be of local provenance	All plant material used in rehabilitation sourced from within 10 km of the area rehabilitated.	Visual inspection
	No new weeds to be introduced into the area	No evidence of weed species, including both declared agricultural weeds and environmental weeds	
	Rehabilitated areas have the potential to regenerate after fire	The rehabilitated area is capable of recovering after fire	
The rehabilitated ecosystem has equivalent functions and resilience as target ecosystem	The capacity to retain water and nutrient resources is equivalent to target ecosystem	Infiltration Index is within the range of values from analogue sites in target ecosystem Nutrient Cycling Index is within the range of values from analogue sites in the target ecosystem	Ecosystem Function Analysis (EFA) Infiltration Index EFA Nutrient Cycling Index
Dominant Plant Species and Plant Strata		Restore vegetation structural complexity 10 years post-mining.	Flora and vegetation survey
Pests and Diseases			
Dieback		Dieback has not infested previously uninfested areas	Dieback mapping
Radiation			

CLOSURE OBJECTIVES	INDICATIVE COMPLETION CRITERIA	COMPLETION CRITERIA	MEASUREMENT TOOLS
Surface level radiation levels are within acceptable standards.	Post mining radiation levels vary little from the baseline conditions	Soil surface gamma radiation levels are accepted by the DMP.	Post-mining surface gamma radiation measurement.
Water			
Ensure that groundwater recovers from drawdown.	Groundwater will recover to 90% of pre mining levels within 3 years.	Groundwater will recover to 100% of pre mining levels within 5 years.	Ensure that groundwater recovers from drawdown.
Surface and groundwater levels and quality are consistent with surrounding areas.		Groundwater levels in monitored bores are stable within the range of variation of surrounding monitoring bores and show the same seasonal patterns as surrounding monitored bores. Groundwater quality (pH, EC, Total Dissolved Salts, Total Acidity, Total Alkalinity, chloride, sulfate, Al, Fe and Mn) is within the range monitored within the surrounding areas.	Groundwater level monitoring Surface and groundwater quality measurement utilising appropriate field meters and samples analysed at a National Association of Testing Authorities accredited laboratory.
Surface and groundwater flows are consistent with surrounding areas.		Groundwater levels in monitored bores are stable within the range of variation of surrounding monitoring bores and show the same seasonal patterns as surrounding monitored bores. Drainage lines flow in the same direction and to the same catchments as they did pre-mining.	Groundwater level monitoring Visual inspection and site audit.
Infrastructure			
All mining and processing equipment and structures are removed from site.		No mining and processing equipment present on site.	Visual inspection and photographic record.
Waste generated during deconstruction is managed in a manner consistent with waste minimisation principles.		Waste disposed of at appropriately licenced waste disposal facilities.	Waste disposal records. Inspection during deconstruction.
Re-established infrastructure is installed	Stock water dams as	Infrastructure is installed, functioning and accepted by	Visual inspection Written acceptance by

CLOSURE OBJECTIVES	INDICATIVE COMPLETION CRITERIA	COMPLETION CRITERIA	MEASUREMENT TOOLS
to standards accepted by key stakeholders.	required by landowner	landowner.	landowner.

This page left blank intentionally.

9 FINANCIAL PROVISION FOR CLOSURE

9.1 FINANCIAL PROVISIONAL PROCESS

Doral has a process established for estimating the cost for closing the Yoongarillup Mine. This cost estimate will be updated annually as part of the annual budgeting cycle. The estimate constitutes two principal components, a rehabilitation cost estimate and a deconstruction (restoration) cost estimate.

The rehabilitation cost estimate is generated for each mining block utilising the following inputs:

- Cost unit rates ($/hr) are maintained for each type of earthmoving equipment as per the current earthmoving contract rates with an escalation factor for future provisioning.
- Equipment productivity rates (bulk cubic metres/hr) are based on average performance achieved for rehabilitation activities at Doral's Dardanup Mine.
- Bulk earth moving volume is calculated for each mining block based on the geological model for the proposed Yoongarillup Mine.
- Sand tailings backfill, in-pit overburden placement, tailings co-disposal and dry clay fines placement are treated as operating costs and are not included within the closure cost estimate.

Cost unit rates are maintained for the following activities which are based on current costings:

- Fencing ($/linear metre).
- Drainage / Erosion Control.
- Revegetation.
- Service Re-establishment.
- Closure Overheads have been provision based on the organisation structure and implementation strategy described in Section 10.

The rehabilitation cost estimate is then generated by summing:

- Calculating costs of bulk earthworks (volume x equipment productivity rate x cost unit rate);
- Revegetation costs;
- Drainage / erosion control costs;
- Fencing costs (length of fencings required x cost unit rate);
- Service re-establishment costs;
- Closure Overheads.

The deconstruction cost estimate has been generated for the following scope:

- Removal of all feed preparation equipment including conveyors, FEL, hopper, apron feeder screens, scrubbers, trammel, sump pumps;
- Removal of the control room, storage shed and lunch room;
- Dismantle and removal of the concentrator;
- Removal of the thickener and supported equipment;
- Miscellaneous tanks around the concentrator area;

- Water feed pumps;
- Monazite disposal feeder and cleaning off;
- Concentrate stacker;
- Work shop and associated storage facility.
- Powerlines (buried and overhead) (excludes Western Power assets).

The following assumptions have been made in the preparation of the deconstruction cost estimate:

- All poly pipelines will be removed at and sold at neutral cost;
- Earthworks associated with the road hopper and refurbishment of the hardstand following equipment removal is not included;
- Electrical feeder lines to remain as is and no changes made;
- Earthworks associated with the concentrator and water feed pumps are removed;
- All remaining underground reticulation remains and are left untouched;
- Existing farm shed remain;
- Bore and pump remain in place;
- Capital spares are not included;
- No culvert crossings or water crossings on access roads are included;
- Scrap yards are cleaned and removed from site at neutral value;
- No vehicles included.

9.2 CLOSURE COST ESTIMATE AND PROVISION

The cost to close the Yoongarillup mine site at the completion of mining operations has been estimated at approximately $ 6.2M. This value includes the cost of removing mine site infrastructure (Table 9-1) and the rehabilitation earthworks and revegetation of disturbed areas (Table 9-2).

As part of the annual budgeting process, Doral undertakes a detailed review of closure costs estimates and provisioning. This annual review makes assessments of current provisions held for rehabilitation and decommissioning with respect to projected future costs to undertake the required works. Doral also undergoes annual independent financial auditing which incorporates rehabilitation provisioning.

TABLE 9-1: DECONSTRUCTION COST ESTIMATE

Commercial information associated with this table has been provided to Regulatory Authorities

This page left blank intentionally.

TABLE 9-2: REHABILITATION COST ESTIMATE YOONGARILLUP MINE

Commercial information associated with this table
has been provided to Regulatory Authorities

This page left blank intentionally.

10 CLOSURE IMPLEMENTATION

10.1 IMPLEMENTATION STRATEGY

The proposed Yoongarillup Mine will operate with an earthworks contractor undertaking all earth movements. During closure the same strategy will be continued with an earthworks contractor completing bulk earthworks to meet Doral's closure requirements.

The overall strategy for closure is once mining has been completed production activities will cease and deconstruction of infrastructure, reinstatement and rehabilitation activities will commence.

10.2 MINE CLOSURE PHASE

10.2.1 Haddon West, Haddon East and Piggott Sub-areas (Agricultural Areas)

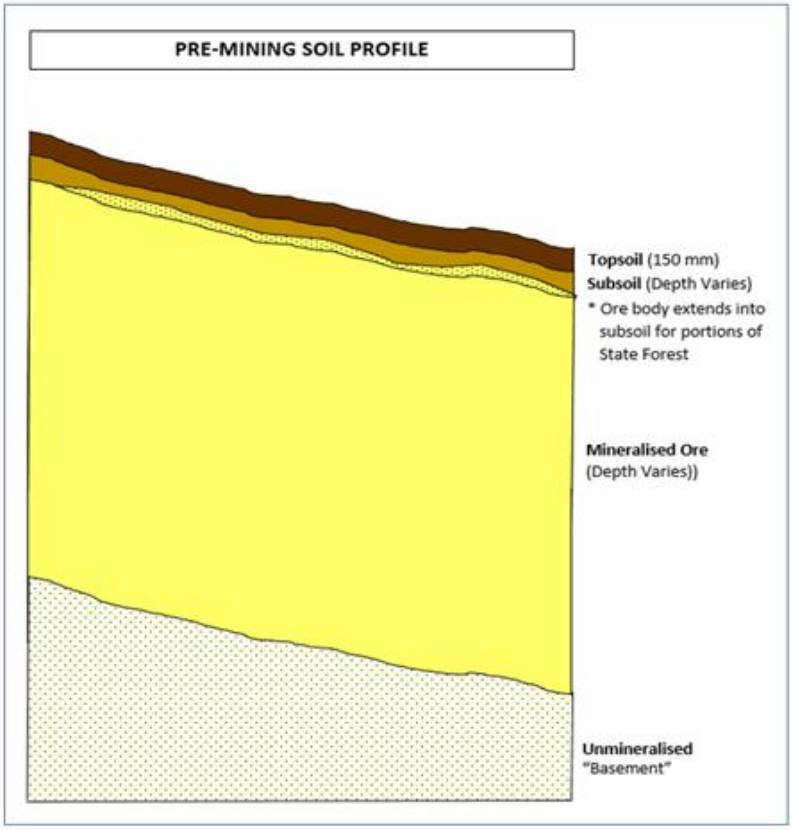
Mine pits within the Haddon West, Haddon East and Piggott sub-areas will be progressively backfilled via co-disposal of sand tailings, dried clay tailings, oversize and overburden. A depth of 300 mm of subsoil and 150 mm of topsoil will then be replaced in order to promote the establishment of pasture grasses. Following replacement of subsoil/topsoil, the surface will be contoured to provide drainage and then ripped to 300 mm.

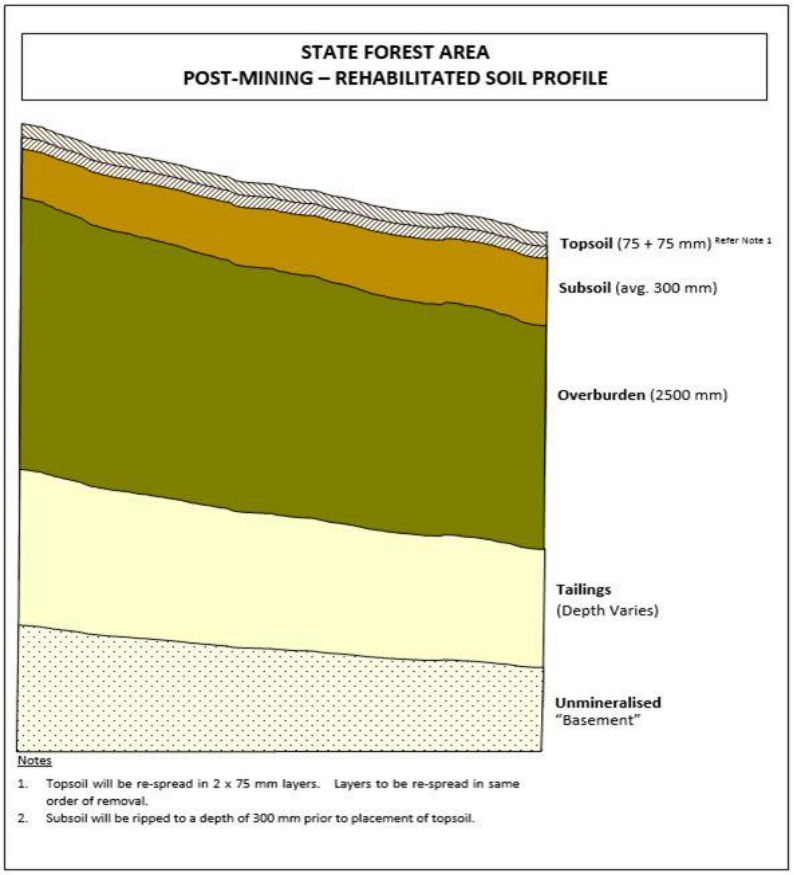
10.2.2 State Forest Sub-areas

Mine pits within the State Forest sub-area will be progressively back filled via co-disposal of sand tailings and dried clay tailings at various depths, prior to backfill with 2,500 mm of overburden material. An average depth of 300 mm of subsoil and 150 mm of topsoil will be replaced in two 75 mm layers, in reverse order of stripping so as to ensure the original seed bearing layer is put back as the final surface layer, to promote the establishment and survival of native vegetation. Following replacement of subsoil and topsoil, the surface will be contoured and then ripped to 800 mm. Plate 10-1 illustrates the reconstruction of the soil profile.

Prior to planting, rip lines will be furrowed along contours to collect water, directing it to the root-zone and also help to remove hydrophobic soils if present. Furrow spoil will be hilled on the down-slope side to better trap and retain water and to minimise erosion.

PLATE 10-1 SOIL PROFILE PRE/POST MINING OF BLOCKS 24 AND 25

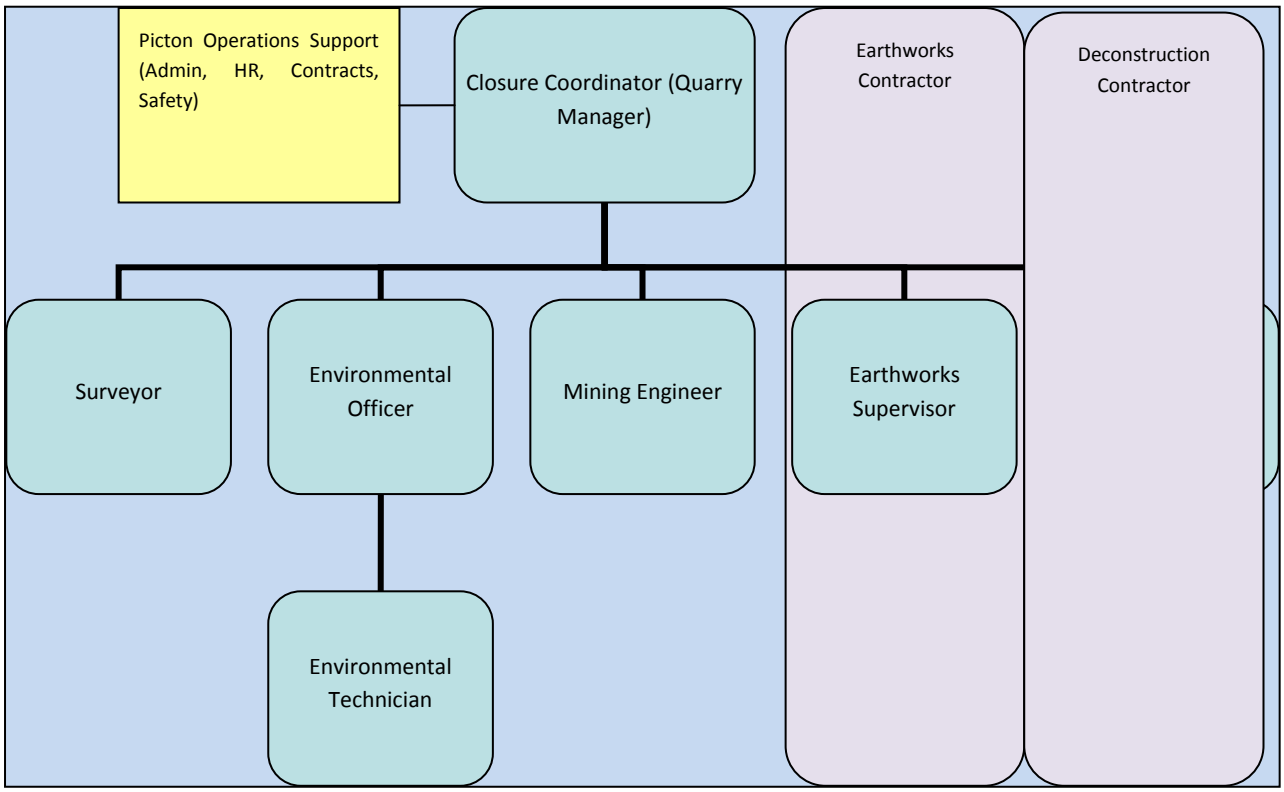




10.3 ORGANISATION STRUCTURE AND RESOURCES

The organisational structure and responsibilities planned for the initial stages of closure implementation phase is illustrated in Plate 10-2. It is expected that as closure progresses the duties required for these roles will reduce to make these effectively part-time roles that Doral will either support from Picton or other mine site operations or will be filled as part-time contract positions. Other contractors will be engaged as required to complete the works.

PLATE 10-2 CLOSURE IMPLEMENTATION ORGANOGRAM



10.4 TOPSOIL AND SUBSOIL MANAGEMENT

10.4.1 Topsoil and Subsoil Stripping

The following procedures are applied to topsoil and subsoil stripping:

- Prior to removal of topsoil, any millable timber will be recovered where practicable;
- The removal of topsoil and subsoil from disturbed areas shall be maximised and, no matter how small the area of disturbance, topsoil and subsoil shall be salvaged. Subsoil is salvaged only from pits; topsoil is stripped from all disturbance areas;
- Topsoil from native vegetation and pasture areas shall be stripped separately and stockpiled separately;
- Small vegetation should be stripped with the topsoil;
- Topsoil from pasture areas will be stripped to the depth of 150 mm or the topsoil horizon whichever is greater in a single pass;
- Topsoil from State Forest Sub-area will be stripped to the depth of 150 mm in two 75 mm layers. Each layer will be stockpiled separately to conserve seed bank density;
- To reduce dust generation topsoil and subsoil stripping will be maximised during early autumn months to minimise the period before natural germination.

10.4.2 Topsoil and Subsoil Handling

Topsoil will not be stripped under saturated soil conditions which would be conducive to soil damage. Similarly scheduling of topsoil and subsoil stripping should be such that dry windy conditions, particularly in mid-late summer will be avoided.

Topsoil and subsoil **shall not be** used for any other purpose than stockpiling or direct placement for rehabilitation.

10.4.3 Topsoil and Subsoil Storage

The following procedure shall be applied to topsoil and subsoil storage:

- Records of topsoil and subsoil removal and storage locations will be maintained;
- Planning will endeavour to facilitate the direct placement of topsoil and subsoil from disturbed areas to areas scheduled for rehabilitation;
- The height of topsoil stockpiles will not exceed a maximum height of 3 m for paddock topsoil and 2 m for State Forest sub-area;
- Stockpiles will be located where they will not be disturbed by future mining and preferably in a location where they will not be trafficked;
- Topsoil and subsoil stockpiles will not be located where they will be mixed with other materials (e.g. drain spoil) or standing vegetation;
- If there is drying of the surface of the topsoil and subsoil stockpiles prior to vegetation establishment dust suppression measures shall be employed as necessary;
- Drainage controls will be established for dieback free stockpiles to prevent the potential for infestation from up-gradient surface water flow.

10.4.4 Topsoil and Subsoil Placement

The following procedure shall be applied to topsoil and subsoil placement:

- Topsoil will be placed on rehabilitation areas just prior to the growing season to avoid dust generation over the summer months;
- Water spraying and/or other appropriate measures shall be used for dust control during the placement of topsoil and subsoil. Under high wind conditions, topsoil and subsoil placement will cease;
- Following subsoil replacement, the surface will be ripped and cross ripped;
- The final surface design and drainage layout will be as close as possible to the pre-mining surface design with minor undulations and erosional features smoothed out;
- GPS controlled techniques are used for topsoil and subsoil replacement as they allow a more accurate final land surface;
- To alleviate any compaction caused by the movement of heavy machinery, all mined areas will be ripped. Ripping requirements will be tailored to suit specific rehabilitation areas. In native rehabilitation areas, deep ripping may be required. In pastured rehabilitation areas, less aggressive ripping (300 mm) will be required after the replacement of subsoil, but prior to replacement of the topsoil.

10.5 PIT BACKFILL AND SOIL PROFILE CONSTRUCTION

10.5.1 Pit Backfill

Progressive pit backfill from new disturbance areas involves the direct placement of materials in mine voids where possible. Backfill material includes:

- Overburden either from within the pit or from stockpiles;
- Sand tails from the Wet Concentrator Plant;
- Dried clay tails from the excavation of SEPs;
- Co-disposed sand and clay tails;
- Oversize from feed preparation plant and wet concentration plant;
- Waste sand and clay material returned from the Picton Dry Separation Plant, blended into returned sand tails.

Backfill methods are designed to satisfy the requirement for maintaining a hydrological regime suitable for sustaining the end land use.

The method for pit backfilling in the land to be rehabilitated back to agricultural use includes:

- Pumping sand tails into previously mined voids to within 1 m of the final rehabilitation surface;
- Final backfilling with solar dried clay fines and clayey overburden, removed from advancing pit development, to within 1 m of the surface;
- The void is then capped with sub-soil and topsoil.

10.5.2 Soil Profile Construction

Across the proposed Yoongarillup Mine there is one primary pre-mining landform as described in Section 4):

- Whicher Scarp landform.

Post-mining soil profile reconstruction is modelled on the pre-mining landform with adjustments made on the basis of practical (the limitations of the materials available) and economic constraints, while also exploiting the opportunities present to remove soil landscape constraints to agricultural productivity where possible.

10.5.3 Pasture Management

Procedures for re-establishment of agricultural land will utilise the following practices. The focus of the program is to rapidly stabilise restored landforms with agricultural pastures. A pasture mixture will be sown and fertilised in autumn to ensure a vigorous re-establishment of the pasture.

The methodology is summarised broadly below:

- Stick picking to remove excessive quantities of large sticks and roots in the returned topsoil;
- Seedbed preparation using a combination of secondary tillage implements (e.g. offset discs, scarifier, drag and harrows);
- Application of fertiliser and lime, for which the type, rate and number of applications will be determined via soil testing and agronomic advice;
- Application of seed mix tailored to landowner's specifications.

10.5.4 Grazing

In the first spring after sowing, the primary objective is to develop a stable, productive soil profile by encouraging proliferation of pasture roots and soil biota. Pasture will be grazed lightly to promote tillering of ryegrass, a healthy component of clover, and to discourage pasture weeds (e.g. capeweed) from attaining dominance.

In subsequent years, it is expected that with appropriate management, pasture productivity will be comparable to other pastures in the locality. Grazing intensity will be gradually increased to levels considered appropriate for the district and seasonal conditions.

10.5.5 Weed and Pest Control

Weed control will primarily be achieved by ensuring pasture species are appropriately grazed such that they out-compete pasture weeds. Pastures will be monitored for problem weeds and pests. Where warranted, weeds will be controlled via herbicide application. Similarly, where warranted, pests such as red-legged earth mite will be controlled via insecticide application.

Invasive weeds or Declared Plants such as Arum Lily, Silver Wattle, Blackberry, Bridal Creeper and Narrow leaf Cotton Bush will require spot spraying with a suitable herbicide should they occur in rehabilitated pasture.

Weed control procedures follow normal agricultural practices, with agronomic advice sought where necessary.

10.5.6 Fertiliser

Pastures are fertilised annually as part of an ongoing maintenance programme. The type, rate and number of fertiliser applications will be determined via soil testing and agronomic advice.

10.6 NATIVE REVEGETATION

The following practices are applied across all areas subject to native revegetation and will be consistent with the yet to be prepared Yoongarillup Rehabilitation Management Plan.

Doral will develop a Rehabilitation Management Plan for the State Forest sub-area which will provide further detail on the management and revegetation of these areas (including species list).

10.6.1 Photo-point Setup

At least one photo point will be established for each restoration area and is be marked and recorded in the same way as existing environmental monitoring photo points within the mine area. GPS coordinates and compass bearings are recorded for each photo point, which is visited quarterly.

10.6.2 Weed Control

Weed control is undertaken prior to planting (i.e. herbicide applications in autumn, spring and summer).

Necessary weed control should be determined by site weed inspections undertaken three times per year, in autumn, spring and summer. Each of the restoration sites should be assessed individually for the presence and severity of weed re-establishment. Weed species can then be treated with herbicide as required based on observations during site inspections.

There are two main aims of the weed control program: one, to prevent weed seed set and two, to reduce competition with planted seedlings for resources. The site weed inspection schedule will therefore need to be continually audited in order to determine whether an increase or decrease in the frequency of inspections is necessary in order to achieve this aim.

10.6.3 Slashing

Slashing dead weed biomass on a site prior to planting has proven very useful in reducing weed germination and fungal and mould infestations. Slashing is best undertaken in combination with herbicide treatment. Slash post-spraying once the weeds have died using a tractor-slasher or ride on mower as appropriate. The biomass can usually be left when it falls, to act as mulch and eventually end up as organic matter in the soil.

10.6.4 Ripping

Deep ripping has been proven highly effective for seedling survival in revegetated areas. Ripping fractures compacted soil, facilitating aeration and the infiltration of water down into the soil profile. Ripping is necessary in areas that have not been mined.

Where necessary, the soil should be ripped where possible to 800 mm depth in late summer / early autumn, as this is when the soil compaction layer will shatter. Riplines should follow contours and be kept outside the foliage line of remnant vegetation.

Seedlings should be planted into rip lines for two reasons; first, plant roots will be able to make good use of the fissures created in the compaction layer, and second, follow-up weed control will be rendered much easier if seedlings are in rows as mechanised equipment can be utilised.

Where riplines are not necessary, planting should be undertaken in rows approximately 2 m apart. Plants should be placed every 1.5 – 2 m along the row and staggered, so that a zigzag effect is achieved.

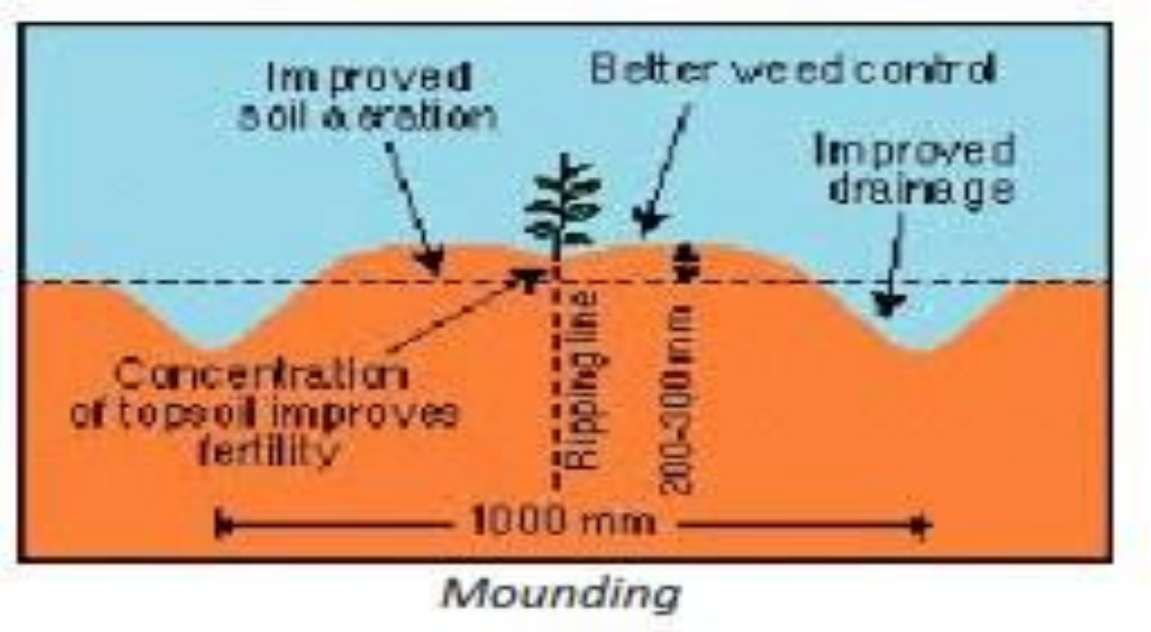
10.6.5 Mounding

Mounding is recommended on all but elevated, deep sandy soils. The concentration of topsoil as a medium in which to plant trees is beneficial for survival and early growth.

Mounding is essential on wet sites. On wet sites mounds should be aligned to allow excess water to drain off the site without causing erosion.

The drainage furrows created on each side of the mound provide important additional drainage. For maximum effect, these should be continuous, and connected into the drainage network. The mound should be constructed at least 200 mm to 300 mm high, about 1000 mm wide and located over the ripline (see Plate 10-3). Even larger mounds may be required on very wet sites.

PLATE 10-3 SCHEMATIC REPRESENTATION OF MOUNDING FOR REVEGETATION

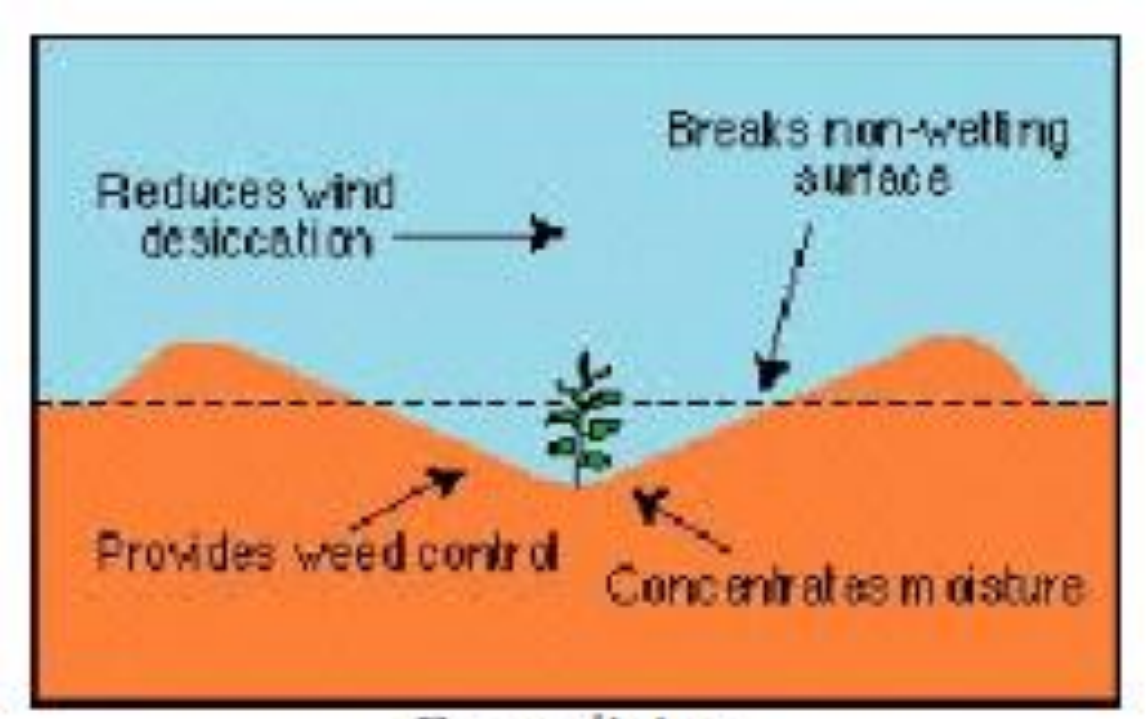


Mounding

10.6.6 Furrowlining

Furrowlining, as illustrated in Plate 10-4, can be used to break the water repellent layer on elevated, non-wetting, deep sands, and allow water to enter through the bottom of the furrow. This is also an effective means of weed control, and can give some shelter to small seedlings. Caution should be used where exposure could lead to wind erosion, or where water erosion could occur down the furrow. In these situations, ripping followed by a press wheel or tyre will provide a suitable entry point for water. Weed control can then be undertaken with herbicides. Furrows are usually 200 to 300 mm deep and about one metre wide. As furrowlining removes topsoil, fertilising of trees may be necessary.

PLATE 10-4 SCHEMATIC REPRESENTATION OF FURROWLINING FOR REVEGETATION



10.6.7 Revegetation Method (Seedling/Direct seeding)

For various reasons there is reduced likelihood of successful direct seeding and as such, tubestock will used to supplement the seeding effort. Seeding rates shall be confirmed after consultation with DPaW.

10.6.8 Seed Sourcing and Collection: Seedling Sourcing

Seed will be sourced locally. An assessment of potential seed sources for the rehabilitation of the State Forest sub area will be undertaken; refer to these management plans and other documentation collated over the seed-collection period for more information.

Seed collected will be given to a suitably experienced nursery where it will be grown specifically for rehabilitation of the proposed Yoongarillup Mine. Any species not able to be supplied by this nursery may be sourced from other nearby suppliers.

10.7 SCHEDULE

A description of planned rehabilitation schedule is provided below and relates to the areas illustrated in Figure 2-5 and summarised below in Table 10-1.

TABLE 10-1: REHABILITATION SCHEDULE

Rehabilitation Year	Area to be Rehabilitated
2018	Block 10 - 13 Blocks 24 – 25 (State Forest Sub-area)
2019	Block 2 - 5 Block 7 - 9
2020	Solar Evaporation Ponds Block 14 – 17 Block 18 -22 Block 23 Sues Road, Goulden Road Infrastructure area: including concentrator, workshop, process water dam and internal roads.

10.8 UNEXPECTED CLOSURE OR TEMPORARY CLOSURE (UNSCHEDULED CARE AND MAINTENANCE)

If a scenario arises which results in the need to temporarily cease operations (global economic factors, delays in obtaining regulatory approvals), Doral personnel would be retained on site and it is likely that contractor labour force would be partially stood down. No deconstruction works would be conducted. The operating processing equipment (feed preparation plant, concentrator etc.) would be subject to a managed cessation and placed in a care and maintenance management regime with the operational integrity of all production critical equipment maintained such that production could recommence quickly once all approvals had been obtained.

Doral's provisions for closure are expected to be able to provide adequate funds for any care and maintenance scenarios.

10.9 RELINQUISHMENT

Following the completion of the closure activities described above, Doral intend to relinquish the mining tenements that the Yoongarillup Mine operates on, and return property to landowners.

The proposed process to achieve this outcome is:

- Implement rehabilitation, deconstruction and infrastructure reinstatement;
- Document fulfilment of completion criteria;
- Obtain written acceptance from landowners that property meets the landowner's requirements, that Doral has fulfilled its obligations to rehabilitate the property and the landowner is willing to resume control of the property;

- Request relinquishment of the mining leases from the DMP and receive release of any financial environmental securities.

10.10 REHABILITATION TRIALS

Given the relative short duration of the Yoongarillup mine, the availability of conducting long term rehabilitation trials may be limited, however Doral is willing to work in consultation with DPaW in order to establish an effective set of strategies and short term trials as required. The overall objective of the establishment of successful rehabilitation shall be conducted with reference to previous successful rehabilitation projects. Any trials will be planned and conducted in accordance with revisions to relevant environmental management plans and reported within relevant regular Government submission documentation such as the Annual Environmental Report and future revisions to the Mine Closure Plan.

This page left blank intentionally.

11 CLOSURE MONITORING AND MAINTENANCE

11.1 CLOSURE MONITORING

Closure monitoring and measurement is focussed on demonstration of fulfilment of the completion criteria (see Section 1) and meeting all relevant obligations.

Doral will continue to undertake environmental monitoring as required by site specific licences (e.g. Water licences, DER operation licence) until such time those licence instruments are removed.

The methodology for those monitoring aspects is described within Doral Annual Environmental Report.

11.1.1 Compliance

Pending environmental approvals of the proposed Yoongarillup Mine by the EPA and the DMP, Doral will update the checklist of closure obligations located as Appendix J. This checklist will be populated and maintained as an ongoing check that obligations are being met.

Where Doral has an access agreement with a landowner, at the completion of rehabilitation Doral will obtain written acceptance from the landowner that rehabilitation and reinstatement of infrastructure has been completed to the landowner's satisfaction and that the landowner accepts transfer of the land from Doral.

11.1.2 Landforms

Doral will conduct post-mining final land surface elevation surveys. These are used to check that final surface topography is as designed, to identify maintenance work (if required as a result of subsidence).

Within agricultural land use areas Doral will undertake pasture productivity monitoring. Doral utilises current best practice pasture productivity methodology developed and promoted within the agricultural industry by CSIRO and the Department of Agriculture and Food (Pastures from Space, 2006). This method utilises site specific plant and soil nutrition information together with satellite imagery to calculate pasture growth rates.

Within road reserves pit backfill is conducted under the technical direction and to the standards of the City of Busselton for Goulden Road and Main Roads WA for Sues Road. During road construction geotechnical assessments will be undertaken and reports generated by the road building contractor. Prior to the road being opened for public use Doral will obtain written acceptance from the City of Busselton and Main Roads WA to confirm that the road construction meets safety and operational requirements.

11.1.3 Native Vegetation

Doral is committed to implementing a range of revegetation works. A photo monitoring program will be developed and implemented to monitor the success of these works. This program shall be continued during closure implementation. Furthermore a vegetation health monitoring program will be undertaken. Photo points will be established for the State Forest Sub-area rehabilitation in order to allow visual monitoring of rehabilitation progress and success. The photo-points will be visited quarterly. Monitoring quadrats will also be established to provide a more quantitative measure of change over time. Quadrats will be set up adjacent to the rehabilitation areas to use as comparison. Quadrats will be established within the planted areas to allow monitoring of rehabilitation success. Characteristics such as species composition, soil type and ground cover will be assessed and noted during the periodic visits to the quadrats.

Quadrat monitoring will be undertaken by a suitably qualified botanist.

11.1.4 Radiation

Doral will conduct post-mining ground level (1 m from surface) gamma radiation surveys following the completion of mining and rehabilitation. This data is recorded to ensure that post-mining landforms are returned to acceptable background gamma radiation levels and similar to pre-mining levels.

Should post mining background gamma levels be unacceptable, then post rehabilitation earthworks may be required.

11.1.5 Water

Doral will continue the comprehensive groundwater monitoring program conducted during operations to maintain the data set for the mine. All the elements of this monitoring program shall be maintained until such time that it has been demonstrated that water levels have returned to pre-mine levels and the water quality is within the range of a 'slightly to moderately disturbed ecosystem', as per criteria set in ANZECC & ARMCANZ (2000) guidelines.

11.1.6 Infrastructure

Photo-documented visual inspection shall be utilised to demonstrate that mining and processing equipment has been removed from site and agreed post-mining infrastructure has been installed.

Doral will seek written acceptance from landowners that infrastructure has been installed to an acceptable working standard.

During deconstruction waste disposal records will be retained to demonstrate that waste is disposed to appropriately licenced facilities.

11.2 CLOSURE MAINTENANCE

Doral will undertake maintenance works on rehabilitation areas. These activities will be continued into closure and will include:

- Reinstatement of designed surface levels where these are affected by subsidence (this method involves the stripping of topsoil, placement of subsoil or sand fill and reinstatement of topsoil);
- Where post mining background gamma radiation levels are found to be unacceptable, then earthworks will be undertaken to remove materials with elevated levels from near the soil surface;
- Weed control, where detected;
- Seeding, planting and fertilising in State Forest sub-area;
- Pest control;
- Pasture seeding and fertilising as relevant to the agricultural production system in place;
- Maintenance of fencing;
- Activities to correct erosion;
- Maintenance of artificial fauna habitats.

12 MANAGEMENT OF INFORMATION AND DATA

12.1 MANAGEMENT OF DATA

Doral maintains an operational environmental management system (EMS) which provides for the storage and retrieval of environmental data. All environmental data collected and reports produced are stored in accordance with the requirements of the EMS.

This MCP document serves as a focal point for containing a summary of data relevant to closure planning and implementation and contains reference to source documentation that is maintained within the EMS. The MCP is a living document and will continue to be updated as information gaps are filled and information becomes available.

The MCP will describe and document the following information:

- History of regulatory approval of the proposed Yoongarillup Mine;
- History of development of the proposed Yoongarillup Mine;
- Summary of data relevant to planning and implementing closure of the proposed Yoongarillup Mine;
- Results of closure monitoring;
- History of progressive rehabilitation practices and materials placement.

12.2 REPORTING

Doral produces an Annual Environmental Report (AER) that reports on progress in operating their mines and implementing progressive rehabilitation. Monitoring of progressive rehabilitation performance is described in detail within the AER.

After the first three years, the AERs will be reviewed and discussions will be held with DMP to decide if alterations to the agreed monitoring programs are required.

This page left blank intentionally.

13 REFERENCES

Allen, G.R., Midgley, S.H., Allen, M. (2003), *Freshwater Fishes of Australia*. Western Australian Museum, Perth, Western Australia.

ANZECC & ARMCANZ (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000*. Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand.

Aurora Environment (2012), *Conservation Management Plan Yoongarillup Exploration Program State Forest No.33 – M70/459*. Unpublished report prepared for Doral Mineral Sands. June 2012.

Australian Government (2013), *Interim Biogeographic Regionalisation of Australia (IBRA)* Version 7, Department of the Environment, Heritage and the Arts (retrieved February 2031 from http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra

Australian Heritage Database (2014), http://www.environment.gov.au/topics/heritage/publications-and-resources/australian-heritage-database

Baddock, L., Vine, J. and Leathersich (2005), *Southwest Yarragadee Hydrological Investigations and Evaluation, Southern Perth Basin*. Infrastructure Planning Branch, Planning and Development Division, Water Corporation (IPB Project No: R302; File No: 1506).

Bamford, M. J., Huang, N., Bancroft, W., and Bamford, M. (2010), *Level 2 Fauna Assessment of Remnant Vegetation at the Proposed Point Grey Marina*. Unpublished report for RPS.

Bancroft, W. and Bamford, M.J. (2008), *Fauna values of Bemax's Happy Valley minerals sands deposit*. Prepared for Bemax Resources Limited, Bunbury.

Baxter, J.L. (1977), *Heavy mineral sand deposits of Western Australia*. Western Australia, Geological Survey, Mineral Resources Bulletin 10.

Beard, J.S. (1990), *Plant Life Western Australia*. Kangaroo Press, Kenthurst. NSW.

Belford, S.M. (1987), *Busselton Sheet No. 130. Environmental Geology Series (1:50,000),* Geological Survey of Western Australia

Biota (2007a), *Yoganup 215 Strand Fauna and Faunal Assemblage Survey*. Unpublished report for Iluka Resources. February 2007.

Biota (2007b), *Tutunup South Fauna Habitat and Fauna Assemblage Seasonal Survey*. Unpublished report for Iluka Resources. December 2007.

Biota (2009), *Tutunup, Fauna Assemblage and Fauna Habitat Seasonal Survey*. Unpublished report for Iluka Resources. March 2009

Boland, C.R.J. (2004), Introduced Cane Toads Bufo marinus are active nest predators and competitors of Rainbow Bee-eaters *Merops ornatus*: observational and experimental evidence. Biological Conservation.

Bureau of Meteorology, (2013), http://www.bom.gov.au. Accessed 10 December 2013.

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. (2002), *Reptiles and Frogs of the Perth Region*. UWA Press, Nedlands.

Christensen, P., Annels, A., Liddelow, G. and Skinner, P. (1985), *Vertebrate Fauna in The Southern Forests of Western Australia, A Survey*. Forest Department of Western Australia, Bulletin. No. 94. Perth.

Churchward H.M., and McArthur W.M. (1980). '*Landforms and Soils of the Darling System'* in Atlas of Natural Resources, Darling System, Western Australia. Government of Western Australia.

Conservation and Land Management (CALM) (1994), *Chuditch Recovery Plan 1992-2001*. By Peter Orell and Keith Morris for the Chuditch Recovery Team.

Commonwealth Heritage Databse (2014), http://www.environment.gov.au/topics/heritage/publications-and-resources/australian-heritage-database

Davidson, W.A. (1995), *Hydrogeology and groundwater resources of the Perth region, Western Australia*, Western Australia Geological Survey, Bulletin 142.

Dell, J. (2000), *A draft summary assessment of the fauna values of the Kemerton Bushland*. Unpublished report for the Conservation Branch, Policy Division, Department of Environmental Protection.

Department of Agriculture and Food Western Australia (DAFWA) (2007), *GIS Soil-landscape mapping in South-Western Australia*. Department of Agriculture and Food, Western Australia.

Department of Agriculture Western Australia (DAWA) (2003), *AGMAPS Land Profiler – Shires of Capel, Busselton and Augusta-Margaret River*. Department of Agriculture, Western Australia.

Department of Environmental and Conservation (DEC) (2012), *Investigation and Management of Acid Sulfate Soil Hazards Associated With Silica and Heavy Mineral Sand Mining Operations*. Prepared by Contaminated Sites Branch Environmental Regulation Division. Department of Environment and Conservation Guideline Series, 2012.

Department of Environmental and Conservation (DEC) (2013a), *Threatened and Priority Ecological Community Buffers in WA*. Extract from the DEC Species and Communities Branch dated 24 January 2013.

Department of Environmental and Conservation (DEC) (2013b), *Extract from the Department's Threatened (Declared Rare) Flora database and the Western Australian Herbarium*. DEC species and Communities Branch dated 3 January 2013.

Department of Mines and Petroleum (DMP) (2013), *Code of Practice: Tailings Storage Facilities in Western Australia*. Viewed 28 January 2014. http://www.dmp.wa.gov.au/documents/Code_of_Practice/MSH_COP_TailingsStorageFacilities.pdf

Department of Parks and Wildlife (DPaW) (2013a), Priority Fauna Listing. Viewed 10 January 2013.

Department of Parks and Wildlife (DPaW) (2013b), NatureMap Database search. "By Circle" 115°25' 23'' E, 33°45' 43''S – Study area (plus 10 km buffer). Viewed 18 September 2013.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012a). EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012b). Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013a). EPBC Act Protected Matters Report: Point Search - 33.7623, 115.423 (10km Buffer). Available from: http://www.environment.gov.au Accessed 18 September 2013@10:52:08

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013b), Matters of National Environmental Significance. Significant Impact Guidelines 1.1. Environmental Protection and Biodiversity Conservation Act 1999

Department of Water (DoW) (2009a), *Busselton–Capel groundwater area subarea reference sheets*. Plan companion for the South West groundwater areas allocation plan. May 2009.

Department of Water (DoW) (2009b), Whicher Area surface water allocation plan. September 2009.

Department of Water (DoW) (2010), Vasse Wonnerup Wetlands and Geographe Bay water quality improvement plan. March 2010.

Department of Parks and Wildlife (DPaW) (2014). *NatureMap Database Search*. Available from http://naturemap.dpaw.wa.gov.au. Viewed August 2014.

Doughty, P and Oliver, P.M. (2013). Systematics of *Diplodactylus* (Squamata: Diplodactylidae) from the south-western Australian biodiversity hotspot: redefinition of *D. polyophthalmus* and the description of two new species. Records of the Western Australian Museum. 28. 044-065 (2013).

Ecoedge Environmental (2014), *Level 2 Flora and Vegetation survey at Yoongarillup*. Unpublished report for Doral Mineral Sands Pty Ltd.

Environmental Protection Authority (EPA) (2004a), *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. Guidance Statement No. 51. EPA, Perth.

Environmental Protection Authority (EPA) (2004b), *Guidance for the Assessment of Environmental Factors - Terrestrial fauna surveys for environmental impact assessment in Western Australia*. Guidance Statement No. 56. EPA, Perth.

Environmental Protection Authority (EPA) (2006a), *Guidance for the Assessment of Environmental Factors. Rehabilitation of Terrestrial Ecosystems*. Guidance Statement No. 6. EPA, Perth.

Environmental Protection Authority (EPA) (2006b), *Guidance for the Assessment of Environmental Factors. Level of Assessment for Proposals Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region*. Guidance Statement No. 10. EPA, Perth.

Environmental Protection Authority (EPA) (2009), *Environmental Protection Bulletin No. 6, The Natural Values of the Whicher Scarp*. August 2009.

Environmental Protection Authority (EPA) and Department of Mines and Petroleum (DMP) (2011), *Guidelines for Preparing Mine Closure Plans*. June 2011.

Ethnosciences (2012), *Report of an Ethnographic Survey of Doral's Yoongarillup Resource Zones, Yoongarillup, near Busselton, Western Australia*. Prepared for Doral Mineral Sands.

Griffin, E.A. (2008), *Numerical Analysis of Floristic Data from Vegetation Recording Sites Happy Valley*. Western Australia. Prepared by EA Griffin, Consultant Botanist for Bemax Resources Ltd

Geological Survey of Western Australia (GSWA) (WA) (1976), *Geology of the Perth Basin*. Bulletin 124, Perth, W.A.

Harewood, G. (2014), *Phase 1 and 2 Seasonal Fauna Surveys (Level 2), Yoongarillup Mineral Sands Project*. Unpublished report prepared for Doral Mineral Sands Pty Ltd, Report # SF008335, V3.

Hart, Simpson and Assoc. (1997), *Wonnerup -Tutunup Road - Vertebrate Fauna*. Unpublished report for Westralian Sands Ltd.

Harvey, M. (2002), Short Range Endemism Amongst the Australian Fauna: some examples from non-marine environments.Invertebrate Systematics 16(4) 555-570. September 2002.

Havel, J.J. and Mattiske, E.M. (2000), *Vegetation mapping of south west forest regions of Western Australia*. Calm Science Division, Australia, Environment Australia Pagination: 113p.

Hazelton, P. and Murphy, B. (2011), *Interpreting Soil Test Results*. CSIRO Publishing.

Heddle, E.M., Loneragan, O.W. and Havel, J.J. (1980), *Vegetation complexes of the Darling System, Western Australia*. In: Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Perth 37-72.

Johnstone, R.E. and Storr, G.M. (1998), *Handbook of Western Australian Birds: Volume 1 – Nonpasserines (Emu to Dollarbird).* Western AustralianMuseum, Perth Western Australia.

Johnstone, R.E. & T. Kirkby (1999), *Food of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south-west Western Australia.* Western Australian Naturalist. 22:167-177.

Jones, B.A., R.A. How and D.J. Kitchener (1994), *A field study of Pseudocheirus occidentalis (Marsupialia: Petauridae)*. II. Distribution and habitat. Population studies in Wildlife Research 21:

Page(s) 175-187.

Kay, G.M. and Keogh, J.S. (2012), *Molecular phylogeny and morphological revision of the Ctenotus labillardieri (Reptilia: Squamata: Scincidae) species group and a new species of immediate conservation concern in the southwestern Australian biodiversity hotspot*. Zootaxa, vol. 3390, pp. 1 18.

Keighery, B.J. (1994), B*ushland Plant Survey: A Guide to plant community survey for the community*. Wildflower Society ofWestern Australia (Inc.), Nedlands.

Keighery, B.J., Keighery, G.J., Webb, A., Longman, V.M. and Griffin, E.A. (2008), *A Floristic Survey of the Whicher Scarp (A Report for the Department of Environment &Conservation as part of the Swan Bioplan Project April 2008*). Department of Environment & Conservation, Government of Western Australia.

Landloch (2014), *Soil Assessment Yoogarillup Mineral Sands Mine*. Unpublished report prepared for Doral Mineral Sands Pty Ltd.

Mattiske Consulting (2012a), *Flora and Vegetation Survey of Yoongarillup Resource Zone Survey Area*. Non published report prepared for Doral Mineral Sands Pty Ltd. Report reference: DOR1101/009/12.February 2012.

Mattiske Consulting (2012b), *Threatened and priority species survey of drill lines within the Millbrook State Forest*. Non published report prepared for Doral Mineral Sands Pty Ltd. March 2012.

Mattiske, E.M. and Havel J.J. (1998), *Vegetation Mapping in the South West of Western Australia and Busselton-Margaret River, Mt Barker, and Perth, Western Australia*. Scale 1:250,000. Department of Conservation and Land Management, Perth.

McArthur, W.M. and Bettenay, E. (1974), *The Development and Distribution of the Soils of the Swan Coastal Plain, Western Australia*. Soil Publication No. 16. CSIRO, Melbourne.

Meissner, R. and V. English (2005), *Shrubland association on southern swan coastal plain ironstone (Busselton area) (Southern Ironstone Association) Interim Recovery Plan No. 215 2005-2010*. Perth: Department of Conservation and Land Management.

Menkhorst, P. and Knight, F. (2011), *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.

Mitchell D., Williams, K., & Desmond, A. (2002), *Swan Coastal Plain 2 (SWA2– Swan Coastal Plain subregion).* In; A Biodiversity Audit of Western Australia. Eds McKenzie, N.L., May, J.E. and McKenna, S. Department of Conservation and Land Management, Perth.

Molloy, S, O'Connor, T, Wood, J and Wallrodt, S (2007), *Addendum for the South West Biodiversity Project Area*. Western Australia Local Government Association, West Perth, Western Australia

Moore, G (ed). (2004), *Soil Guide: A handbook for understanding and managing agricultural soils*. Western Australia Department of Agriculture.

Moore Mapping, (2014), *Report and Recommendations for the Mapping of Disease caused by Phytophthora cinnamomi (P.c.): Disease occurrence, Whicher Block: Yoongarillup Resource Zone.* Unpublished report prepared for Doral Mineral Sands Pty Ltd.

Morcombe, M. (2004), *Field Guide to Australian Birds*. Steve Parish Publishing, Archerfiled, Queensland.

Morgan, D.L., Beatty, S.J., Klunzinger, M.W, Allen, M.G. and Burnham, Q.E (2011), *Field Guide to the Freshwater Fishes, Crayfishes and Mussels of South Western Australia*. Published by SERCUL.

Morgan, D.L., Gill, H.S. & Potter, I.C. (1996), *Distribution of freshwater fish in the south-western Corner of Australia*. Water Resource Technical Series. Water and Rivers Commission ReportWRT4 996.

National Heritage Database (2014), http://www.environment.gov.au/topics/heritage/about-australias-heritage/national-heritage

Nevill, S. (ed) (2005), *Guide to the Wildlife of the Perth Region*. Simon Nevill Publications, Perth.

Office of the Environmental Protection Authority (OEPA) (2012), *Generic Guidelines for Preparing a Public Environmental Review.* EPA, Perth.

Paper Daisy Environmental Services (2000), *Vasse River Action Plan*. Prepared for Geographe Catchment Council – Geocatch and the Vasse Wonnerup LCDC. Funded by the National Heritage Trust and Geocatch.

Parsons Brinckerhoff Pty Ltd (PB) (2014a), *Simple site water balance – Yoongarillup mineral sands project*. Unpublished letter report to Doral Mineral Sands Pty Ltd, ref: 2200516A-RES-LTR-002 RevB.

Parsons Brinckerhoff Pty Ltd (PB) (2014b), *Yoongarillup hydrogeological investigation and groundwater modelling report*. Unpublished report prepared for Doral Mineral Sands Pty Ltd, ref: 2200516A-RES-RPT-7634.

Parsons Brinckerhoff Pty Ltd (PB) (2014c), *Surface water assessment for the proposed Yoongarillup Mineral Sands Project*. Unpublished report prepared for Doral Mineral Sands Pty Ltd, ref 2200516-WATLTR-001 Rev B.

Phoenix Environmental Sciences (2012), *Short-range endemic invertebrates from Yoongarillup, Whicher Range, Western Australia*. Unpublished report for Greg Harewood. March 2012

Ponder, W. F. and Colgan, D. J., (2002), W*hat makes a narrow-range taxon? Insights from Australian freshwater snails*. Invertebrates Systematics 16(4) 571-582. September 2002.

Rhind, S. G. (1998), *Ecology of the brush-tailed phascogale in jarrah forest of southwestern Australia*. PhD thesis. Murdoch University, Perth.

Salma, R.B., Pollock, D.W., Byrne, J.D. and Bartle, G.W. (2001), *Geomorphology, soils and landuse in the Swan Coastal Plain in relation to contaminant leaching.* Proceedings of the Agrochemical Pollution of Water Resources Conference. 16-18 February, 2001, Thailand. Pp 105-117.

Saunders D. A. (1974), *Subspeciation in the White-tailed Black Cockatoo, Calyptorhynchus baudinii, in Western Australia*. Australian Wildlife Research 1: 55-69.

Schafer D.B., Johnson, S.L, and Kern, A.M., (2008), *Hydrogeology of the Leederville aquifer in the western Busselton-Capel Groundwater Area*, Department of Water, Hydrogeological Record Series, HG31.

Soderquist T. (1995), *Brush-tailed Phascogale Phascogale tapoatafa*. pp 104-106 in Strahan R. (ed). (1995). The Mammals of Australia. Australian Museum / Reed Books.

Storr, G.M., Smith, L.A. and Johnstone R.E. (1999), *Lizards of Western Australia*: Skinks. Revised Edition,WA Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone R.E. (2002), *Snakes of Western Australia*. Revised Edition, WA Museum, Perth.

Tempus Archaeology (2012), *Report of an Archaeological Survey Doral Yoongarillup Resource Zones Southwestern W.A*. Unpublished report prepared for Doral Mineral Sands. Prepared by K. Edwards.

Tille, PJ and Lantzke NJ (1990), *Busselton-Margaret River-Augusta Land Capability Study*. Western Australia Department of Agriculture, Land Resources Serries No.5.

Varma, S., (2009), *Southern Perth basin groundwater-resource assessment: Application of the SWAMS and ESCP models*, Department of Water, Government of Western Australia, Hydrogeological record series, Report no. HG26.

**Wayne, A.F., Rooney J. F., Ward C. G., Vellios V.C., and Lindenmayer D.B. (2005*), The life history of Pseudocheirus occidentalis (Pseudocheiridae) in the jarrah forest of south-western Australia*. Australian Journal of Zoology 53, 325-337.

Western Australian Heritage Database (2014), http://stateheritage.wa.gov.au/state-heritage-register

Wilson, S. and Swan, G. (2013), *A Complete Guide to Reptiles of Australia*. Reed, New Holland, Sydney.