

**Alcoa of Australia
Limited**

**Final Mining and Management
Program (MMP)**

2024-2028 Inclusive

Final

**Huntly Mine and
Willowdale Mine**

04 April 2024



**In this document, references to the 2023-2027 MMP should be read as references to the 2024-2028 MMP*

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Acronyms

Abbreviation	Definition
AACR	Annual Audit Compliance Report
ACMC	Aboriginal Cultural Material Committee
ADWG	Australian Drinking Water Guidelines
AEP	Annual Exceedance Probability
AER	Annual Environmental Review
AFFF	Aqueous Film Forming Foams
AHD	Australian Height Datum
ACHIS	Aboriginal Cultural Heritage Inquiry System
BAM	Blast Acoustic Model
BC Act	Biodiversity Conservation Act 2016 (WA)
BHC	Bauxite Hydrological Committee
BOM	Bureau of Meteorology
CAR	Comprehensive Adequate Representative
CARIREC	CAR Informal Reserves Evaluation Committee
CER	Consultative Environmental Review
CHMP	Cultural Heritage Management Plan
DAP	Drilling Approval Plan
DBCA	Department of Biodiversity, Conservation and Attractions
DBH	Diameter at breast height
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DCMP	Drainage Control Management Plan
DCP	Drainage Control Plan
DG	Dangerous Goods
DMIRS	Department of Mines, Industry Regulation and Safety
DPLH	Department of Planning, Lands and Heritage
DRA	Disease Risk Areas
DWER	Department of Water and Environmental Regulation
DWRA	Drinking Water Risk Assessment
EIA	Environmental Impact Assessment
EPA Act	Environmental Protection Act 1986 (WA)
EPA	Environmental Protection Authority

Abbreviation	Definition
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPS	Pinjarra Refinery Efficiency Upgrade, Environmental Protection Statement
ERMP	Environmental Review and Management Programme
FCA	Forest Clearing Advice
FEL	Front End Loading
FMEA	Failure Mode Effect Analysis
FMP	Fauna Management Plan
FPC	Forest Products Commission
FVMP	Flora and Vegetation Management Plan
GDA94	Geocentric Datum of Australia (GDA94)
GDE	Groundwater Dependent Ecosystems
GDV	Groundwater Dependent Vegetation
GIS	Geographic Information System
GKB	Gnaala Karla Booja Aboriginal Corporation
GL	Gigalitres
GPS	Global Positioning System
HRRT	Harvey River Restoration Taskforce
HVAS	High Volume Air Sampler
IBRA	Interim Biogeographic Regionalisation of Australia
INMS	Integrated Noise Management System
IWSS	Integrated Water Supply Scheme
JIRZRP	Joint Intermediate Rainfall Zone Research Program
JORC	Joint Ore Reserves Committee
JTSI	Department of Jobs, Tourism, Science and Innovation
LOA	Life of Asset
LOC	Loss of Containment
LTFMP	Long Term Fauna Monitoring Programme
MDB	Minesite Drainage Book
ML	Megalitres
ML1SA	Mineral Lease 1SA
MMP	Mining and Management Program
MMPLG	Mining and Management Program Liaison Group

Abbreviation	Definition
MNES	Matters of National Environmental Significance
MOG	Mine Operations Group
MS	Ministerial Statement
Mtpa	Million tonnes per annum
MUSLE	Modified Universal Soil Loss Equation
NEMP	National Environmental Management Plan
NJF	Northern Jarrah Forest
NSHA	Noongar Standard Heritage Agreement
NTU	Nephelometric Turbidity Units
OCA1	Operational Control Area 1
OCA2	Operational Control Area 2
PDWSA	Public Drinking Water Source Areas
PEC	priority ecological communities
PER	Public Environmental Review
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
POW	Prisoner of War
RAMP	Recreation and Access Management Plan
RDD	Resource Definition Drilling
RIWI	Rights in Water and Irrigation Act 1914 (WA)
ROM	Run of Mine
RPZ	Reservoir Protection Zone
RTFMP	Recreational Trails and Facilities Management Plan
RUSLE	Revised Universal Soil Loss Equation
SCP	Swan Coastal Plain
SED	Strategic Exploration Drilling
SIA	Social Impact Assessment
Simcoa	Simcoa Operations Pty Ltd
SPMS	Social Performance Management System
SRE	Short-Range Endemic
TARP	Trigger Action Response Plan
tpa	tonnes per annum
TDS	Total Dissolved Solids

Abbreviation	Definition
TEC	Threatened Ecological Communities
TWL	Top Water Level
UAV	Unmanned Aerial Vehicle
WA	Western Australia
WC	Water Corporation
WRMP	Water Resource Management Plan
WWTP	Waste Water Treatment Plant

Definitions

Term	Definition
Activities	Refers to mining activities, and infrastructure development and sustainment.
Average pit slope	Average slope of a pit area based on Department of Land Administration (DOLA) derived slope dataset.
Black Cockatoo habitat trees	Trees on a haul road alignment that have the potential to provide nest hollows in the future. These are primarily marri trees with DBH \geq 500mm. The tree should already be starting to develop a hollow or have a form that is conducive to hollow formation.
Black Cockatoo nest trees	<p>A tree containing one or more hollows suitable as Black Cockatoo breeding habitat. A suitable hollow is based on hollow size, shape, and entry angle, irrespective of signs of use for breeding.</p> <p>Potential breeding trees that have hollows:</p> <ul style="list-style-type: none"> potentially suitable for breeding, being hollows of suitable diameter, height above ground and aspect, and not impacted by feral bees (i.e. potential breeding trees with suitable hollows); or with evidence of past use, such as a chewed entrance (i.e. actual breeding trees); or <p>that are currently being used (i.e. actual breeding trees).</p>
Black Cockatoo significant trees	Jarrah trees with DBH \geq 2000mm or Marri trees with DBH \geq 1500mm.
Clearing for mining	Refers to Alcoa's activities after FPC harvesting – removing native vegetation from the mining area in readiness for stripping of topsoil.
Completion criteria	Completion Criteria are agreed standards that indicate the success of rehabilitation and enable Alcoa to identify the standards to apply for handback/relinquishment. These are

Term	Definition
	developed with, and approved by, the MMPLG on the advice of DBCA.
Conservation significant fauna	<p>Environmental values which are protected by legislation or are considered to be of ecological importance, which includes:</p> <ul style="list-style-type: none"> • Threatened Fauna under BC Act and EPBC Act • Priority Fauna
Conservation significant flora or vegetation	<ul style="list-style-type: none"> • Environmental values which are protected by legislation or are considered to be of ecological importance, which includes: • Threatened Flora under BC Act and EPBC Act • Priority Flora • Significant species (novel species, range extensions, and restricted occurrences) • Vegetation types which support conservation significant flora species • Threatened ecological communities. • Priority ecological communities • State forest • Old growth forest
Drainage event or failure of drainage	Event where surface water runoff from the mining disturbance footprint to surrounding environment except where turbidity is measured below 25 NTU.
Drainage controls	Controls to manage surface water runoff from the mining disturbance footprint to surrounding environment
Environmentally hazardous material	Components of the waste stream which by its characteristics poses a threat or risk to public health, safety or the environment (includes substances which are toxic, infectious, mutagenic, carcinogenic, teratogenic, explosive, flammable, corrosive, oxidising and radioactive).
Exploration	Exploration drilling targets areas outside of Alcoa's current mining operational envelope with a broader extent but less intense activities, namely 240 m x 60 m, 120 m x 60 m, 60m x 60m, 30m x 30m, or 15m x 15m drilling densities.
Failure of containment infrastructure	Uncontrolled or unmanaged release of surface water from constructed drainage management infrastructure
Infrastructure	Includes any structures that enable or support mining activities including (but not limited to) stockpiles, haul roads, conveyors, crushers, water storage, and water pumps.
Landscaping	The act of moving or shaping the land, including, but not limited to, marginal amounts of clearing to re-slope pits and movement or removal of material or bauxite if needed, ripping, for the purpose of shaping the landform to blend with the surrounding environment in line with completion criteria.

Term	Definition
Mining activities	Refers to the integrated process of extracting bauxite from mineral reserves below the surface by coordinating the use of people and equipment. This refers specifically to removing topsoil and overburden, breaking caprock (blasting or ripping) to expose the viable bauxite, removal of viable bauxite, crushing and conveying bauxite to the refineries. Excludes infrastructure or rehabilitation activities.
Mining Avoidance Zone	Spatial area which prohibits mine pits and infrastructure, with the exception of monitoring and management activities which have minimal impacts
Mining Exclusion Zone	Spatial area which prohibits mine pits
Nesting Trees	A tree containing one or more hollows suitable as Black Cockatoo breeding habitat. A suitable hollow is based on hollow size, shape, and entry angle, irrespective of signs of use for breeding
Other operations	Adjunct activities associated with mining, infrastructure, and rehabilitation
Rehabilitation	The rehabilitation process consists of landscaping, ripping, returning overburden and topsoil, contour ripping and seeding, and access to perform these activities.
Rehabilitation season	Rehabilitation is undertaken all year round with a focus on the drier period for some activities. Weather dependent activities are undertaken typically from October to late April in the following year.
Stabilising	Landscaping and ripping to promote infiltration and manage surface water runoff.

Executive Summary

Alcoa of Australia Limited (Alcoa) has been mining and refining in Western Australia since 1963, employing directly approximately 4,300 people, some 2,200 of whom reside in the Peel region.

Alcoa operates two bauxite mines, located approximately 100 km south of Perth. The Huntly Mine, established in 1972, supplies bauxite to the Pinjarra and Kwinana refineries. The Willowdale Mine, established in 1984, supplies bauxite to the Wagerup Refinery.

Alcoa submits a mine plan for bauxite mining within Mineral Lease 1SA (ML1SA) to the State for review and approval. The 10 Year Mine Plan is submitted in accordance with clause 5 of the Alumina Refinery (Wagerup) Agreement Act 1978 (Wagerup State Agreement) and as voluntarily agreed by the State and Alcoa for mining not covered by the Wagerup State Agreement. Mining and Management Programs (MMP) are submitted to the Mining and Management Program Liaison Group (MMPLG) in accordance with *Environmental Protection Act 1986* Ministerial Statement 728 and the Pinjarra Refinery Efficiency Upgrade Environmental Protection Statement, which was approved by Ministerial Statement 646.

This 2024-2028 MMP (This MMP) has been developed to relate to Alcoa's proposed mining operations for Huntly and Willowdale mines within ML1SA from 1 January 2024 to 31 December 2027. This MMP is considered a technical rollover of the 2023-2027 MMP approved on 20 December 2023 by the Minister for State Development. It excludes mine development activities associated with Myara North or Holyoake mining regions currently under consideration by the Environmental Protection Authority¹ (EPA) and the Department of Climate Change, Energy, the Environment and Water² (DCCEEW).

Table ES 0-1 provides an overview of the proposed maximum final boundaries of native vegetation clearing that will enable mine pit and infrastructure design to be implemented. Clearing is presented for the 2024 to 2027 period. Clearing associated with the re-entry into the O'Neil mine region includes conceptual clearing buffers to provide flexibility for final infrastructure detailed design and further avoidance of environmental values.

Clearing for 2026 to 2027 is conceptual only and subject to change pending detailed design. This MMP requests endorsement of the 24 Month Clearing Schedule (2024 and 2025) with the remaining Five Year Clearing Schedule provided for consideration only. This table does not include areas that have been previously approved under an MMP and endorsed via Forest Clearing Advice (FCA) submissions.

The 24 Month Clearing Schedule has the potential to direct and indirectly impact upon conservation significant flora and fauna. Threatened fauna species considered likely to occur include three Black Cockatoo species, Chuditch, Quokka and Woylie. No direct impacts to Threatened flora are expected to occur, as any individuals identified from pre-clearance surveys will be avoided. Management Plans have been developed to minimise potential impacts.

Alcoa has committed to an annual clearing limit (800 ha) based on the committed rehabilitation rate (Commitment 1). This will deliver no net increase to open areas over the life of this MMP.

Table ES 0-2 provides a summary of the proposed rehabilitation plan for 2024-2027.

¹ Pinjarra Alumina Refinery Revised Proposal, Assessment No. 2253,

² Huntly Bauxite Mine (WA) Transition, EPBC 2022/09204

Following regulatory consultation, Alcoa has revised the 24 Month Clearing Schedule and Five Year Mine Plan to:

- Reduce mining inside higher risk areas within drinking water catchments.
- Increase rehabilitation and reduce open areas where possible, with priority in higher risk areas.
- Increase survey and monitoring, modernise standards.
- Improve transparency on the MMP, Management Plans and environmental review.

Commitments have been proposed in Table ES 0-3 to ensure the above objectives are met.

A schedule of activities has been provided in Table ES 0-4.

Table ES 0-1: Proposed Clearing Schedule for 2024-2027

Proposed Clearing	2024	2025	2026	2027
Proposed Conceptual Clearing Area for Huntly Mine (Ha)	926	762	605	785
Proposed Conceptual Area for Willowdale Mine (Ha)	422	358	331	297
Total Proposed Conceptual Clearing Area (Ha)	1,349	1,119	936	1,082
Proposed Conceptual Clearing Buffer (ha)	830			
Maximum Clearing Area (Ha)	800	800	800	800

Table ES 0-2: Proposed Rehabilitation Plan for 2024-2027

Proposed Rehabilitation	2024	2025	2026	2027
Rehabilitation for Huntly Mine	459	458	646	790
Rehabilitation for Willowdale Mine	179	196	218	213
Total Planned Rehabilitation (Ha)	638	654	864	1,003

Table ES 0-3: 2024-2028 MMP Commitments

#	Environmental Factor	Commitment
1	Flora and vegetation, terrestrial fauna, inland waters	Actual MMP-related clearing of native vegetation will be limited to 800ha per calendar year for the duration of the current MMP; annual clearing under the cap will be rolled over into the next years
2	Flora and vegetation, terrestrial fauna	Alcoa will not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024

#	Environmental Factor	Commitment
3	Inland waters	Alcoa will not undertake any clearing for mining within 1km of the top level of any water reservoir in Myara Central and Myara South
4	Inland waters	Alcoa will not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (excludes rehabilitation activities, and access)
5	Inland waters, flora and vegetation	Alcoa will not undertake any new pit clearing in any areas with an average pit slope greater than 16% within any Reservoir Protection Zone (RPZ, 2km from reservoir top water level)
6	Inland waters	<p>Clearing within 2km of Serpentine Dam top water level or within Serpentine Pipehead Catchment, must be either rehabilitated, stabilised, or have drainage controls in place within the first rehabilitation season available.</p> <p>Any clearing within 1km of Serpentine Dam top water level or within Serpentine Pipehead Catchment that is required for any purpose other than that prohibited, must be either rehabilitated, stabilised, or have drainage in place within the first rehabilitation season available</p>
7	Flora and vegetation, terrestrial fauna	Alcoa will relinquish 1,231 ha of FCAs endorsed prior to 1 September 2023, 1,016 ha in Huntly, and 214 ha in Willowdale
8	Inland waters	Provision of a detailed rolling 5 yearly stabilising, rehabilitation, and meeting completion criteria schedule by 31 December 2024
9	Inland waters	Alcoa will only undertake approved MMP clearing only after FCA endorsement has occurred
10	Stakeholder engagement	Publish current and future approved MMPs and associated Management Plan on the Alcoa website within 7 days of Alcoa receiving written notice of approval by the Minister for State Development
11	Flora and vegetation, terrestrial fauna	Increase the area (ha) in which rehabilitation activities are being undertaken each year over the next 4 years on a rolling basis, achieving a minimum of 3,159 ha of rehabilitation (cumulative) over this period (2024-2027)
12	Flora and vegetation, terrestrial fauna	Revise the Rehabilitation Completion Criteria by 31 December 2024, in consultation with DBCA
13	Inland waters	Reconstitute the Bauxite Hydrology Committee (BHC) with an independent chair by 1 July 2024
14	Inland waters	In consultation with the BHC, develop a full mining cycle planning approach and cumulative catchment scale risk assessment methodology. Consultation will occur on the following; (a) Development of the

#	Environmental Factor	Commitment
		Drainage Design Manual; and (b) Development of the Rehabilitation Design Manual
15	Inland waters	Provide Drainage Control Management Plans for FCA submissions as of 1 September 2023 for pits or haul roads within the public drinking water catchment areas. DCMPs will be developed using the Drainage Design Manual and field data and will include an assessment against the Groundwater Risk Assessment Framework (2021 Forest Clearing Advice 23 March 2022).
16	Inland waters	<p>Clearing for haul roads or pits where the average slope is greater than 16% or where sub-catchments in which mining disturbance is greater than 30% of the total sub catchment area will include:</p> <ul style="list-style-type: none"> a) Provision of pit and drainage control as-builts and details on any design variations to the Mine Operations Group twice a year, at least 4 months apart b) Provision of surface water and groundwater data as per an agreed monitoring schedule and any drainage or Loss of Containment events, to DWER and Water Corp c) Provision of conceptual rehabilitation designs to the Mine Operations Group six months after FCA approval, for areas with average pit slope greater than 16% <p>No clearing where TWI is greater than equal to 9, and groundwater data availability is less than 12 months</p>
17	Flora and vegetation, Terrestrial fauna, Inland waters	Implement by 31 December 2024, the Flora and Vegetation, Fauna, and Recreational Trails and Facilities Management Plans
18	Flora and vegetation, terrestrial fauna	Where reasonably practicable to do so, undertake targeted surveys and associated risk avoidance & management for all future clearing under the MMP, as per the Flora and Vegetation and Fauna Management Plans
19	Flora and vegetation, terrestrial fauna	All revisions of Flora and Vegetation and Fauna Management Plans will be done in consultation with the Department of Biodiversity, Conservation and Attractions (DBCA)
20	Social surroundings	Alcoa will revise Recreational Trails and Facilities Management Plan in consultation with DBCA and relevant stakeholders by 31 December 2024
21	Inland waters	Implement the current draft Water Resources Management Plan (WRMP), and revise and implement updated WRMP within six months after receiving feedback from MMPLG
22	Social surroundings	In consultation with Gnaala Karla Booja, prepare a ML1SA operational Cultural Heritage Management Plan by 31 December 2024

Table ES 0-4: 2024-2028 MMP Activity Schedule

Activity	Location	Extent					
Physical activities							
Huntly Mine activities, including: <ul style="list-style-type: none"> • Pits • Haul Roads • Topsoil stockpiles • Conveyors • Supporting infrastructure • Rehabilitation 	Figure 3-4	The clearing limit for Huntly and Willowdale combined is detailed in Table 1. Physical activities will be contained within the Operational Clearing Areas as detailed in Table 1. The maximum clearing within restricted areas is detailed within the Restricted Clearing Areas in Table 1. Table 1: Maximum clearing extent					
		Clearing Type	Timeframe				Total
			2024	2025	2026	2027	
		Clearing Limit (Huntly & Willowdale combined) ³	800	800	800	800	3,200
Operational Clearing Areas							
		Conceptual clearing area	926	762	605	785	3,078
		Conceptual clearing buffer	726		-	-	726
		FCA Endorsed Areas	792				792
		Open Areas	3,998				3,998

³ Clearing limit applies to actual MMP-approved clearing and any surplus clearing from one year may roll over into subsequent years

Activity	Location	Extent					
		Rehabilitated areas	13,418				13,418
		Restricted Clearing Areas					
		Within 200m of Reservoir Top Water Level	13	4	-	-	17
		Within 1 km of Reservoir Top Water Level	15	4	-	0	18
		Within Reservoir Protection Zone	100	42	42	24	209
		Within Public Drinking Water Catchment	927	758	605	785	3,076
		An indicative rehabilitation plan is detailed in Table 2.					
		Table 2: Rehabilitation Plan					
		Rehabilitation Type	Timeframe				Total
			2024	2025	2026	2027	
		Within 1 km of Reservoir Top Water Level	137	198	91	-	427
		Within Reservoir Protection Zone	204	388	399	123	1,114
		Within Public Drinking Water Catchment	457	458	616	790	2,322
		Total rehabilitation	459	458	646	790	2,353

Activity	Location	Extent						
Willowdale Mine activities, including: <ul style="list-style-type: none"> • Pits • Haul Roads • Topsoil stockpiles • Conveyors • Supporting infrastructure • Rehabilitation 	Figure 3-6	The clearing limit for Huntly and Willowdale combined is detailed in Table 3. Physical activities will be contained within the Operational Clearing Areas as detailed in Table 3. The maximum clearing within restricted areas is detailed within the Restricted Clearing Areas in Table 3. Table 3: Maximum clearing extent						
		Clearing Type		Timeframe				Total
				2024	2025	2026	2027	
		Clearing Limit (Huntly & Willowdale combined) ⁴		800	800	800	800	3,200
		Operational Clearing Areas						
		Conceptual clearing area		422	358	331	297	1,408
		Conceptual clearing buffer		2	26	39	36	103
		FCA Endorsed Areas		281				281
		Open Areas		1,687				1,687
		Rehabilitated areas		5,041				5,041

⁴ Clearing limit applies to actual MMP-approved clearing and any surplus clearing from one year may roll over into subsequent years

Activity	Location	Extent					
		Restricted Clearing Areas					
		Within 200m of Reservoir Top Water Level	-	-	-	-	0
		Within 1 km of Reservoir Top Water Level	-	-	-	-	0
		Within Reservoir Protection Zone	-	-	-	-	0
		Within Public Drinking Water Catchment	421	284	166	175	1,047
An indicative rehabilitation plan is detailed in Table 4.							
Table 4: Rehabilitation Plan							
		Rehabilitation Type	Timeframe				Total
			2024	2025	2026	2027	
		Within 1 km of Reservoir Top Water Level	-	-	-	-	0
		Within Reservoir Protection Zone	-	-	-	-	0
		Within Public Drinking Water Catchment	51	61	175	213	500
		Total rehabilitation	182	196	218	213	809
Operational elements							

Activity	Location	Extent
Bauxite production	Figure 3-4	Production of up to 38 Mtpa (wet) of bauxite ore
Water abstraction	Figure 3-6	Abstraction of 3.7 GL/annum
Bauxite Crushing		Processing of up to 38 Mtpa (wet) of bauxite ore
Bauxite conveying and transport		Transport of up to 38 Mtpa (wet) of bauxite ore
Exploration	Appendix 1	105,000 drill holes per year within the Drilling Area (233,488 ha)

1 Legislative Framework

1.1 Introduction and Background

Alcoa of Australia Limited (Alcoa) began operations in Western Australia (WA) in 1963 with the commissioning of the Kwinana Refinery, in accordance with the *Alumina Refinery Agreement Act 1961*. This State Agreement, between Alcoa and the WA Government, permitted Alcoa to mine bauxite within Mineral Lease 1SA (ML1SA). The area extends from Mundaring to Collie, and the agreement initially supported development of the Kwinana Refinery. Since then, Alcoa and the WA Government struck two further State Agreements covering the development of the Pinjarra Alumina Refinery and the Wagerup Alumina Refinery:

- Alumina Refinery (Pinjarra) Agreement Act 1969.
- Alumina Refinery (Wagerup) Agreement and Acts Amendment Act 1978.

These three State Agreements support the entirety of Alcoa's operations in Western Australia and the approximately 4,300 associated direct jobs and 1,600 indirect jobs, predominantly in regional areas. Alcoa's Western Australian operations include the following facilities:

- Two bauxite mines (Huntly and Willowdale).
- Three alumina refineries (Kwinana, Pinjarra and Wagerup).
- Two dedicated port facilities (Kwinana and Bunbury).

1.2 Purpose and Objective of this Document

The purpose of this document is to fulfill Alcoa's requirements to submit a 10-Year Mine Plan⁵ and an annual MMP that provides a rolling five-year operational plan⁶. The MMP requires approval from the Minister for State Development, on advice received from the MMPLG and with concurrence from the Minister for the Environment, Minister for Water and Minister for Forestry.

This MMP is structured to facilitate regulators and stakeholders to assess, consider and endorse Alcoa's plan for operations at the Huntly and Willowdale mines.

The 2023 – 2027 MMP was submitted on 29 November 2022 and resubmitted on 31 January 2023 and subsequently withdrawn. Submission of this MMP meets Alcoa's requirement to submit an annual MMP during 2023. This MMP is considered a technical rollover of the 2023-2027 MMP approved on 20 December 2023 by the Minister for State Development.

Based on ongoing consultation with the MMPLG, significant work has been undertaken to improve the structure of this document to provide more comprehensive technical content to support ongoing and future mine operations. Alcoa acknowledges that future MMPs will continue to improve and evolve, based on feedback from review and consultation processes.

⁵ Clause 5 of the *Alumina Refinery (Wagerup) Agreement Act 1978 and Acts Amendment Act 1978*

⁶ MMPLG Terms of Reference (July 2020)

This MMP, and the information that unpins it, demonstrates that risks and impacts are well understood, and will be adequately managed to, as low as reasonably practicable.

1.3 State Agreement Acts

Alcoa's WA mines operate within ML1SA (Figure 1-1) under the following State Agreement Acts:

- Alumina Refinery Agreement Act 1961
- Alumina Refinery (Pinjarra) Agreement Act 1969
- Alumina Refinery (Wagerup) Agreement Act 1978 and Acts Amendment Act 1978
- Alumina Refinery Agreements (Alcoa) Amendment Act 1987.

ML1SA was granted under *the Alumina Refinery Agreement Act 1961*.

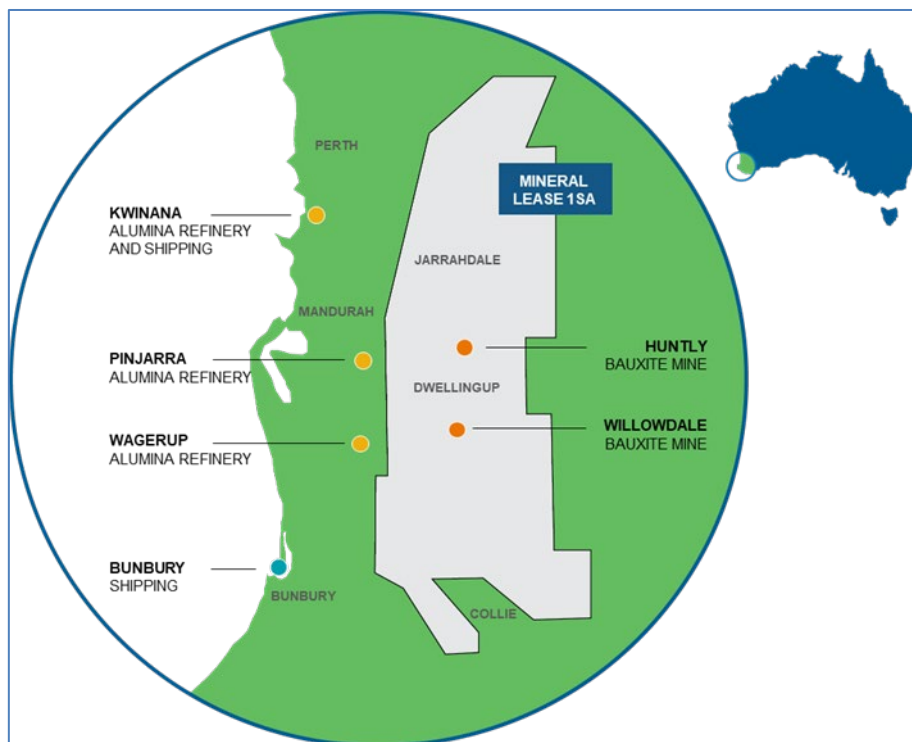


Figure 1-1: ML1SA and locations of Alcoa mining operations

Alcoa's operations are assessed through various Environmental Impact Assessment (EIA) processes by the WA Government and relevant agencies. To date, Alcoa's operations have been approved under these robust statutory processes with the inclusion of specified controls. Alcoa complies with, the processes under relevant State Agreements, legislation, and legislative instruments. A list of current approvals and licences held by Alcoa for its WA operations is included in Table 1-1.

Clause 5 of the *Alumina Refinery (Wagerup) Agreement Act 1978 and Acts Amendment Act 1978* requires Alcoa (after consultation with the Conservator of Forests) to annually prepare and submit a mining plan outlining proposed mining operations during the succeeding ten years (10-year mining plan).

Alcoa's mining operations have been assessed by various regulatory agencies, as detailed in the table below.

Table 1-1: Statutory Approvals and Licences

Legislation	Approval/Licence	Expiry Date
State Agreement	<i>Alumina Refinery Agreement Act 1961</i> <i>Alumina Refinery (Pinjarra) Agreement Act 1969</i> <i>Alumina Refinery (Wagerup) Agreement and Acts Amendment Act 1978</i> <i>Alumina Refinery Agreements (Alcoa) Amendment Act 1987</i>	-
<i>Biodiversity Conservation Act 2016</i>	Authorisation to take or disturb Threatened Fauna in a Management Operation (section 40)	Application in progress
<i>Environmental Protection Act 1986 - Part IV</i>	Wagerup Refinery Ministerial Statements 728, 1069, 1157 Pinjarra Refinery Ministerial Statement 646	-
<i>Environmental Protection Act 1986 - Part V</i> Operating Licences	Huntly Mine: L6210/1991/10 Willowdale Mine: L6465/1989/10	12 September 2035 [amended 09/02/2021] 4 October 2031 [amended 30/11/2020]
<i>Environmental Protection Act 1986</i>	Alcoa – Huntly and Willowdale Mine Sites Exemption Order 2004	
<i>Dangerous Goods Safety (Storage or Handling of Non-Explosives) Regulations 2007</i>	Huntly Mine Licence: DGS008201 Willowdale Mine: DGS009279	14 April 2024 28 July 2026
<i>Dangerous Goods Safety (Explosives) Regulations 2007</i>	Huntly Mine Licence: ETS002357 Willowdale Mine: ETS002354	18 May 2024 18 May 2024
<i>Rights in Water and Irrigation Act 1914</i>	Banksiadale Dam: 63409 Pig Swamp Waterhole: 153635 Boronia Dam: 83356 Marrinup Nursery: 68893 Samson Dam: 61024	10 January 2024 10 January 2024 10 January 2024 9 January 2024 22 December 2022

1.4 Environmental Protection Act 1986

1.4.1 Wagerup Refinery and Willowdale Mine

The Wagerup Refinery was first granted State government approval in 1978 under *Alumina Refinery (Wagerup) Agreement Act 1978 and Acts Amendment 1978*. The approval was for a Refinery

production capacity of up to 2 million tonnes per annum (Mtpa) which was commissioned in 1984 and had a capacity of 670,000 tonnes per annum (tpa) which was expanded to 840,000 tpa in 1988. The associated Willowdale Bauxite Mine was established that same year. It is located in the Darling Scarp, east of Waroona and Cookernup and supplies bauxite ore to the Wagerup Refinery. In 2020, Willowdale Mine supplied approximately 10 million tonnes of bauxite to the Wagerup Refinery via a direct overland conveying system.

In January 2021, amendments to MS 728 via MS 1157 permitted the refinery to increase production in two stages, the first to 3.3 Mtpa, and the second to 4.7Mtpa. Each stage is subject to implementation of Ministerial conditions. Table 1-2 provides a history of the Ministerial Statements (MS) at Wagerup Refinery.

Table 1-2: History of Ministerial Statements at Wagerup Refinery

Activity	Statement Number	Approval Year
Consultative Environmental Review	N/A	1989
Wagerup Alumina Refinery Expansion	MS 095	1990
Increase in Alumina Production to 3.3 Mtpa at Wagerup Alumina Refinery, and Associated Bauxite Mining Activities	MS 390	1995
Amend Conditions Applying to the Proposal: Increase in Alumina Production to 3.3 Mtpa at Wagerup Alumina Refinery, and Associated Bauxite Mining Activities	MS 564	2001
Revised Proposal: Wagerup Alumina Refinery – Production to a Maximum Capacity of 4.7 Mtpa and Associated Bauxite Mining	MS 728	2006
Amend Conditions Applying to the Proposal: Wagerup Alumina Refinery – Production to a Maximum Capacity of 4.7 Mtpa and Associated Bauxite Mining	MS 897	2012
Amend Conditions Applying to the Proposal: Wagerup Alumina Refinery – Production to a Maximum Capacity of 4.7 Mtpa and Associated Bauxite Mining	MS 1069	2017
Amend Conditions Applying to the Proposal: Wagerup Alumina Refinery – Production to a Maximum Capacity of 4.7 Mtpa and Associated Bauxite Mining	MS 1157	2021

1.4.2 Kwinana Refinery, Pinjarra Refinery and Huntly Mine

1.4.2.1 Kwinana Refinery

On commencement of the EP Act in 1987, State Agreements were expressly exempt from the operation of the legislation. In 2003, the specific exemption for State Agreements was removed. However, given Kwinana’s operations predate the introduction of the Act, assessment under the EP Act has never been required.

Future approvals under Part IV of the EP Act (refer to section below), will approve clearing and mining activities for new Huntly Mine regions to supply bauxite to the Pinjarra and Kwinana Refineries under a contemporised assessment process.

1.4.2.2 Pinjarra Refinery and Huntly Mine

In December 2003, Alcoa referred a change to the refinery under Part IV of the EP Act. The referral document, *Pinjarra Refinery Efficiency Upgrade, Environmental Protection Statement (EPS)*, outlined an increase in production from 3.5 Mtpa to 4.2 Mtpa and associated increase in the bauxite mining rate.

The proposal was assessed and approved by MS 646, which was granted in March 2004. Schedule 1 of MS 646 sets out the key proposal characteristics of alumina production of 4.2 Mtpa and a project life of greater than 45 years.

The EPS document included a commitment that bauxite mining would continue to be undertaken following an MMP approved by the Minister for State Development in concurrence from the Minister for Environment and the MMPLG. The MMPLG is recognised by the Minister for Environment in Ministerial Statements (95, 390, 564, 728, 897, 1069 and 1157) regarding expansion of Alcoa operations.

Environmental Protection Act 1986 Ministerial Statement 728 and the Pinjarra Refinery Efficiency Upgrade Environmental Protection Statement⁷ require that, in addition to the 10-year mining plan, Alcoa will submit mining and management programmes to the State. These programmes will specify the areas which are proposed to be mined, the method of mining and the proposed method of rehabilitation in accordance with the procedures agreed between Alcoa and the State.

Changes to the proposal were approved under Section 45C of the EP Act after MS 646 was issued (MS 646 Attachment 1 (1 July 2008) and MS 646 Attachment 2 (21 September 2015)). Approval of the second amendment in 2015 increased the maximum production of the refinery to 5.0 Mtpa with an associated increase in bauxite mining at the Huntly Mine.

In June 2020, Alcoa submitted the Pinjarra Alumina Refinery Revised Proposal (Revised Proposal), Assessment No. 2253, to the EPA proposing an increase in Pinjarra Refinery's alumina production by 5%, from 5.0 Mtpa to 5.25 Mtpa and an increase to the mining rate to supply up to 2.5 Mtpa of bauxite for export from the Huntly Mine⁸. The Revised Proposal is under assessment and covers mining operations for Huntly Mine when the mine relocates from the current Myara region to Myara North.

This MMP includes current and proposed mining areas within the Myara mining region and excludes mine development activities associated with Myara North or Holyoake mine regions or matters currently under consideration by the EPA.

1.4.2.3 Future Huntly Mining Areas and Approvals Framework

In response to stakeholder feedback and to meet contemporary expectations, Alcoa is modernising its environmental approvals framework for its Huntly Bauxite Mine, by referring proposal for future mining regions for assessment under Part IV of the State *Environmental Protection Act 1986* and the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The referrals were associated with the Pinjarra Alumina Refinery, given the associated MS 646 referral included mining activities. The proposal for future mining regions that have been referred to both state and federal departments (which were triggered by an increase in already authorised rates of bauxite mining), involve the following components:

⁷ Approved by Ministerial Statement 646

⁸ A section 43A request to change the Proposal submitted on 19 May 2023 includes the removal of the bauxite export component.

- The transition of Huntly Mine into the proposed Myara North and Holyoake mine regions within ML1SA (inclusive of bauxite for the Pinjarra Alumina Refinery and the Kwinana Alumina Refinery).
- An increase in the rate of mining within ML1SA to supply up to 2.5Mtpa of bauxite for export⁶.

The EPA (State) has determined that the Revised Proposal, which includes the Huntly Bauxite Mine, will be assessed via a Public Environmental Review (PER) with ten weeks of public consultation.

Alcoa referred two separate Proposed Actions under the *EPBC Act* (Commonwealth) for the following components:

- Huntly Bauxite Mine Transition – Myara North and Holyoake; and
- Pinjarra Alumina Refinery – development of water storage ponds and associated borrow pits.

The referral of these Proposed Actions has been determined as controlled actions, and as such, require assessment under the *EPBC Act*.

The resulting Environmental Impact Assessment (EIA) will inform stakeholders on long-term mine plans and environmental management requirements and facilitate the setting of contemporary approval conditions.

Subject to receipt of relevant approvals, construction for Myara North is planned to commence in approximately mid-2025 with mining to be fully operational from approximately mid-2027. Alcoa plans to commence construction, to facilitate the transition to Holyoake, from approximately 2028 and commence operation from approximately 2030.

1.5 Mining and Management Program Liaison Group (MMPLG)

The MMPLG was initially created in 1979 by an arrangement between Alcoa and the State pursuant to clause 5 (Mining Plan) of the *Alumina Refinery (Wagerup) Agreement and Acts Amendment Act 1978*.

The Bauxite Mining Operations of Alcoa of Australia Ltd – Guidelines for Submission and Approval of Mining and Management Programmes dated 13 February 1979 contemplated that a cross-agency working group of senior State officers would liaise with Alcoa in the preparation of the initial MMP and thereafter as necessary. Ministerial Statement 728 identifies the MMPLG as comprising representatives of State Government agencies whose areas of responsibility are affected by the mining operations of Alcoa. MS 728 states that the MMPLG will continue to review Alcoa's mining plans, manage issues relating to its mining operations and coordinate environmental auditing of Alcoa's MMP. Alcoa consults closely with the State on the preparation of these programmes and does not implement these programmes until agreement has been reached with the State or they have been determined by arbitration.

1.5.1 Role of Mining and Management Program Liaison Group

The MMPLG's primary roles⁹ are to:

1. Oversee all activities within ML1SA that involve Alcoa's mining, infrastructure, environmental and any other associated activities that occur within ML1SA.
2. Provide advice to the Minister for State Development (responsible for the three Alcoa State Agreements) on the environmental and social acceptability of the MMPs – which are the five year 'rolling' mine plans prepared annually by Alcoa.
3. Endorse clearing for mining and associated infrastructure and activities, in line with the MMPs approved by the responsible Minister. [Note: Under the *Environmental Protection (Alcoa – Huntly and Willowdale Mine Sites) Exemption Order 2004*, clearing within ML1SA is exempt from section 51C of the EP Act, provided the clearing is in accordance with a mining plan approved by the Minister for State Development, taking into account advice from the Mining for the Environment and the MMPLG.]
4. Oversee the activities of the Mining Operations Group (MOG), which was created to address ongoing operational issues within ML1SA.
5. Evaluate Alcoa's planned incursions into Comprehensive Adequate Representative (CAR) Informal Reserves within ML1SA as required under the Regional Forest Agreement.

1.5.2 Representatives of Mining and Management Program Liaison Group

The MMPLG is chaired by the Department of Jobs, Tourism, Science and Innovation (JTSI) and comprises the following State Government agencies:

- Department of Biodiversity, Conservation and Attractions (DBCAs)
- Department of Mines, Industry Regulation and Safety (DMIRS)
- Department of Planning, Lands and Heritage (DPLH)
- Department of Water and Environmental Regulation (DWER)
- Water Corporation (WC).

1.5.3 Sub-committees of the Mining and Management Program Liaison Group

The MMPLG has two sub-committees:

- Mining Operations Group (MOG); and
- CAR Informal Reserves Evaluation Committee (CARIREC).

The role of MOG is to oversee and report to the MMPLG on environmental and community issues arising from Alcoa's operational activities. The MOG also endorses the Forest Clearing Advice (FCA).

CARIREC was established to evaluate Alcoa's planned incursions into CAR Informal Reserves within ML1SA, as required under the Regional Forest Agreement. The CARIREC reports its findings and

⁹ MMPLG Terms of Reference as of July 2020

recommendations to the MMPLG which makes its recommendations directly to the EPA on the acceptability of the incursions into CAR Informal Reserves.

1.5.4 Mining and Management Program

The MMP (this document) details the proposed Five Year Mine Plan, relevant operational details, environmental management, and community consultation and is submitted annually to the MMPLG.

The MMP relates to:

- activities contained within the Five Year Mine Plans, as shown in Figure 3-4 and Figure 3-6 for Huntly and Willowdale, respectively;
- activities contained within the Drilling Approval Area (Appendix 1); and
- minor clearing activities associated with installation of monitoring infrastructure and remediation rehabilitation activities.

It should be noted that the minor clearing activities occur outside of the Five Year Mine Plan spatial extent, including:

- installation of monitoring infrastructure for surface water, groundwater and air quality; and
- minor clearing for rehabilitation remediation activities such as drainage control.

Prior to disturbance, the minor clearing activities associated with these activities will be applied for and approved by the DBCA Mining Liaison Officer, through delegation by the MMPLG. The DBCA Local Notice clearing approval process allows Alcoa to seek permission to clear areas less than 1 hectare at short notice. Approval will be carried out under the DBCA's Disturbance Approval System or approved under a Regulation 4 Lawful Authority under the *Conservation and Land Management Regulations 2002*. Any clearing approved by Local Notice is reported in the Annual Environmental Review.

1.5.5 Environmental Review

Ministerial Statement 728 (as amended by MS 1157) Condition 5 Compliance Reporting requires Alcoa to submit an Annual Audit Compliance Report (AACR) for the previous 12-month period. The AACR provides a summary of conditions, procedures and commitments outlined within the Ministerial Statement and is submitted by the end of March.

Commitment 11 in Schedule 2 of MS 728 requires Alcoa to submit a brief review of research and management program annually to JTSI with a more detailed review submitted triennially. The 2021 and 2022 Environmental Reviews were submitted to JTSI with the triennial report for 2021 to 2023 due in 2024.

1.5.6 Forest Clearing Advice

On 30 June 2004, the WA Government proclaimed amendments to the EP Act, to enhance native vegetation protection (Government Gazette 2004/114). In recognition of the annual MMP process, the Minister for the Environment additionally proclaimed the *Environmental Protection (Alcoa – Huntly and Willowdale Mine Sites) Exemption Order 2004*.

This order requires Alcoa to undergo an assessment of clearing areas via the annual MMP process rather than requiring a clearing permit under Part V of the EP Act. This provides Alcoa with clearing endorsement, within ML1SA, in accordance with a mine plan approved by the Minister for State Development.

A Forest Clearing Advice (FCA) is used to obtain endorsement to clear within Conceptual Clearing Areas (as per the 5-Year Mine Plan), approved by MMPs. The FCAs are submitted to the MOG, at an average rate of two per year. Endorsement of the FCA, by MOG, is required before commencing vegetation clearing activities including timber harvesting for mining, haul roads and constructing associated infrastructure.

The FCA process was introduced in order to allow specific issues arising from the implementation of proposed clearing activities within the approved conceptual areas to be resolved at a more granular or technical level (between Alcoa and the MOG), without overtaking the MMP approval process. Alcoa will only undertake approved MMP clearing, after an FCA endorsement has occurred (Commitment 9).

2 Exploration Drilling

2.1 Types of Drilling

Exploration drilling provides detailed information to support Alcoa's long term strategic decisions and planning for near term future mine development.

Alcoa undertakes two styles of drilling campaign to obtain information for mine planning purposes. Although using different drilling techniques, both types of drilling are aligned in operating practices and risk management controls to ensure minimal to no ground disturbance in the lease.

2.1.1 Exploration and Development

Exploration and development drilling is used to define the lateral and vertical extents of ore bodies, understanding the location and quality of bauxite and improve the confidence of tonnes and grade estimations. It represents the bulk of drilling activity and utilises a fleet of tractor-mounted drill rigs, which have been modified to operate in forested areas with minimal ground disturbance. While this fleet uses drilling techniques generally used in the WA mining sector, it has been customised to be compact and self-contained (no support trucks). This suits the environment and the smaller diameter shallow holes it drills.

Exploration drilling targets areas outside of Alcoa's current mining operational envelope with a broader extent but less intense activities, namely 240 m x 60 m or 120 m x 60 m drilling densities. The results from this drilling activity are used to inform longer-term strategic business decisions. For MMPLG agencies, this allows for longer-term knowledge for planning and assessment of mining constraints (i.e., heritage, water resource planning, forest management planning).

Development drilling activity enables improved resource knowledge, evaluation of future mine development options, and accurate identification of the proposed clearing boundaries. This drilling is completed in three phases of targeted drilling, namely 60 m x 60 m, 30 m x 30 m and 15 m x 15 m drilling densities.

The exploration and development drilling program areas are shown in Appendix 1

2.1.2 Supplementary Drilling

Alcoa is proposing to undertake a small volume of supplementary drilling, namely diamond drilling or triple tube aircore as part of ongoing exploration activities. This work aims to improve Alcoa's knowledge of the regolith profile, water tables, geophysical and metallurgical properties of bauxite. It will provide additional information that may be required to support mining studies with respect to approvals, mining and processing.

Alcoa plans to hire the most suitable drill rigs available that can operate without the requirement to construct tracks, pads or sumps. The drill rigs will be of a compact design utilising a method to recirculate and contain drilling fluids for off pad disposal. Drill rigs accessing uncleared forest will be mounted on metal tracks helping to minimise soil compaction. Holes will be of a diameter up to 140 mm with a maximum depth of 60 m, holes will be collar cut and plugged in-line with DMIRS drill hole rehabilitation guidelines.

The environmental impact of this activity will be low as there will be less than 50 holes per annum that will be drilled. The path to the drill location will be pre-planned and marked to ensure the rig can access with minimal disturbance to the forest.

In the event that ground disturbance is visibly greater than the typical exploration and development tractor-mounted drill rigs, appropriate rehabilitation of that disturbance will be undertaken. Rehabilitation will be back to a level equivalent to the disturbance that typically results from the exploration and development tractor-mounted drill rigs traversing through the forest. Such rehabilitation can be completed through the use of manual hand tools, however the specific methodology will be dictated by the scale and nature of the disturbance. Where ground disturbance requires rehabilitation, a selection of locations will be photographed for record keeping by Alcoa's Environmental Department; showing prior to rehabilitation, immediately post rehabilitation and one year post rehabilitation.

2.2 Drilling Approval Plan

The 2024-2028 Drilling Approval Plan (DAP) details the location of drilling and is provided in Appendix 1. Appendix 2 details the extent of the DAP on various land tenures. The plan covers activities such as access considerations and provides alignment with forest management activities (i.e. harvesting, controlled burns). These items are discussed during the annual Forest Management Conflict Meetings, held with Alcoa, Forest Products Commission (FPC), DBCA and WC.

In 2021, Alcoa completed a review of bauxite resources in previously mined areas to optimise reserves within ML1SA. This work identified the need for additional Strategic Exploration Drilling (SED) in various areas to provide early, additional information on mineralisation presence, extent, quality, and continuity. The proposed DAP therefore reflects an expanded program to further investigate residual resource within historically mined areas.

The maximum number of holes drilled per year does not exceed 105,000 (Table 2-1) of which is small and shallow holes, in comparison to standard exploration drilling practices, Alcoa utilises custom built drill rigs, which has been designed to be compact and self-contained (no support trucks or drill pads is needed), therefore significantly reducing the impact in comparison to standard exploration drilling rigs. In addition, the holes drilled by the tractor-mounted drill rigs (being 3m in width) are smaller in diameter and shallower (being 4.5cm to 7.5cm diameter holes), to an average depth of 6m. This is more suitable for drilling in a forested areas, and therefore, no clearing takes place and minimises the impact to the environment. Disturbance to ground occurs, only in the event the smaller custom-built drill rig drives over shrub vegetation. However, where possible, drilling is undertaken in minimal vegetated areas.

Table 2-1: Indicative Exploration Drilling Plan Per Year

Drill Spacing (m)	Holes per hectare	Number of holes planned per year	Number of hectares where we operate per year	Active exploration area per year (ha)
60 x 60	2.8	10,375	3,735	189
30 x 30	11.1	33,875	3,049	305

Drill Spacing (m)	Holes per hectare	Number of holes planned per year	Number of hectares where we operate per year	Active exploration area per year (ha)
15 x 15 (infill)	44.4	44,000	990	198
Strategic drilling, incremental capacity	2.8	16,750	6,030	302
Total		105,000	13,804	991

2.3 Potential Impacts

The following environmental values have the potential to be impacted from exploration drilling activities:

- Heritage values
- Fauna
- Flora and vegetation
- Water
- Spread of dieback

2.4 Mitigation

Alcoa's environmental management includes the mitigation hierarchy, consistent with standard environmental risk management principles, in the following order:

- Impact avoidance
- Impact minimisation
- Rehabilitation

As stated above (Section 2.3), significant work has been undertaken to develop custom built drill rigs, which are more suited to forested areas, therefore ensuring impact minimisation.

The associated mitigation actions are provided in Table 2-2 as a risk register. A risk-based approach has been taken to align with Alcoa's environmental management system and management plans. The risk assessment methodology is provided Appendix 3 .

Table 2-2: Exploration Drilling Environmental Risk Assessment

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Damage or harm to / loss of Aboriginal cultural heritage	<p>Non-compliance with Alcoa's Aboriginal Cultural Heritage Standard (Global Standard)</p> <p>Impact to unidentified Aboriginal cultural heritage</p>	<ul style="list-style-type: none"> Compliance with Cultural Heritage Mitigation Hierarchy – consisting of avoid, minimise based on site avoidance survey outcomes. No drilling is undertaken within the standard buffer for Dandalup River. No drilling is undertaken within the 100m buffer of the Serpentine River. 	<ul style="list-style-type: none"> Alcoa's GIS Constraints Layer - which includes heritage survey results and a 10m non-negotiable buffer on Aboriginal cultural heritage sites. Training package presented as part of Alcoa's initial training induction to all employees on Aboriginal cultural heritage. Prior to any proposed exploration drilling activity, on-ground site avoidance surveys are undertaken with knowledge holders for the area(s). 	<ul style="list-style-type: none"> 	Low
Damage to / loss of European heritage sites	Impact to unidentified European heritage site		<ul style="list-style-type: none"> Desktop reviews of European heritage Drilling program designed to avoid European heritage sites. Consultation with stakeholders prior to disturbance and development of a European Heritage 	<ul style="list-style-type: none"> 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			Management Plan will be considered		
Loss of fauna due to entrapment			<ul style="list-style-type: none"> • Exploration drilling holes capped immediately 	<ul style="list-style-type: none"> • 	Low
Increase in feral predator populations as a result of exploration drilling activities	Direct loss of, or injury to, individual fauna Competition of food resources Destruction of habitats		<ul style="list-style-type: none"> • Custom build drill rigs to suit forested areas. • Maintain current contributions to Western Shield program and other feral control programs. • All exploration phase food wastes bagged and disposed off-site. • No domestic animals are to be brought onsite by mining personnel or contractors. • All construction and operational food wastes stored in containers with secured lids and disposed off-site at a licensed waste facility 	<ul style="list-style-type: none"> • 	Low
Direct loss of conservation significant vegetation, communities and flora individuals from clearing	Significant impacts to conservation significant flora populations, vegetation or communities as a result of clearing activities	<ul style="list-style-type: none"> • Implementation of Exploration Avoidance Zones for: <ul style="list-style-type: none"> ○ DBCA Old growth forest 	<ul style="list-style-type: none"> • Custom build drill rigs to suit forested areas. • Spatial data of conservation significant flora and communities retained and review as Surface Disturbance 	<ul style="list-style-type: none"> • 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	Impact to threatened flora individuals or communities without regulatory consultation and appropriate approvals	<ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1) ○ National Park, formal conservation reserves ○ Bibbulmun Track ○ Drill program to avoid conservation significant flora. 	<p>Procedure to ensure clearing impacts are not significant.</p> <ul style="list-style-type: none"> ● Training for all personnel around requirements for licences to handle/remove flora 		
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from drill rigs or other vehicles.	<p>Localised contamination of surface water and/or groundwater</p> <p>Cumulative contamination of surface water and/or groundwater</p> <p>Localised contamination of PDWSA</p>	<ul style="list-style-type: none"> ● No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1) 	<ul style="list-style-type: none"> ● Custom build drill rigs to suit forested areas. ● Maintenance programs & pre-start checks. ● Re-fuelling procedure ● Personnel inductions / training - LOC and spill response ● Drill rigs chemical approval process. ● Authority to proceed procedure for contractors. ● Regular audits & inspections ● Spill kits and spill remediation equipment kept on hand. ● Emergency response team and procedure 	<ul style="list-style-type: none"> ● 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> • Remediation Validation Procedure • Pre-mobilisation inspections 		
Risk of bacterial contamination of groundwater and/or surface water as a result of human pathogens.	<p>Localised contamination of surface water and/or groundwater.</p> <p>Localised contamination of PDWSA</p>	<ul style="list-style-type: none"> • No exploration drilling activities occur within Serpentine Pipehead Dam Catchment. 	<ul style="list-style-type: none"> • Where practicable, personnel should use designated ablution block facilities, if this is not possible then biological waste must be bagged and disposed of at a designated disposal location outside of the RPZ. • Reservoir Protection Zone Management Plan (AUACDS-2053-5554) • Fit for work policy includes restriction to RPZ for personnel with gastrointestinal symptoms. • Minimise worker access in stream zones. • Worker training and awareness around hygiene practises within the RPZ. 	<ul style="list-style-type: none"> • 	Low

During the development of the exploration drilling program, environmental attributes and protected areas are identified, as detailed in Table 2-3.

Table 2-3: Environmental Constraints Avoided for Exploration Drilling

Environmental Constraints	Environmental Constraints Avoided
Old Growth Forest	Yes
National Parks / Formal Conservation Reserves	Yes
Aboriginal Cultural Heritage Sites	Yes
Serpentine Pipehead Catchment	Yes
Operational Control Area 1 (OCA1), within 200 m of the Top Water Level (TWL) of a drinking water dam	Yes
Avoid features in Constraints layer (including heritage, black cockatoo trees, etc)	Yes
Bibbulmun Track (200 m buffer on either side)	Yes
Will not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (excludes rehabilitation activities, and access) (Commitment 4)	Yes

When preparing DAPs, Geographical Information System (GIS) mapping of environmental constraints is used to identify potential interaction risks, ensuring drill points are identified away from these areas.

2.4.1 Vegetation Impacts

Exploration drilling activities aim to minimise impacts on vegetation disturbance through the use of comparatively small and light weight drill rigs, designed to operate in uncleared forest and on a variety of slopes safely, with minimal disturbance to the environment. Drill rigs contain GPS navigation systems, which display constraints, dieback and hazard information to the drillers, as they move through an area.

Drilling activities are managed in accordance with Alcoa/DEC Working Arrangements (DEC now DBCA) 2015, and associated limitations on vegetation disturbance (i.e. tree diameter), soil disturbance and dieback management procedures. Where small supplementary drill activities occur (i.e., diamond drilling), minor variations to the working arrangements are sought on a case-by-case basis.

2.4.2 Drinking Water Catchments

Alcoa's mining lease is located within Priority 1 drinking water catchments and therefore drilling activities occur within these catchments. Drilling activities involve minimal disturbance and therefore minimal risk is posed for turbidity impacts.

2.4.3 Fauna

To prevent fauna injury and entrapment in open drill holes, all drill holes are capped using naturally occurring items such as rocks, branches and plant debris on completion of drilling. To prevent surface water pooling, current practice is to push a rock or other organic materials into the small diameter drill holes, such that the material is at ground surface level and is then covered with soil. DMIRS have previously requested that Alcoa plug all drill holes 400 mm below the surface and fill to above ground level. As drilling predominantly takes place in the laterite, excavating to a 400 mm depth is usually not possible due to the presence of caprock. Consultation with DMIRS on the preferred methodology/ best practice for plugging drill holes is ongoing.

2.4.4 Dieback

Exploration drilling has the potential to spread Phytophthora Dieback. Dieback mapping is carried out over a significant proportion of planned drilling areas. Where Dieback mapping has not been undertaken prior to exploration drilling, drilling can only occur under dry soil conditions as outlined in the working arrangements. Where Dieback mapping has been undertaken, cleaning of drill rigs on entry of areas and between drill holes, and the preferencing of dieback infested areas for drilling during the wetter periods at the start and end of the season are the main dieback control measures.

3 Mining Cycle Planning

3.1 Ore Bodies and mining cycle sequence

Bauxite occurs as tabular ore pods that vary in depth from 2 – 10m with an average depth of about 3.5m. The ore is overlaid with gravel and soils varying in depth from 0 – 1.5m. The upper part of the ore frequently presents as cemented caprock, ranging in thickness from 0 – 2.5m. Beneath the caprock is a friable zone that merges into clay and uneconomic quantities of alumina.

Due to the nature of the ore pods, the mine is characterised by a constantly moving mining footprint followed by progressive rehabilitation. The mine consists of a mosaic of shallow mine pits, located within the ore pods, linked via a network of haul roads to a centrally located crusher and facilities area. The mining sequence is illustrated in Figure 3-1 and described below.

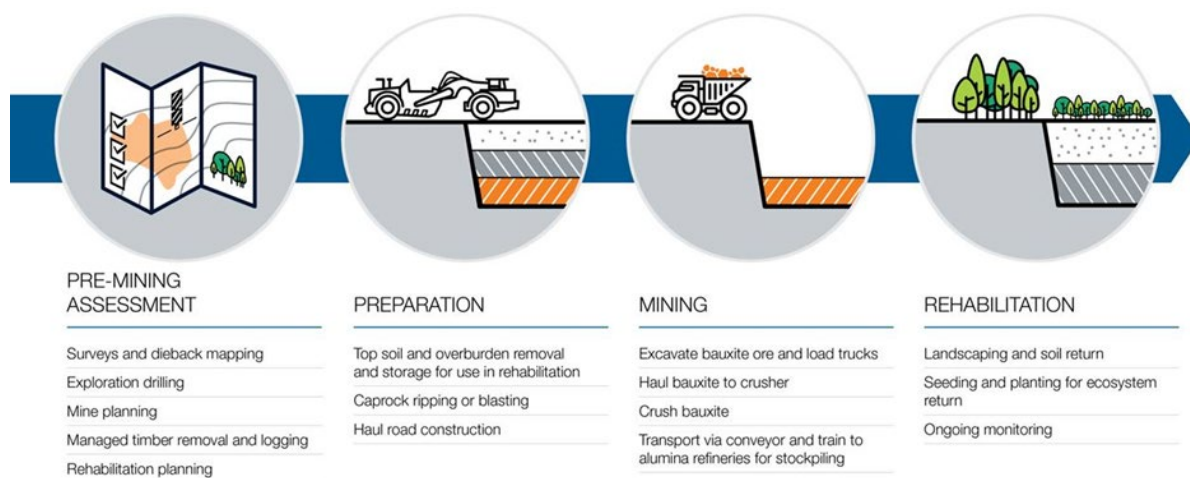


Figure 3-1: Mining cycle sequence

3.1.1 Pre-mining assessment

Pre-mining surveys

Alcoa undertakes surveys to inform the mine plan development, facilitate characterisation of ore quality and volumes, assess geotechnical conditions, identify constraints and protect or manage important environmental, cultural heritage and social values.

Surveys include:

- Vegetation mapping - to delineate Havel vegetation community types, ensure clearing does not have cumulative impacts on underrepresented species assemblages and identify critical habitat for known threatened species.
- Establishment of forest reference vegetation monitoring plots - for representative comparison with post-mining rehabilitation. Mean species richness of forest reference sites is utilised to measure the effectiveness of rehabilitation.

- Black cockatoo surveys - to locate trees that will be protected from disturbance, to minimise impact on these species. All nest trees and significant trees¹⁰ are conserved with a buffer (10m) wherever they occur in the landscape. Habitat trees¹¹ are conserved on haul road alignments, where the alignment can be adjusted to avoid these trees.
- Assessment of Phytophthora dieback - to inform activities which may cause soil disturbance, to manage dieback soils and prevent contamination of dieback free areas. This data is also utilised in soil movement and rehabilitation planning.
- Baseline hydrology data acquisition - to inform detailed design of mine pit and infrastructure. Refer to section 7.3.

As part of Alcoa's continuous improvement strategy for survey and management practices, immediate increased survey effort will include:

- Targeted flora surveys
- Targeted fauna surveys
- Various water improvement programmes

Proposed improvements to the baseline and pre-clearance survey standards are detailed in Sections 5.3, 6.3, 7.3, 8.3, 9.3 and 10.3.

The results of the surveys and exploration activities (refer to section 2) inform mine planning, including scheduling of mine pits and infrastructure, and planning of clearing, soil movement, and dieback management activities.

Table 3-1 summaries the environmental constraints Alcoa applies to its mining operations to protect environmental and social values.

Table 3-1: Environmental constraints

Environmental Constraint	Environmental Constraint Avoided
Old Growth Forest	Yes
OCA1	Yes
National Parks / Formal Conservation Reserves	Yes
Granite outcrops >1ha +50m buffer	Yes
Riparian Vegetation	Yes – as far as practicable
Aboriginal Cultural Heritage Sites	Yes

¹⁰ *Eucalyptus marginata* Diametre at Breast Height (DBH)>2000mm and *Corymbia Calophylla* DBH>1500mm

¹¹ *C. calophylla* DBH>500mm with a form conducive to forming hollows

Environmental Constraint	Environmental Constraint Avoided
European Heritage Sites	Yes
Bibbulmun Track	Yes
Serpentine Pipehead Catchment	Yes
Tree containing one or more hollows suitable as Black Cockatoo breeding habitat <ul style="list-style-type: none"> • Nest trees with a suitable hollow (size, entry angle, position), regardless of evidence of use • Significant trees, which include marri with DBH>1500mm and Jarrah with DBH>2000mm 	Yes
Threatened flora	Yes – unless appropriate approvals obtained
Threatened Ecological Communities	Yes
Operational noise >35dB(A)L10	Yes
No clearing for mining within 1km of the top water level of any water reservoir in Myara Central and Myara South (Commitment 2)	Yes
Will not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024 (Commitment 3)	Yes
Will not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (excludes rehabilitation activities, and access) (Commitment 4)	Yes

3.1.2 Preparation

Timber Harvesting and clearing

Timber harvesting is carried out by the Forest Products Commission (FPC). The FPC is responsible for the sustainable management and development of Western Australia's forest products industry on land owned or leased by the State, and is an autonomous commercial entity governed by an independent Board of Commissioners and accountable to the Western Australian Government through the Minister for Forestry.

Wood products derived from FPC's operations hold an Australian Standard for Sustainable Forest Management sustainability certification. In line with commitments made in MS 095, Alcoa works closely with FPC to preferentially ensure mine clearing involves sustainable forest harvesting and maximises wood residue re-use practices.

Prior to entering an area, the State has the right to cut and remove from the area any merchantable timber or other forest products. FPC are responsible for harvesting activities in the majority of mining areas. Harvesting is a separate activity, independent of mining and Alcoa does not have control over the extent to which harvesting occurs, or if harvesting occurs at all. Alcoa may liaise or coordinate with FPC, including through the “Research projects into all aspects of operation that have the potential to adversely impact the environment.”

Working Arrangements, Alcoa does not contract with FPC or FPC’s contractors to perform the timber harvesting and salvage activities.

Alcoa’s interaction with the FPC is facilitated using the Forest Products Commission ‘Harvesting inspection and Action Sheet (Mine Site)’¹². This document facilitates the handover of operational harvesting areas to Alcoa and provides a coordinated approach to the management of mining operations and timber harvesting operations within, and adjacent to, Alcoa’s bauxite mining regions.

Following harvesting activities, Alcoa works with other authorised third parties to further utilise the forest resource. The primary contributor to forest residue re-use is Simcoa Operations Pty Ltd (Simcoa), who obtained access to the forest resource to meet their requirements under the *Silicon (Kemerton) Agreement Act 1987*. Alcoa’s non-commercial agreement with Simcoa facilitates their access to remove forest residue from harvested pits and provides procedures for their interaction with Alcoa. Simcoa’s operation substantially reduces the quantity of forest residue that is burnt by Alcoa.

Alcoa is actively investigating, in consultation with the FPC, other methods to reduce forest residue burning, including composting, biofuel, and charcoal manufacturing. Some of the remaining forest residue not used by third-parties is stockpiled to minimise burning.

Soil removal

Soil is stripped in two layers including a surface layer of topsoil (~ 150 mm) and a thicker layer (average 400 mm) of overburden.

The topsoil contains the majority of seeds, organic material, plant nutrients and microbial activity and is an important resource for rehabilitation. The topsoil for direct return is stripped to 75 mm to avoid diluting the seed resource that is concentrated within the top 50-75 mm of the topsoil. This process involves stripping from an area that is about to be mined and returning the soil to an area that is being rehabilitated within three months. This avoids long term storage in a stockpile, which can cause degradation of the biological components of the topsoil. When topsoil has to be stockpiled for more than three months before being used in rehabilitation, it is stripped to a depth of 150 mm.

The overburden, which extends to the top of the cemented caprock layer, is stockpiled next to the mined area to be returned to the pit floor during rehabilitation.

3.1.3 Mining

¹² Forest Products Commission, 2014. Harvesting Inspection and Action Sheet (Mine Site). FPC Document No. FPC27, Forest Products Commission, Perth.

The bauxite ore deposit that frequently presents as cemented caprock is broken either by blasting or by ripping with a large bulldozer. Blasting uses conventional Ammonium Nitrate - Fuel Oil (ANFO) explosives.

The broken cemented caprock and the underlying friable bauxite are removed by excavators and loaded on haul trucks. The mining fleet is diesel fuelled and includes excavators, loaders, trucks and earthmoving equipment.

The bauxite is trucked via a network of haul roads to Run of Mine (ROM) pads for primary and secondary crushing. The crushed ore is transported via a conveyor to stockpiles at the Pinjarra or Wagerup Refinery.

3.1.4 Rehabilitation

An overview of Alcoa's mine rehabilitation implementation process is provided in Section 3.3 and Appendix 4 .

3.2 Mine Planning

Alcoa's full cycle mine planning process starts with Long Term Planning and development of a Life of Asset (LOA) Plan, which defines the drilling program. As drilling progresses, the 10 Year Mine Plan is further refined.

The 10 Year Mine Plan provides the directional sequence of mining, and subsequent rehabilitation within mining regions. The 10 Year Mine Plan also informs the progressive move to future mine regions.

The 10 Year Mine Plan cascades into a 3 Year Mine Plan, in quarterly mining sequence, developed to deliver bauxite grade targets and other key requirements from the long term plan. It includes detailed mine pit designs and subsequent rehabilitation designs, incorporating seasonality and associated constraints, resources and equipment productivity. These 3 Year Mine Plans further cascade into plans focused on daily, weekly and monthly production planning to support mining and refinery requirements, which manage and adapting to daily issues while aligning to superior plans.

3.2.1 Ten Year Mine Plan

Alcoa provided a 10 Year Mine Plan to JTSI, on 22 November 2022. A revised version is included in Figure 3-2 and Figure 3-3 for Huntly and Willowdale, respectively.

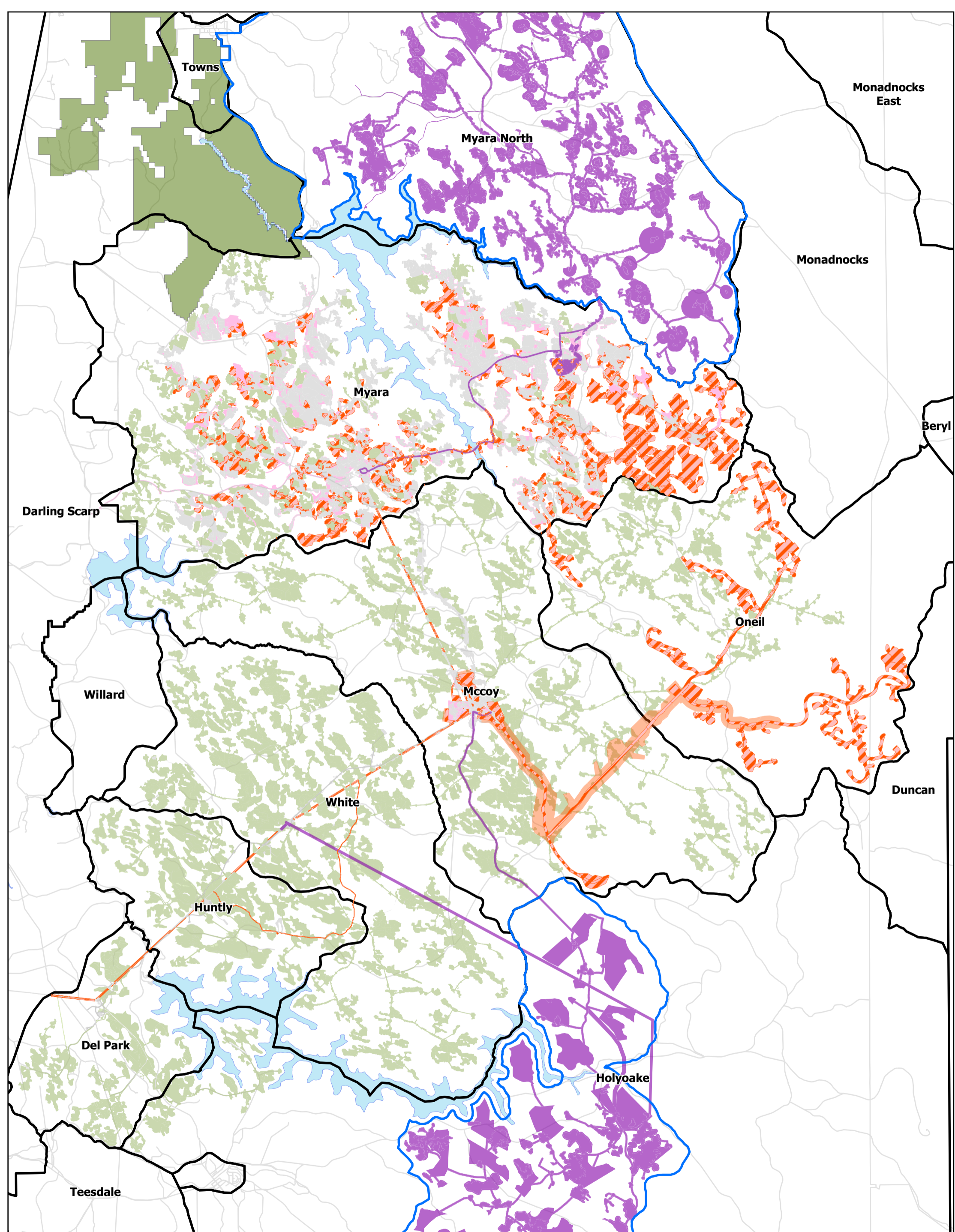
The first five years of the 10 Year Mine Plan reflect the content of this MMP and historically approved areas, although MMP approval is requested for the 24 Month Clearing Schedule. The balance of the 10 Year Mine Plan (final five years) is indicative and subject to change, as more detailed data becomes available through exploration drilling, mine cycle planning and environmental studies.

These areas (final five years) are provided for context only and do not form part of the MMP, particularly as some of the areas are associated with the Revised Proposal and will be assessed and approved under Part IV of the EP Act.

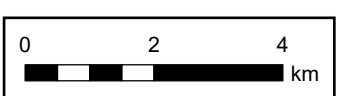
As the Revised Proposal is currently under assessment, the timing to commence development of these areas, in addition to the ongoing operational needs of the business, may have implications for the

10 Year Mine Plan. These areas are not intended to be authorised under the Clearing Exemption Order 2004, rather Part IV of the EP Act.

The 10 Year Mine Plan includes current mining and rehabilitated areas, including those approved under a previous MMP and previously endorsed FCAs, areas approved under a previous MMP and FCA but not yet cleared, and those included in this MMP for approval.



Legend			
	Five years clearing schedule		National Parks
	Conceptual clearing buffer		Major Dams
	Indicative Mine Plan (Years 6-10)		Mining Regions
	Part IV Assessment Areas		FCA Endorsed
			Rehabilitation
			Cleared Areas

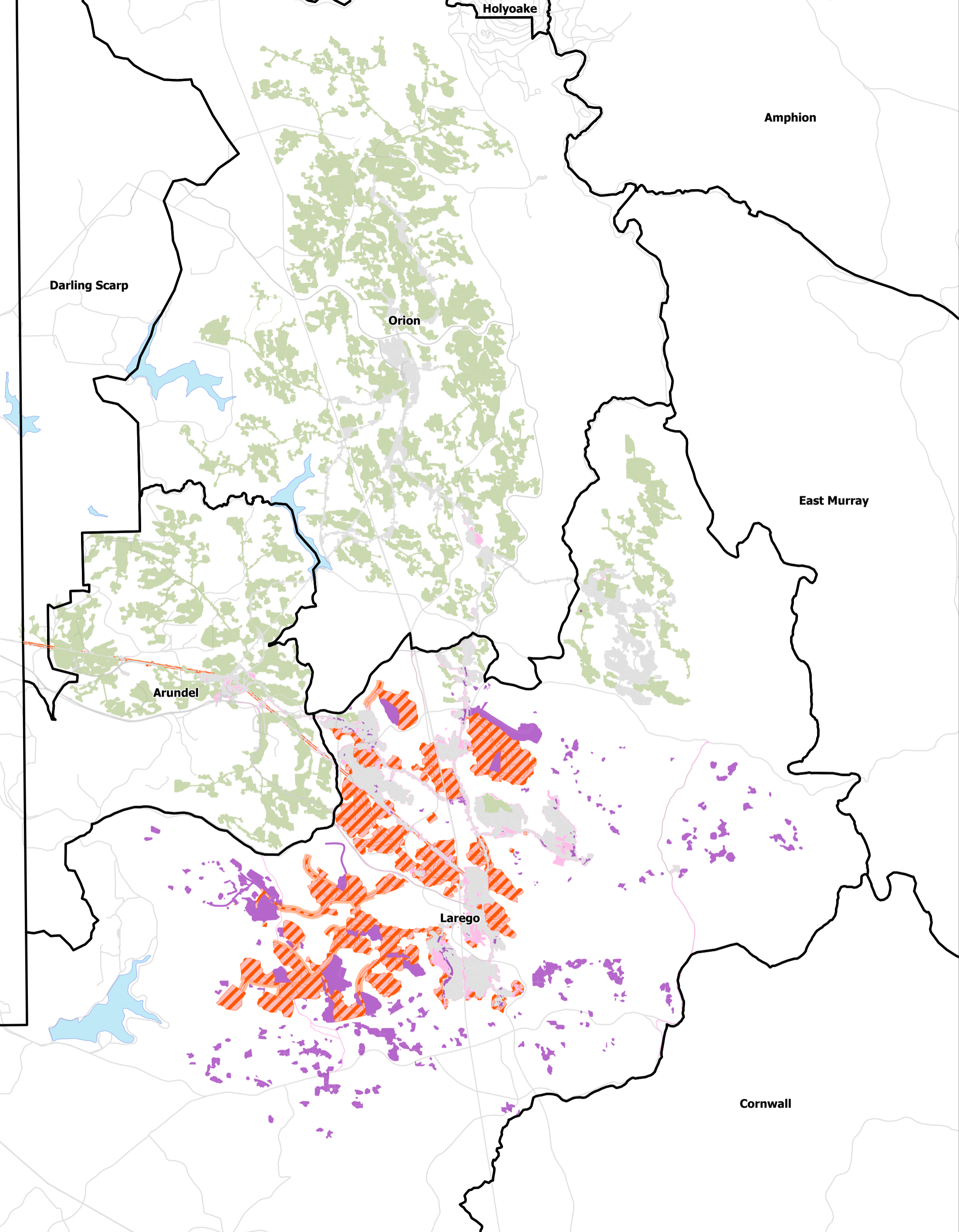


2023 – 2027 Mining and Management Plan









Figure 3-2: Ten year mine plan - Huntly

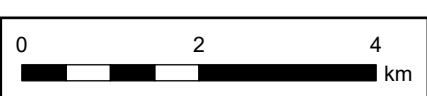
Scale: 1:117,413

Date Printed: 30/10/2023



Legend

 Five Years Clearing Schedule	 FCA Endorsed	 Mining Regions
 Conceptual Clearing Buffer	 Rehabilitation	 Major Dams
 Indicative Mine Plan (Years 6-10)	 Cleared Areas	



2023 – 2027 Mining and Management Plan

Figure 3-3: Ten Year Mine Plan - Willowdale

Scale: 1:85,380

Date Printed: 3/11/2023

3.2.2 Five Year Mine Plan – Huntly

A Five Year Mine Plan has been developed for Huntly and excludes areas associated with the Revised Proposal.

This, and future mine plans administered under the MMPLG, will predominately target the balance of the Myara region with extent shown in Figure 3-4. Subject to receipt of approvals under EP Act Part IV Assessment No. 2253, Huntly Bauxite mine operations will transition to Myara North in the coming years.

The Huntly mine plan is presented in Table 3-2 and Figure 3-4 shows the associated disturbance which provides the bauxite volumes that will support the Pinjarra and Kwinana refineries to operate within the approved alumina production limits. Wet tonnes are annotated in brackets.

Table 3-2: Bauxite Volumes for Huntly Five Year Mine Plan

Key Activities	2024	2025	2026	2027
Huntly total tonnes X 10 ⁶	24.1 (26.5)	24.1 (26.5)	24.1 (26.5)	24.1 (26.5)
Pinjarra Refinery tonnes X 10 ⁶	17.3 (19.0)	17.3 (19.0)	17.3 (19.0)	17.3 (19.0)
Kwinana Refinery tonnes X 10 ⁶	6.8 (7.5)	6.8 (7.5)	6.8 (7.5)	6.8 (7.5)

3.2.3 24 Month Clearing Schedule - Huntly

The 24 Month Clearing Schedule and Five Year Mine Plan includes conceptual clearing areas and detailed clearing areas. Alcoa is requesting approval of the 24 Month Clearing Schedule based on the conceptual clearing areas. An environmental impact assessment is included within this MMP to conservatively assess potential impacts from the associated clearing and activities. The mine plan is subject to continued optimisation to actively seek opportunities to minimise clearing.

Table 3-4 provides the conceptual clearing areas planned for the remainder of the Five Year Mine Plan period which is subject to change pending further detailed design. These areas are not submitted for approval, rather are included for consideration. The Revised Proposal has clearing occurring from 2025, pending approvals. The five year conceptual clearing schedule contains additional clearing due to uncertainty of the Revised Proposal approval timeframe. The transition to Myara North will be determined by the Myara mine plan and Revised Proposal timeframe.

Spatial data for the proposed 24 Month Clearing Schedule and the following 3 to 5 year clearing areas is shown in Figure 3-4 and 3-5.

Table 3-3: Huntly 24 Month Clearing Schedule areas

Item	Year		Total
	2024 ¹³	2025	
Pits (Ha)	520	459	979
Mine plan infrastructure -stockpiles, haul roads, supporting infrastructure (ha)	407	302	709

¹³ Pending MMP Approval and FCA endorsement timeframes, some clearing may occur in 2023.

Item	Year		Total
	2024 ¹³	2025	
Total (ha)	926	762	1,688
Conceptual Clearing Buffer (ha)	726		2,414

Table 3-4: Huntly year 3 to year 5 - conceptual Clearing Schedule area

Year	2026	2027	Total
Pits (ha)	479	689	1,168
Mine plan infrastructure -stockpiles, haul roads, supporting infrastructure (ha)	126	96	222
Total (ha)	605	785	1,391

The conceptual clearing areas depict the maximum final boundaries of proposed native vegetation clearing that will enable mine pit and infrastructure design to be implemented. The actual clearing area is expected to be smaller than the conceptual clearing as an allowance is made for “contingency”. For example, if some parcels of conceptual clearing areas are not endorsed during the FCA process or pre-mining survey information leads to an avoidance requirement (e.g. avoidance of black cockatoo breeding tree). Historically, actual disturbance averages 85% of conceptual clearing areas. Alcoa has committed to an annual clearing limit based on the committed rehabilitation rate, equating to 800 ha per year (Commitment 1). This will deliver no net increase to open areas over the life of this MMP. The clearing limit will apply to actual MMP-approved clearing and any surplus clearing will be rolled over to subsequent year.

The conceptual clearing areas:

- Include approximately 100m width for haul road in areas where detailed designs and pre-clearance surveys are required. The detailed design final haul road is expected to be approximately 40m wide.
- include a 15m clearing buffer for conceptual and detailed pits, and infrastructure, which is not expected to be impacted.

Conceptual clearing buffers have been included for the O’Neil haul road and water pipelines, which consists of a buffer within which actual disturbance will occur. The conceptual clearing buffers have been excluded from the environmental impact assessment process, although the environmental values are described in cumulative impacts to provide context.

Detailed clearing areas are contained within the conceptual boundary and are refined based on further engineering designs. Detailed pit design typically results in a smaller footprint of minable ore versus conceptual clearing shapes which only considers the top of the “ore surface”. It is proposed that final detailed clearing areas for the 24 Month Clearing Schedule are included in the FCAs.

Error! Reference source not found. provides a summary of the proposed conceptual clearing (in hectares) for 2024 and 2025¹⁴ which requires approval, as illustrated in Figure 3-5.

Proposed clearing is largely confined to the Myara region, with portions of clearing for the haul road from McCoy to O'Neil to occur within those regions. The 24 Month Clearing Schedule and Five Year Mine Plan includes the move to previously mined O'Neil region, with the following indicative clearing areas:

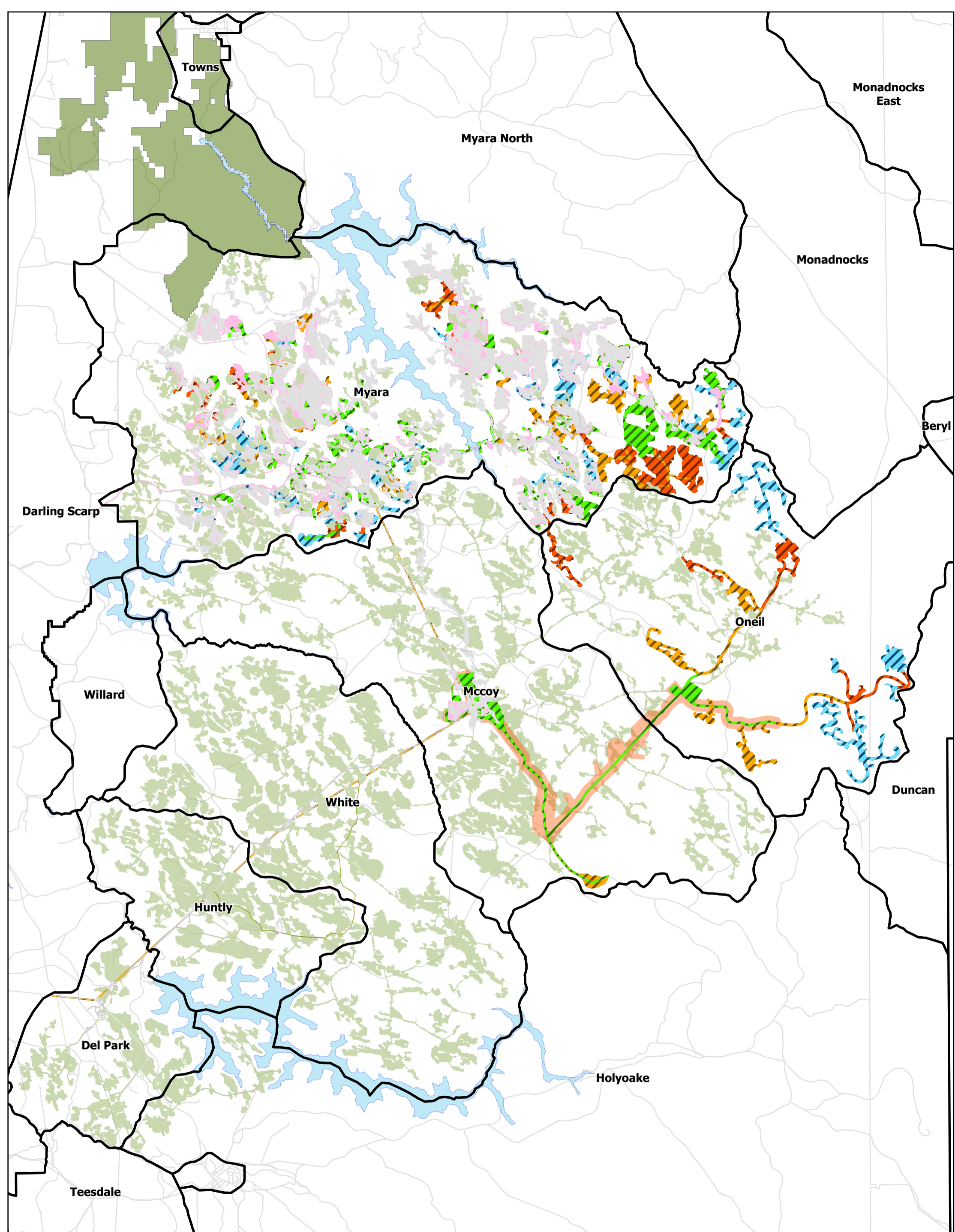
- 2024 – 308 ha for mine infrastructure (McCoy crusher upgrades and O'Neil Run of Mine (ROM)), water pipelines, borrow pits and haul road development.
- 2025 – 154 ha for haul roads and borrow pits and 208 ha for mine pit development.
- 2026 until 2027 – 179 ha for mine infrastructure (haul road) and 406 ha for mine pit development.

The O'Neil haul road is an existing access track which will be widened to accommodate the transport fleet. Clearing associated with the O'Neil mine move is considered conceptual, with an additional conceptual clearing buffer of 726 ha to allow for flexibility for haul road, borrow pits, infrastructure and water pipeline routes. The conceptual clearing buffer of 726 ha is not included in the environmental impact assessment or within the 24 Month Clearing Schedule disturbance areas.

To facilitate bushfire management activities required for asset protection, an additional 48 ha of clearing will be undertaken along the conveyor corridor between the Myara and McCoy regions and the Pinjarra Refinery. This area consists of regrowth vegetation that has been subject to previous clearing and may be undertaken in response to bushfire events.

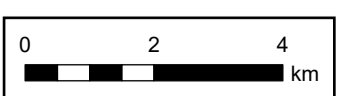
Clearing of rehabilitated areas may occur for the O'Neil haul road and within Myara to safely access ore.

¹⁴ Pending MMP Approval and FCA endorsement timeframes, some clearing may occur in 2023.



Legend

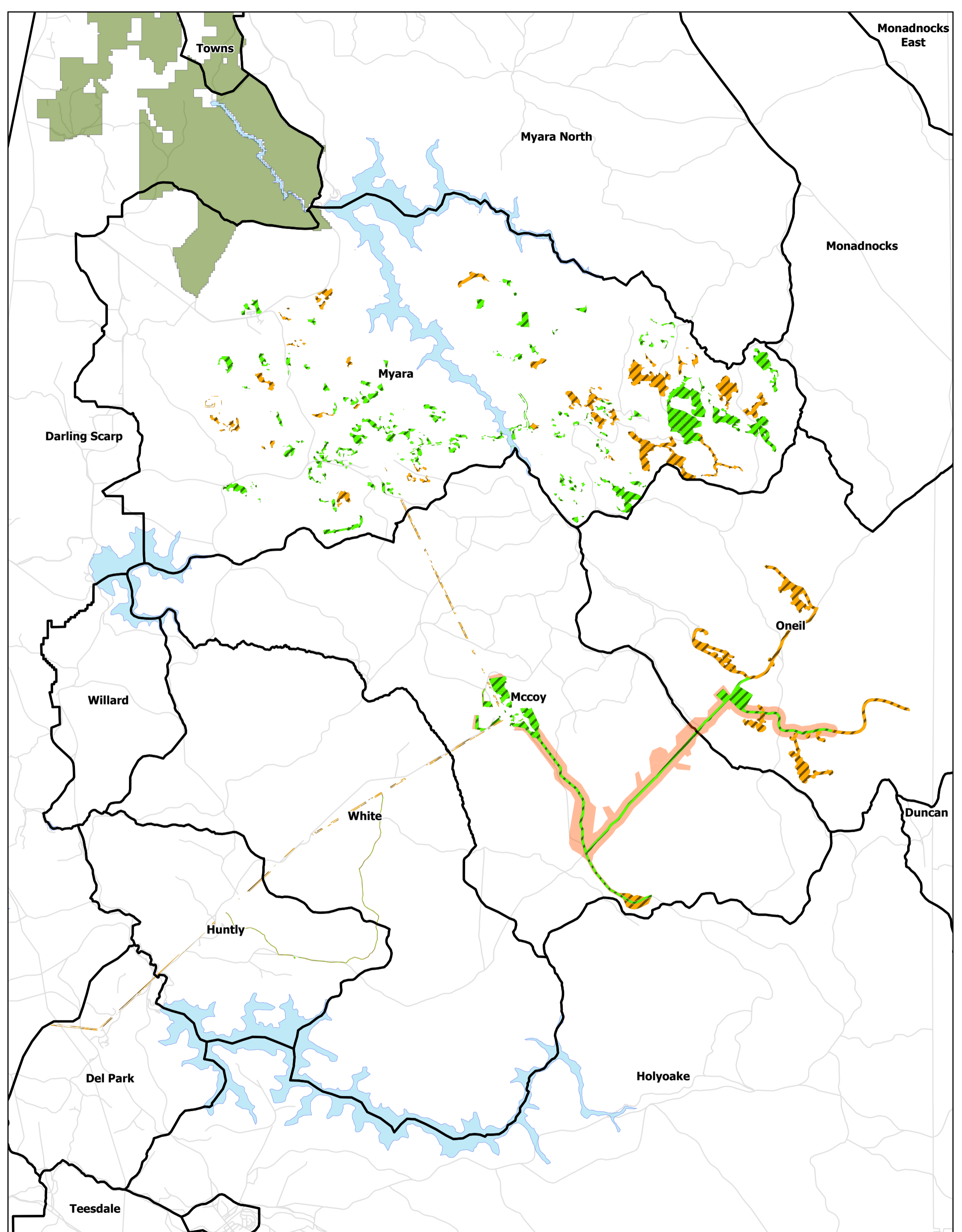
Proposed Clearing Schedule	Conceptual clearing buffer	Mining Regions
2024	FCA Endorsed	National Parks
2025	Rehabilitation	Major Dams
2026	Cleared Areas	
2027		



2023 – 2027 Mining and Management Plan

Figure 3-4: Proposed clearing – Five Year Mine Plan - Huntly

Scale: 1:117,413 Date Printed: 30/10/2023



Legend

Proposed Clearing Schedule	Mining Regions
2024	National Parks
2025	Major Dams
Conceptual clearing buffer	



2023 – 2027 Mining and Management Plan	
Figure 3-5: Proposed clearing – 24 Month Clearing Schedule - Huntly	
Scale: 1:108,899	Date Printed: 2/11/2023

3.2.4 Five Year Mine Plan – Willowdale

The Five Year Mine Plan for Willowdale will predominately occur within the Larego mine region with boundaries consisting of the Murray River to the east, private property and the Arundel and Orion mining regions to the north-west.

The Willowdale mine plan presented in Table 3-5 and Figure 3-6 shows the associated clearing which provides the bauxite volumes that will support the Wagerup Refinery to operate within the approved alumina production limits. Wet tonnes are annotated in brackets.

Table 3-5: Bauxite Volumes for Willowdale Five Year Mine Plan

Key Activities	2024	2025	2026	2027
Willowdale total tonnes X 10 ⁶	9.6 (10.5)	9.8 (10.8)	9.3 (10.2)	9.1 (10.0)
Wagerup Refinery tonnes X 10 ⁶	9.6 (10.5)	9.8 (10.8)	9.3 (10.2)	9.1 (10.0)

3.2.5 24 Month Clearing Schedule - Willowdale

The 24 Month Clearing Schedule and Five Year Mine Plan includes conceptual clearing areas and detailed clearing areas. Alcoa is requesting approval of the 24 Month Clearing Schedule based on the conceptual clearing areas and have undertaken an environmental impact assessment within this MMP to conservatively assess potential impacts from the associated clearing and activities. The mine plan is subject to continued optimisation to actively seek opportunities to minimise clearing.

Table 3-6 provides a summary of the proposed conceptual clearing (in hectares) for 2024¹⁵ and 2025 which requires approval, as illustrated in Figure 3-7.

Proposed clearing is largely confined to the Larego region. To facilitate bushfire management activities required for asset protection, an additional 7 ha of clearing will be undertaken along the conveyor corridor, between the Orion and Larego regions and the Wagerup Refinery. This area consists of regrowth vegetation that has been subject to previous clearing and may be undertaken in response to bushfire events.

Table 3-7 provides the conceptual clearing areas planned for the remainder of the Five Year Mine Plan period which is subject to change pending further detailed design. These areas are not submitted for approval, rather are included for consideration.

Spatial data for the proposed 24 Month Clearing Schedule and the following 3 to 5 year clearing areas is shown in Figure 3-6 and 3-7.

Table 3-6: Willowdale 24 Month Clearing Schedule areas

Item	Year		Total
	2024 ¹³	2025	
Pits (ha)	218	260	478
Mine plan infrastructure -stockpiles, haul roads, supporting infrastructure (ha)	204	97	302

¹⁵ Pending MMP Approval and FCA endorsement timeframes, some clearing may occur in 2023.

Item	Year		Total
	2024 ¹³	2025	
Total (ha)	422	358	780
Conceptual Clearing Buffer (ha)	28		809

Table 3-7: Willowdale year 3 to year-5 conceptual Clearing Schedule areas

Year	2026	2027	Total
Pits (Ha)	260	248	508
Mine plan infrastructure -stockpiles, haul roads, supporting infrastructure (ha)	71	49	120
Total (ha)	331	297	628
Conceptual Clearing Buffer (ha)	75		703

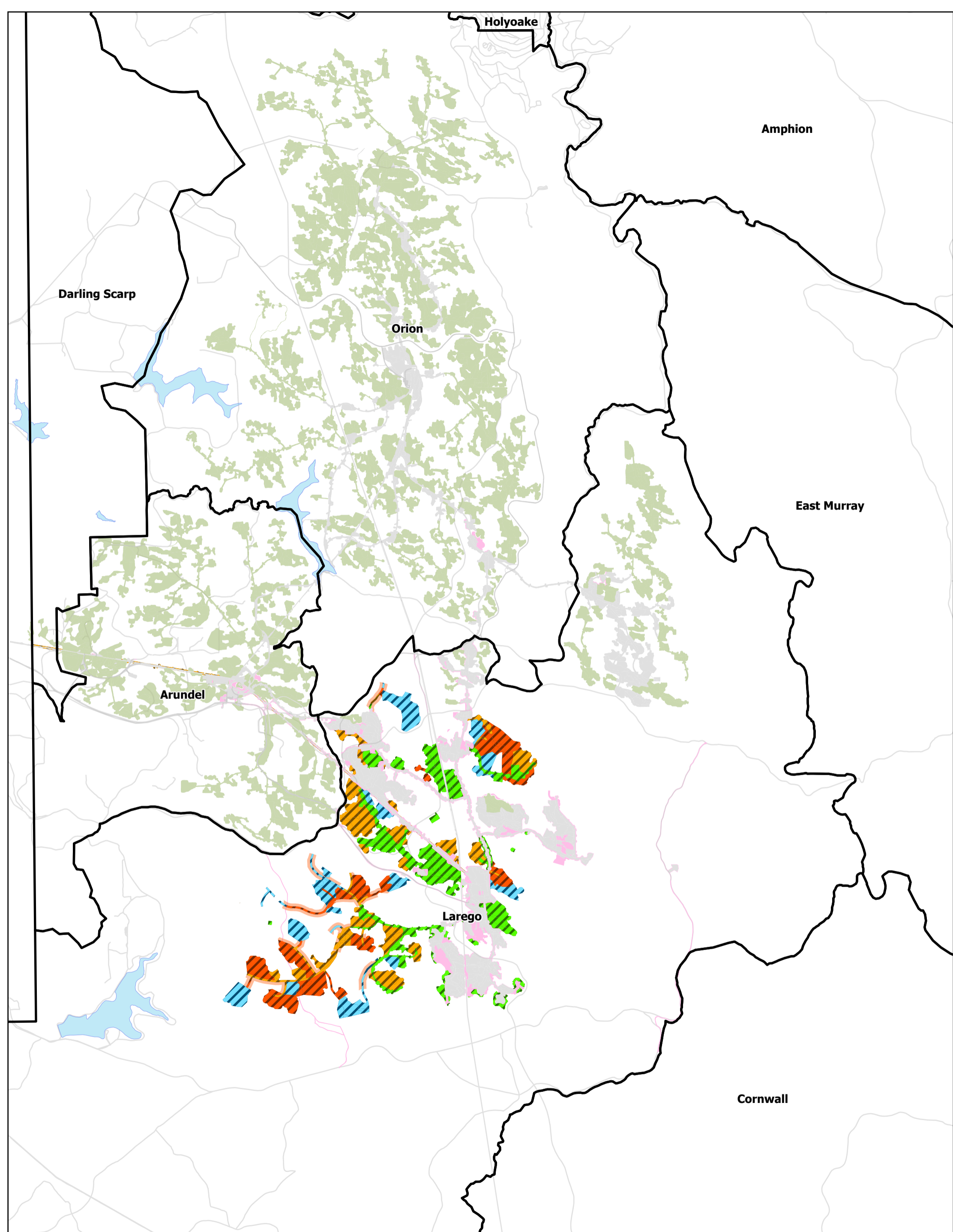
The conceptual clearing areas depict the maximum final boundaries of proposed native vegetation clearing that will enable mine pit and infrastructure design to be implemented. The actual clearing area is expected to be smaller than the conceptual clearing as an allowance is made for “contingency”. For example, if some parcels of conceptual clearing areas are not endorsed during the FCA process or pre-mining survey information leads to an avoidance requirement (e.g. avoidance of black cockatoo breeding tree). Historically, actual disturbance averages 85% of conceptual clearing areas. Alcoa has committed to an annual clearing limit based on the committed rehabilitation rate, equating to 800 ha per year (Commitment 1). This will deliver no net increase to open areas over the life of this MMP. The clearing limit will apply to actual MMP-approved clearing and any surplus clearing will be rolled over to subsequent year.

The conceptual clearing areas include:

- approximately 100m width for haul road in areas where detailed designs and pre-clearance surveys are required. The detailed design final haul road is expected to be approximately 40m wide.
- a 15m clearing buffer for conceptual and detailed pits, and infrastructure, which is not expected to be impacted.


Conceptual clearing buffers have been included for some haul roads, which consists of a buffer within which actual disturbance will occur. The conceptual clearing buffers have been excluded from the environmental impact assessment process, although the environmental values are described in cumulative impacts to provide context.

Detailed clearing areas are contained within the conceptual boundary and are refined based on further engineering designs. Detailed pit design typically results in a smaller footprint of minable ore versus conceptual clearing shapes which only considers the top of the “ore surface”. It is proposed that final detailed clearing areas for the 24 Month Clearing Schedule are included in the FCAs.





Legend

Proposed Clearing Schedule	FCA Endorsed	Rehabilitation
2024	Conceptual Clearing Buffer	Cleared Areas
2025	Mining Regions	Major Dams
2026		
2027		



N

2023 – 2027 Mining and Management Plan

Figure 3-6: Conceptual Proposed clearing – five year clearing schedule - Willowdale

Scale: 1:85,380	Date Printed: 2/11/2023
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Darling Scarp

Orion

Arundel

Larego

Cornwall

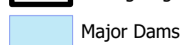
Legend

Proposed Clearing Schedule

 2024

 2025

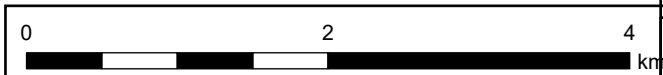
 Mining Regions

 Major Dams



2023 – 2027 Mining and Management Plan

Figure 3-7: Proposed clearing – 24 Month Clearing Schedule - Willowdale



Scale: 1:50,151

Date Printed: 1/11/2023

3.2.6 Ongoing operations

To reflect the full clearing extent of ongoing operations, this MMP includes areas already approved under previous MMPs (including those prior to the 2021-25 MMP) or having endorsed FCAs. Although already approved, these areas have not yet been cleared and are not included in Table 3-3, Table 3-4, Table 3-6 and

Table 3-7. The indicative extent of these clearing areas is detailed in Table 3-8 and shown in Figure 3-4 and Figure 3-6.

Huntly and Willowdale have 792 ha and 281 ha respectively, which are FCA endorsed and may be cleared. It should be noted that this includes areas which may not be cleared, for example clearing buffers for detailed pits and infrastructure.

In response to MMPLG feedback on cumulative impacts, Alcoa has committed to relinquishing 1,231 ha of FCAs endorsed prior to 1 September 2023, consisting of 1,016 ha in Huntly, and 214 ha in Willowdale (Commitment 7). Alcoa will relinquish the previously endorsed FCAs as shown in Figure 3-8 and Figure 3-9 and no clearing will be undertaken without further appropriate approvals.

Table 3-8: Previous endorsed FCA areas not yet cleared

Mine	Clearing area previously approved (ha)
Huntly	792
Willowdale	281
Total	1,073

3.2.7 Mine Plan Refinement – Myara Central

A revision of the Huntly Five Year Mine Plan was undertaken to enable enhanced drinking water protections, and to ensure sufficient bauxite supply until ore from Myara North is available. The following changes have been reflected in the mine plan:

- Reduced ore grade cut-off limits, resulting in some increase in pit depths and width (but still subject to design and groundwater avoidance criteria).
- Reduced production at Kwinana, following announcement to continue to operate at 80% capacity.
- Retreat from areas proximal to the Serpentine and North Dandalup reservoirs.
- Inclusion of additional pits in the previously mined O’Neil region.

Following community, regulator and broader Government feedback, Alcoa has explored all options to decrease potential impacts to Public Drinking Source Water Areas (PDSWAs). Further commitments have been made to minimise activities within close proximity to the reservoirs and in high risk areas (restricted areas) such as the RPZ. To further mitigate the risk of any potential impacts to the Serpentine Dam reservoir, Alcoa will:

- Not undertake any clearing for mining within 1km of the top water level of any water reservoir in Myara Central and Myara South (Commitment 2). Clearing for infrastructure, monitoring and rehabilitation activities will still occur within this area.
- Not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024 (Commitment 3). It should be noted that infrastructure, monitoring and rehabilitation activities will still occur within this area.
- Not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (Commitment 4). It should be noted that rehabilitation activities will still occur within this area.
- Not undertake any new pit clearing in any areas with an average pit slope greater than 16% within any Reservoir Protection Zone (RPZ, 2km from reservoir top water level) (Commitment 5).
- Prioritise rehabilitation within the Serpentine Dam RPZ.
- Prioritise clearing outside of the RPZ through re-entry to O'Neil mine region.

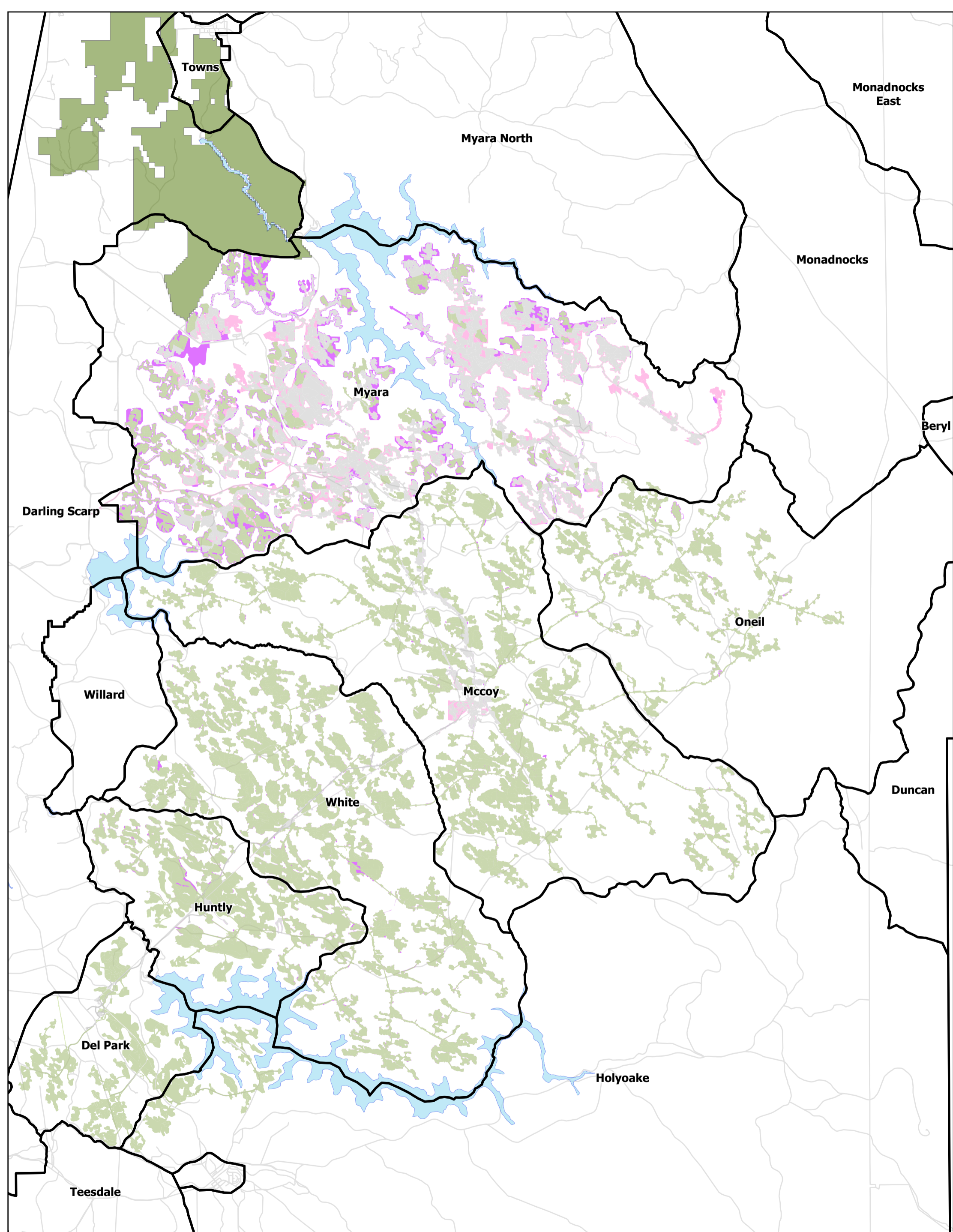
An additional commitment has been made with regards to the clearing of native vegetation. Alcoa has committed that MMP-related clearing of native vegetation will be limited to 800ha per calendar year for the duration of the current MMP. Some further details on this cap are provided below:

- The 800 ha limit has been determined by the average annual rehabilitation rate over this MMP (Table 3-13). The intent is that no net increase of open areas will occur as a result of MMP-related clearing.
- The limit is based on actual clearing, which will be reported in annual environmental reports to MMPLG. The MMP and FCA submission will include greater than 800 ha per year, to allow operational flexibility. However, actual clearing will not exceed 800 ha.
- If annual clearing within one year is below the cap, it is intended that the difference will be rolled over into the next years, to allow operational flexibility.

Alcoa has initiated an integrated mine planning process called Agile Decoupling at Huntly to deliver enhanced progressive rehabilitation through:

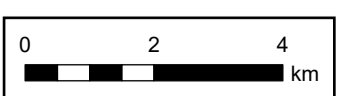
- Reduction of cleared areas.
- Reduction of timeframe whereby pits remain open.
- Minimise clearing and associated groundwater rise.
- Maximise direct return topsoil for rehabilitation.

This involves reviewing the open mine regions and bauxite ore movement to ROM stockpiles or the crusher. The intent is to potentially increase stockpiled ore and maximise stockpile blending thereby reducing the timeframe which areas remain open.

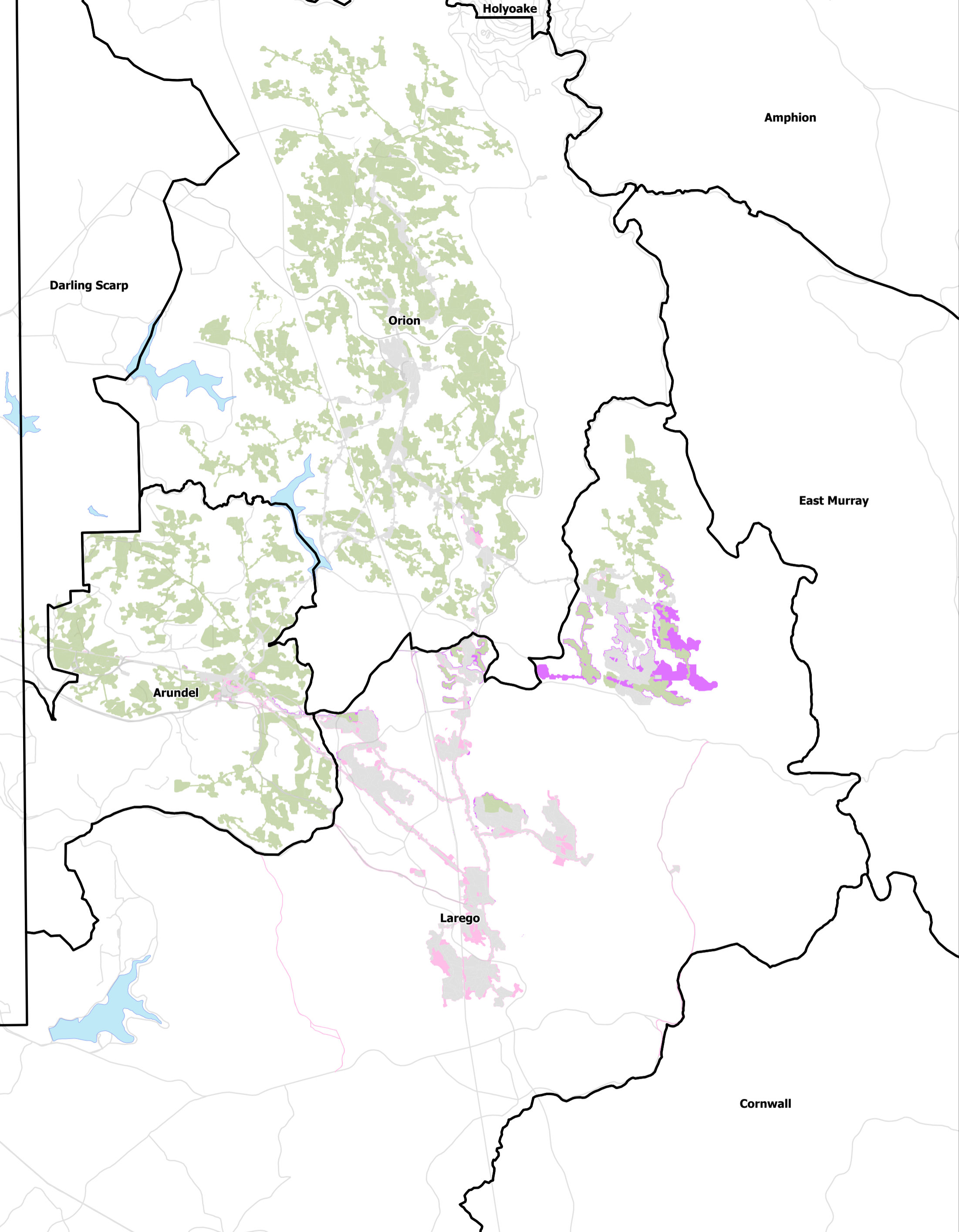


Legend

FCA Endorsed	Rehabilitation	Mining Regions
FCA Endorsed Revoke	Cleared Areas	Major Dams
	National Parks	



2023 – 2027 Mining and Management Plan	
Figure 3-8: Previous endorsed FCAs to be revoked – Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023



Legend

FCA Endorsed	Rehabilitation	Mining Regions
FCA Endorsed Revoke	Cleared Areas	Major Dams



2023 – 2027 Mining and Management Plan	
Figure 3-9: Previous endorsed FCAs to be revoked – Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

3.3 Rehabilitation

3.3.1 Overview

Alcoa’s rehabilitation goal is to establish, and return to the State, a self-sustaining Jarrah Forest ecosystem, that meets the agreed forest values that will support similar management practices as that employed in the surrounding Northern Jarrah Forest.

Alcoa’s operations have a total disturbance footprint of approximately 28,000ha, of which approximately 22,500ha has been rehabilitated (earthworks completed, area has received topsoil and seed, and revegetation in various ages of regrowth).

For the Huntly, Willowdale and Jarrahdale mines, approximately 77%, 75% & 100% have been rehabilitated respectively. At the Jarrahdale mine 1,355 ha has received a ‘certificate of acceptance’ from the landholder (DBCA), a precursory requirement for mine lease relinquishment. A detailed description of Alcoa’s approach to rehabilitation, monitoring and handback is provided in Appendix 4

3.3.2 Rehabilitation Performance (Quantity)

Alcoa’s native vegetation clearing to date, total rehabilitated areas and total cleared land un-rehabilitated (open area) are summarised in Table 3-9 and displayed in Figure 3-11 and Figure 3-12.

Table 3-9: Rehabilitation extents for Huntly, Willowdale and Jarrahdale mines (to June 2023)

Land area category	Huntly	Willowdale	Jarrahdale
Total area of native vegetation clearing to date (ha) ¹⁶	17,416	6,728	4,030
Total area of completed rehabilitation (ha) ¹⁷	13,418	5,041	4,030
Total area of vegetation clearing un-rehabilitated open area (ha)	3,998	1,687	0
Total area of rehabilitation handed back (completion criteria met) (ha)	0	0	1355
Total area of rehabilitation yet to be submitted to MMPLG for assessment (ha)	13,418	5,041	2,675

Further detail on the rehabilitation age and relevant completion criteria are detailed in Table 3-10 and Table 3-11 respectively.

Table 3-10: Rehabilitation age for Huntly, Willowdale and Jarrahdale mines (to June 2023)

Rehabilitation Age	Huntly	Willowdale	Jarrahdale
< 1 year	271	182	
1 – 2 years	746	344	
3 – 8 years	2,293	796	

¹⁶ cleared land is defined as having been logged and understorey debris removed in readiness for stripping of topsoil.

¹⁷ rehabilitated land is defined as having been topsoiled and contour ripped and seeded

Rehabilitation Age	Huntly	Willowdale	Jarrahdale
9 -14 years	2,687	965	
15 – 18 years	1,580	672	
19 – 34 years	3,904	1,911	2,193
35+	1,937	170	1,838
Total	13,418	5,041	4,030

Table 3-11: Rehabilitation age by Completion Criteria for Huntly, Willowdale and Jarrahdale mines (to June 2023)

Rehabilitation Age by Completion Criteria	Huntly	Willowdale	Jarrahdale
Completion Criteria 1966 to 1987			
35+	1,768	100	1,706
Total	1,768	100	1,706
Completion Criteria 1988 to 2004			
19 – 34 years	3,553	1,770	2,193
35+	169	70	132
Total	3,722	1,840	2,324
Completion Criteria 2005 to 2015			
9 -14 years	2,687	965	-
15 – 18 years	1,580	672	-
19 – 34 years	351	142	-
35+	-	-	-
Total	4,617	1,779	-
Completion Criteria 2016 Onwards			
< 1 year	271	182	-
1 – 2 years	746	344	-
3 – 8 years	2,293	796	-
Total	3,311	1,322	-

3.3.3 Rehabilitation Performance (Quality)

Alcoa's current rehabilitation quality monitoring approach is detailed within Appendix 4. The 9- and 15-month botanical monitoring program measures the quality of rehabilitation through recording several metrics across a subset of the total rehabilitation area. Species diversity indices are commonly used in ecology, however, are rarely used in completion criteria, as species richness has been considered the most important aspect to capture in the concept of diversity (Young et al. 2019).

Rehabilitation is carried out annually across Alcoa's mine sites with species richness being monitored using on-ground plots. Over the period of 1990 to 2021, on average, 99% of the total rehabilitated area was deemed to have met the species richness target at 15 months of age, as shown in Figure 3-10.

Noting that the species richness target changed from 50% of forest reference plots from 1992 to 2003 to 60% of forest reference plots from 2004 onwards. Alcoa has achieved the external species richness target of 60% in all years.

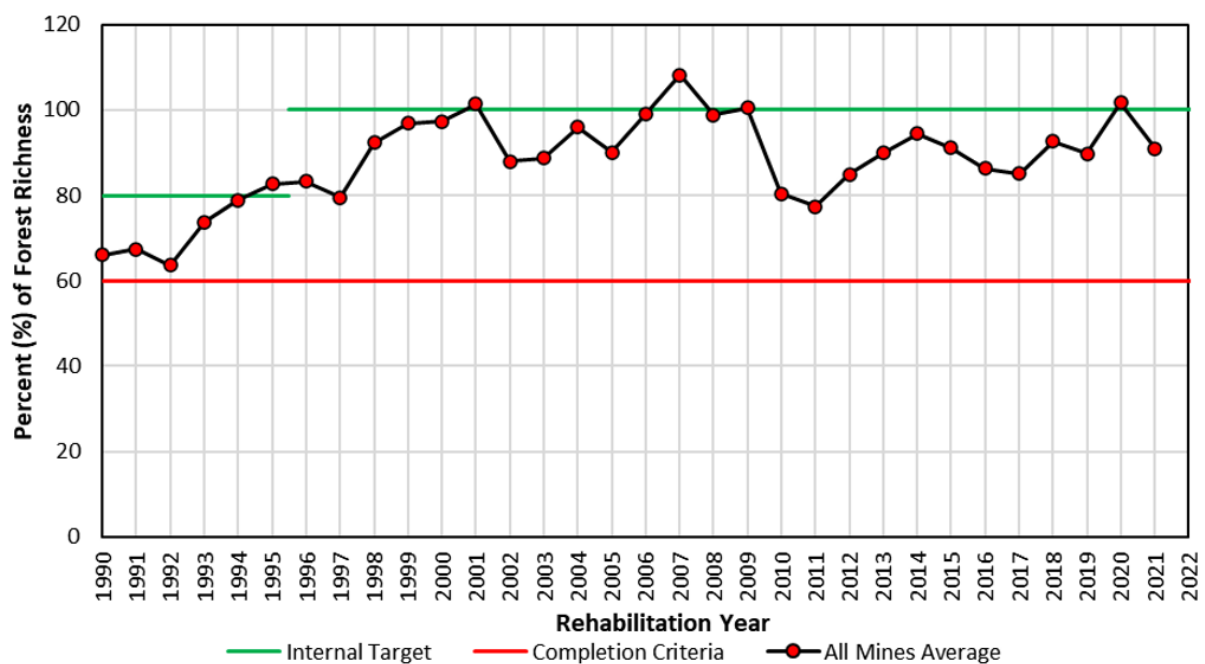


Figure 3-10: Historical mean species richness data

Alcoa has established 12 long-term monitoring sites for vertebrate fauna. Three of the sites are in unmined habitat, and three of the sites are in areas rehabilitated 5, 10 and 15 years ago. It is proposed that the vertebrate fauna at these sites would be periodically monitored (e.g. every 5 years) to enable judgements to be made about the extent to which rehabilitated areas were progressing on a trajectory towards the recreation of functional ecosystems, as determined by the terrestrial vertebrate fauna assemblage, like that in the unmined areas. Outcomes from these monitoring surveys would inform planning for future rehabilitation programs and where appropriate taking corrective action in existing rehabilitated areas. The baseline report for the LFTMP is provided in Appendix 5.

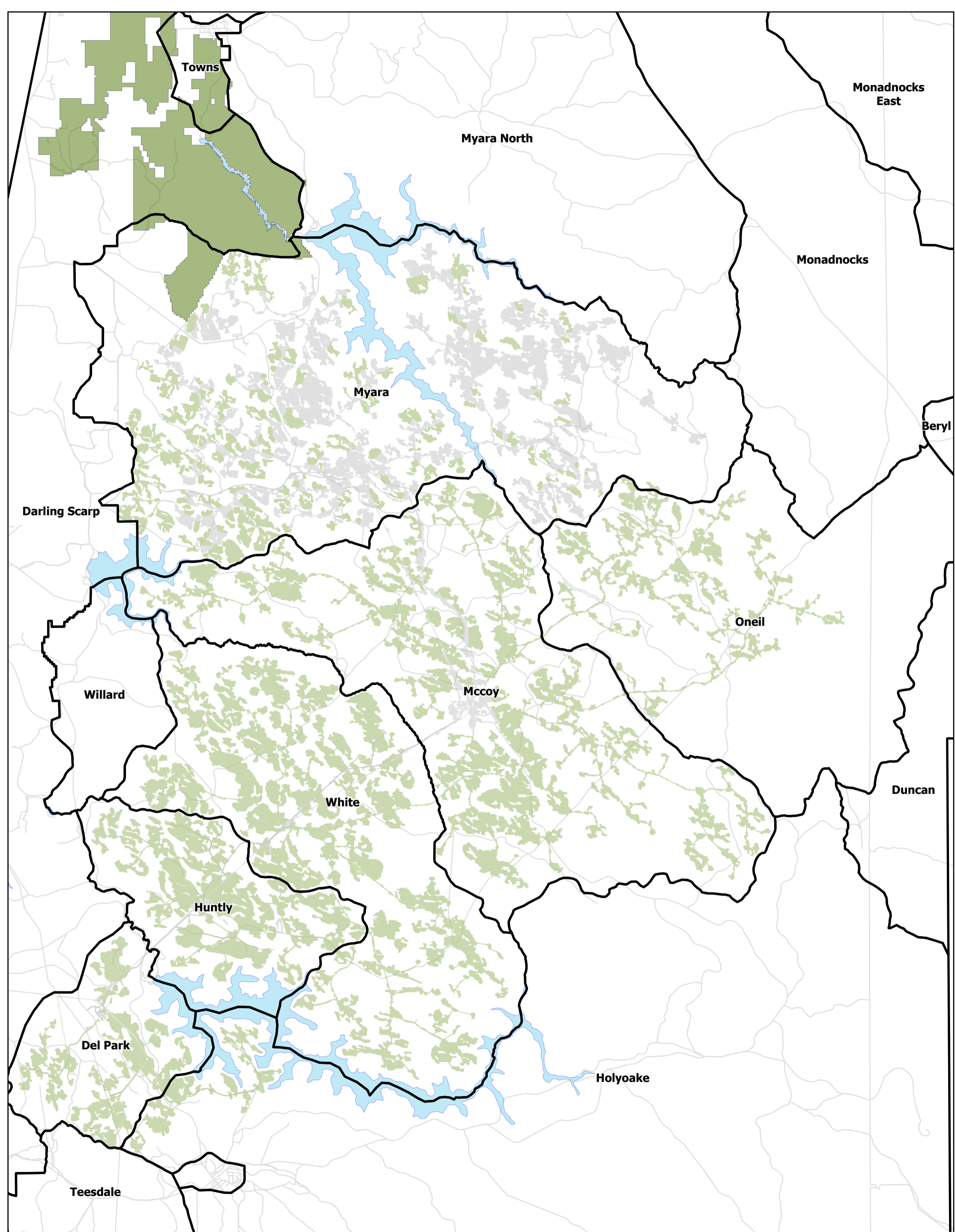
Detection of non-conformance with the performance metrics and targets is reported, investigated and corrective actions implemented via Alcoa's incident reporting system. This process ensures that there is continuous improvement in rehabilitation practice.

Corrective actions may include the following remediation works:

- Additional planting and seeding to correct plant species richness (species range and spatial distribution).
- Additional planting and seeding to correct timber production species stem densities.
- Additional earthworks &/or seeding & planting to correct landform instability (high slope, bare areas, water collection points, subsidence, erosion & sedimentation).
- Additional earthworks to correct aesthetics (landscape integration, rocks on the surface preventing fire vehicle access).
- Complete remediation of the area to correct inadequate pit floor ripping, inadequate soil profile thickness and poor contour ripping.

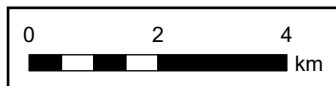
Remediation is always completed using the smallest earthmoving machinery and resources possible to minimise disturbance to surrounding establishing rehabilitation.

Alcoa implements an environmental management system to ensure that rehabilitation is executed to a high quality and maintains a comprehensive set of procedural documents so support rehabilitation performance management. Non-conformances are reported, investigated and corrective actions undertaken. This ensures that there is continuous improvement in rehabilitation practice. Alcoa has undertaken a peer review of rehabilitation methods and success to date and proposed ongoing rehabilitation methods. The peer review document is provided in Appendix 6.



Legend

- Rehabilitation
- Cleared Areas
- National Parks
- Major Dams
- Mining Regions

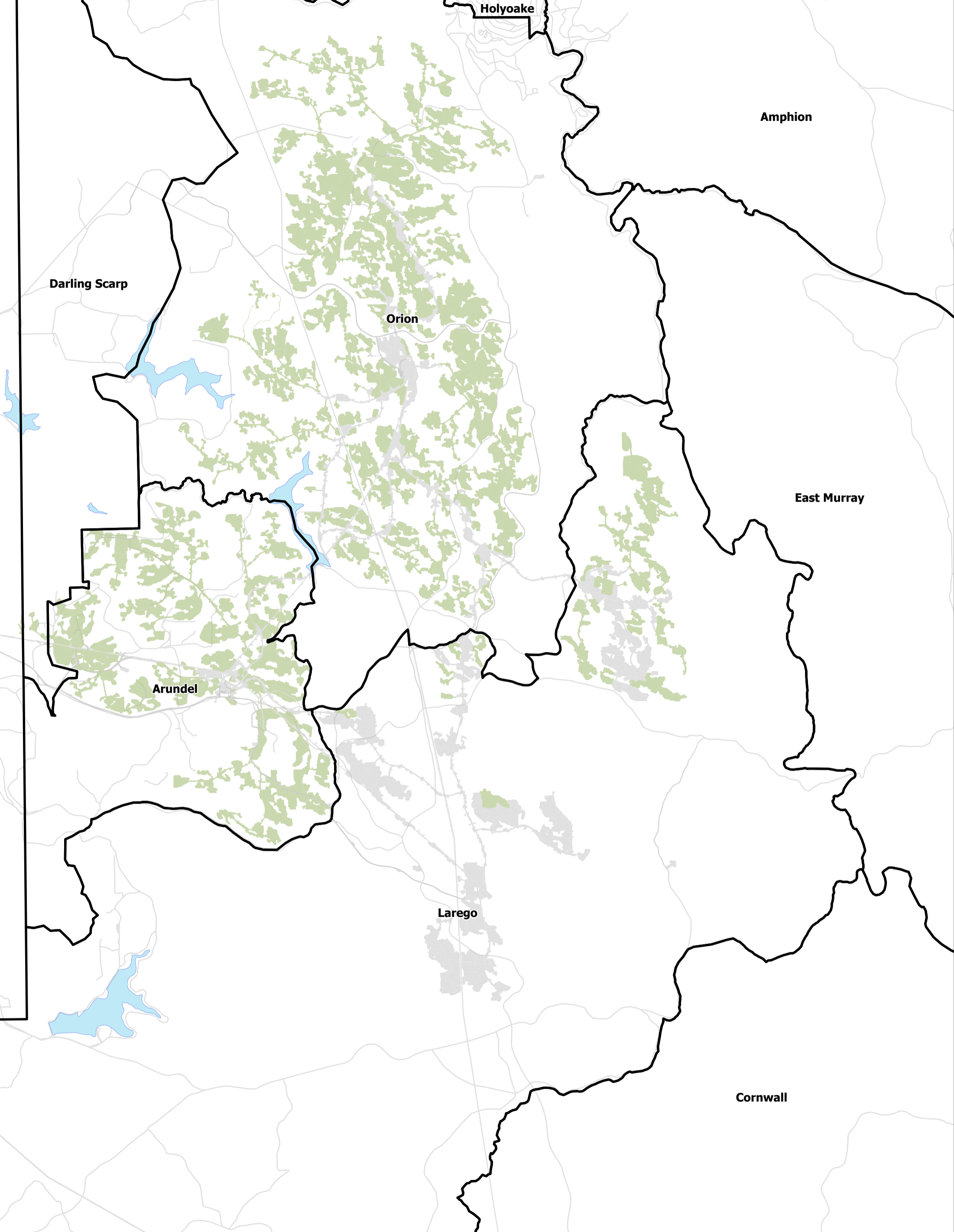


2023 - 2027 Mining and Management Plan

Figure 3-11: Rehabilitation and Open areas
-Huntly

Scale: 1:117,413

Date Printed: 30/10/2023



Legend

- Rehabilitation
- Cleared Areas
- Mining Regions
- Major Dams



2023 – 2027 Mining and Management Plan

Figure 3-12: Rehabilitation and Open areas
–Willowdale

Scale: 1:85,380	Date Printed: 1/11/2023
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3.3.4 Rehabilitation Plan

Total planned rehabilitation hectares are summarised in Table 3-13. The Huntly and Willowdale proposed rehabilitation plans are provided in Figure 3-14 and Figure 3-15, as an indicative spatial representation.

Alcoa has identified five key constraints that have informed the volume of rehabilitation included in the Rehabilitation Plan. Constraints are listed in order of impact within Table 3-12.

Table 3-12: Rehabilitation constraints

Constraints	Description
1. Area available for rehabilitation	Rehabilitation commences when mining of economic ore is complete. With delays to new mining area approvals, the target ore grade at existing mining areas has been reduced to sustain mine and refinery operations. As a result, some areas previously considered complete are still being mined, delaying area handover to rehabilitation. All efforts are being made to maximise area handover to rehabilitation within the mine schedule, particularly within prioritised areas. The Agile Decoupling project may increase blending of ore at stockpile areas, rather than blending ore via direct pit to crusher haulage. The transition to new blending processes will take several years to fully embed.
2. Availability of fresh topsoil (<3 months stockpiled)	Topsoil is a key enabler to achieving species richness targets. Rehabilitation can be completed using 'fallow' (i.e. non-fresh) topsoil, however species richness will be constrained and therefore completion criteria may not be met. Fresh topsoil availability is a function of total hectares cleared, the proportion of these hectares that can be cleared during summer months and mapping of dieback and dieback free areas. Delays to new mining area approvals have reduced the availability of fresh topsoil and therefore limited rehabilitation rates.
3. Resource availability	Additional specialised plant and labour resources are required to execute the higher rates of rehabilitation. Higher than expected pit complexity and improved rehabilitation designs for enhanced drainage management will further increase the demand for earthworks and landscaping resources. Increasing the rehabilitation capacity is likely to take 12 months to 2 years to execute due to the lead time to contract or recruit and then train skilled personnel, and equipment lead times.
4. Recalcitrant plant availability	Species richness targets are achieved with contribution from topsoil seedbank, applied seed and plants. If topsoil is limited, then there will be a greater need for plants to achieve richness targets. Availability of additional plants species and numbers required to complete rehabilitation of topsoil is limited. It is likely to take 18 - 36 months to increase availability depending on nursery contractors and research outcomes.
5. Seed availability	Seeds are collected by seed merchants from the provenance areas in accordance with collection rules. Seed collection is impacted by environmental factors and therefore it is critical that we maintain a seed bank to support at least two seasons of rehabilitation. Expansion of existing seed bank and higher collection rates to maintain the seed bank at a sustainable rate is expected to occur over the next 24 months.

The volume of rehabilitation identified in Table 3-13 includes consideration of the above constraints and excludes any rehabilitation remediation or re-work. Alcoa is committed to increasing the area (ha) in which rehabilitation activities are being undertaken each year over the next four years on a rolling basis, achieving a minimum of 3,159 ha of rehabilitation (cumulative) over this period (2024-2027) (Commitment 11). In combination with the clearing limit of 800 ha per year (Commitment 1), no net increase of open areas should occur.

Alcoa acknowledges the importance of rehabilitation to minimise open areas, therefore will provide a detailed rolling five year schedule by 31 December 2024 (Commitment 8). The schedule will detail areas expected to be stabilised, rehabilitated and which may meet relevant completion criteria. The intent of this commitment is to improve transparency with regards to activities which may prevent drainage failures and decrease open areas. It is also part of Alcoa's Rehabilitation Strategy to move towards the handback of rehabilitation once completion criteria is met.

In addition, revision of the current Completion Criteria in consultation with DBCA will occur by 31 December 2024 (Commitment 12).

Table 3-13: Rehabilitation Plan for Huntly and Willowdale mines

Rehabilitation	2024	2025	2026	2027	4 year average
Conceptual clearing areas (Huntly) (ha)	926	762	605	785	926
Conceptual clearing areas (Willowdale) (ha)	422	358	331	297	422
Total proposed conceptual clearing areas (ha)	1,349	1,119	936	1,082	1,349
Clearing Limit (ha)	800	800	800	800	3,200
Proposed rehabilitation for Huntly (ha)	459	458	646	790	588
Proposed rehabilitation for Willowdale (ha)	182	196	218	213	201
Total proposed rehabilitation (ha)	638	654	864	1,003	790

It is acknowledged that some high risk or restricted areas would benefit from prioritised rehabilitation activities, in particular to minimise potential impacts to public drinking water. Therefore, Alcoa has made the following commitments (Commitment 6):

- Within the Serpentine RPZ (2km from the reservoir's top water level) in Myara Central, once mining in the pit is completed, either rehabilitation, stabilisation activities, or drainage controls will be in place within the first full rehabilitation season available.

- Any clearing within 1km of Serpentine Dam top water level or within Serpentine Pipehead Catchment that is required for any purpose other than prohibited), must be either rehabilitated, stabilised, or have drainage in place within the first rehabilitation season available.

The intent of Commitment 6 is to undertaken rehabilitation or other activities (stabilisation or drainage controls) to minimise potential for drainage failures and turbidity events.

3.3.4.1 Rehabilitation Remediation activities

If rehabilitation remediation is required (as identified by monitoring), this is undertaken in addition to any rehabilitation targets or plan. Additional remediation activities include:

- Remediation of Huntly rehabilitation on the western boundary, which is considered a lower priority.
- Remediation of Serpentine Pipehead Catchment rehabilitation.

Alcoa ceased mining earlier than planned in the Serpentine Pipehead Catchment to minimise impacts to public drinking water. As a result, fractured ore remains in some areas which has resulted in a landscape that does not meet Alcoa's rehabilitation standards. The Serpentine Pipehead Catchment consists of 96 ha of rehabilitation which was undertaken between 2020 and 2021. Further rehabilitation is planned in the 2023 – 2024 rehabilitation season, which may include:

- Revised landscape design, particularly in locations where fractured ore remains. Further quantification of resource requirements will be undertaken for the associated cut and fill processes.
- Removal of rehabilitated soil profile to undertake remediation activities, therefore additional fallow soil and Direct Return Topsoil may be required.
- Rectification of groundwater interception in some areas, due to impacts to surface water control sump capacity. Due to the risk of drainage events, remediation activities will be completed over the summer months.

A Rehabilitation Execution Plan is under development for the Serpentine Pipehead Catchment remediation works. The Scope of Work is expected to be completed by late-2023 and outcomes and associated action plan will be communicated in future MMPs.

Given the complexity and priority of the remediation activities, a preferred contractor with known competence to Alcoa standards will be utilised. It is expected that at least two rehabilitation seasons will be required to complete remediation activities.

Following remediation activities, vegetation growth and erosion rates will improve. Until remedial activities are completed, additional risk mitigation measures will be implemented, including water handling controls to prevent drainage events.

3.3.4.2 Future Rehabilitation Strategy

Alcoa has completed a comprehensive review into its rehabilitation performance, which has identified issues, constraints and opportunities (Section 3.3.4). A Rehabilitation Strategy has been developed to enable rehabilitation quality, quantity and handback targets to be sustainably met. This will support Alcoa to meet the following objectives:

- Meet internal and external stakeholder requirements, including commitments contained within the MMP for the 2023 to 2027 period.
- Enable Completion Criteria for rehabilitated forest blocks to be met in a timely and efficient manner.
- Minimise footprint of the Huntly and Willowdale mines.
- Minimise potential impacts and risks to catchment areas and other socio-environmental features within proximity of the mining operations (i.e., dieback management, groundwater systems etc).

As part of the future Rehabilitation Strategy, Alcoa will review the Rehabilitation Completion Criteria by 31 December 2024, in consultation with DBCA (Commitment 12).

The strategy consists of five key pillars which enable an acceleration of the rehabilitation program and facilitate the long-term objective of formal handback of rehabilitated forest blocks to the State. An overview of each of these pillars is provided in

Table 3-14.

Figure 3-13: Future rehabilitation strategy key pillars

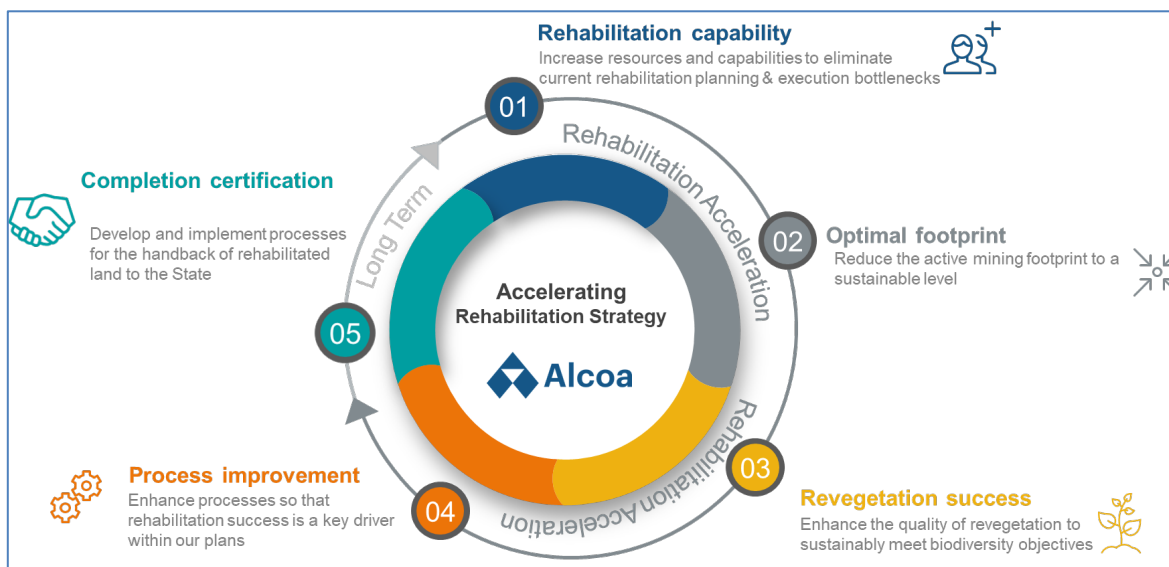


Table 3-14: Future rehabilitation strategy key pillar overview

Pillars	Aim	Targets	Initiative
Rehabilitation capability	Increase resources and capabilities to eliminate current rehabilitation planning & execution bottlenecks.	<ul style="list-style-type: none"> Designs are completed for all pits to be rehabilitated by the 2023/24 season, and in advance of the rehabilitation season for future years. Rehabilitation earthworks supplier contracts for 2023/24 rehabilitation season include incentives to achieve higher productivity. Procure an additional rehabilitation earthworks provider for 2024/25 rehabilitation season. 	<ul style="list-style-type: none"> Review organisational chart and increase resourcing to support rehabilitation strategy. Increase rehabilitation earthworks resources. Review logging and clearing capacity
Optimal footprint	Reduce the active mining footprint to a sustainable level.	<ul style="list-style-type: none"> Optimal mine footprint reached by end of 2028/29 rehabilitation season. 	<ul style="list-style-type: none"> Develop and implement a decision-making framework for pit handover. Actively seek to reduce long term infrastructure across the mining lease. Decouple ore sourcing from feeding the crusher reducing the duration of years that a pit remains open. Ensure the GIS information is accurate to support reporting and planning activities.
Revegetation success	Enhance the quality of revegetation to sustainably meet biodiversity requirements.	<ul style="list-style-type: none"> Ensure sufficient fresh topsoil is available to match the rehabilitation ramp up. Procure additional seed orders (quantity & species range) to match the rehabilitation ramp up. Procure additional plants (quantity & species range) to match the rehabilitation ramp up. 	<ul style="list-style-type: none"> Improve fresh topsoil management and scheduling to minimise waste supported with research to extend topsoil viability. Increase seed collection (quantity & species range) and build the seed storage capability & enhance security (includes investing in research and development programs such as investigation of provenance genetics to identify additional suitable collection areas).

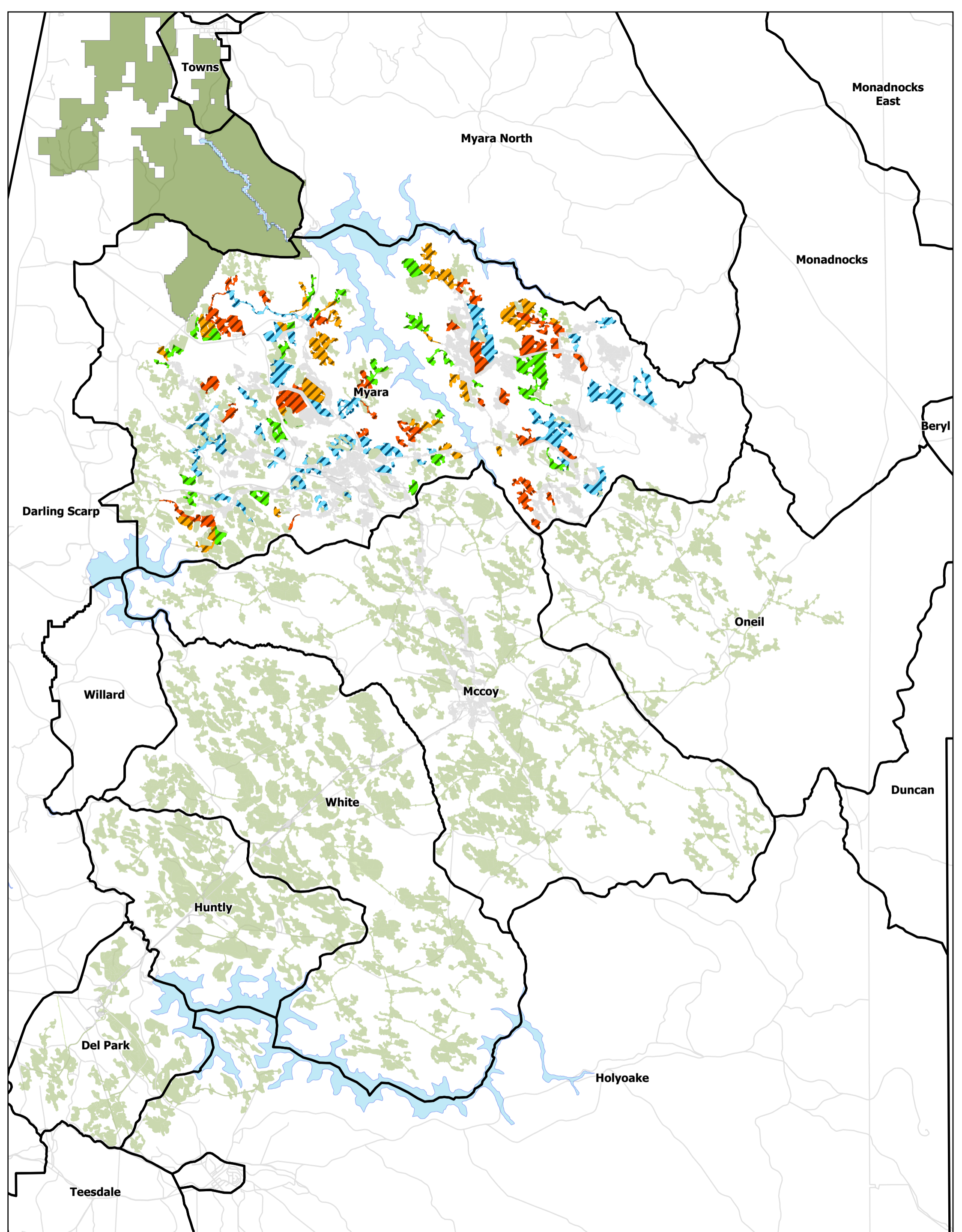
Pillars	Aim	Targets	Initiative
			<ul style="list-style-type: none"> Increase recalcitrant plant contribution to vegetation through procurement (quantity & species), targeted research and development, intervention in early years to increase survivorship.
Process Improvement	Enhance processes so that rehabilitation success is a key driver within the plans.	<ul style="list-style-type: none"> Detailed process mapping of mine activities, articulating inputs, outputs, resources, dependencies & risks. Internal peer review on short- medium- and long-term mine plans for manager's sign-off. Rehabilitation factors and success measured as a core operational KPI. 	<ul style="list-style-type: none"> Prioritise most critical areas for rehabilitation such as areas which are visible from public roads or major dams, OCA1 and OCA2 areas. Update and integrate rehabilitation procedures, policies and standards. Develop rehabilitation accountability and ongoing performance management. Revise closure risk management. Process and accountability mapping to provide further clarity on roles and responsibilities across the organisation.
Completion Certification	Review rehabilitation completion criteria and accelerate assessment of successfully rehabilitated land.	<ul style="list-style-type: none"> External consultative group established to enhance handback transparency. Rehabilitation completion criteria review by end 2024. Establish and endorse handback process and tools. Assess legacy rehabilitated land for suitability for hand-back ~ 1,000 – 2,000 ha p.a. Submit an Assessment Report for Banksiadale forest block (455 ha) and receive a Certificate of Acceptance. 	<ul style="list-style-type: none"> Review rehabilitation working arrangements and completion criteria with stakeholders to ensure there is alignment on expectations and outcomes. Handback a Forest Block (455 ha) to the State in line with the completion criteria and handback program. Develop rehabilitation handback procedures.

3.3.4.3 Risks and Challenges in achieving the rehabilitation rates

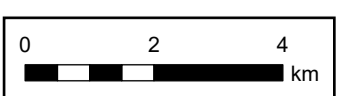
The primary risks associated with Alcoa achieving the revised rehabilitation plan are detailed in Table 3-15.

Table 3-15: Rehabilitation Plan risks

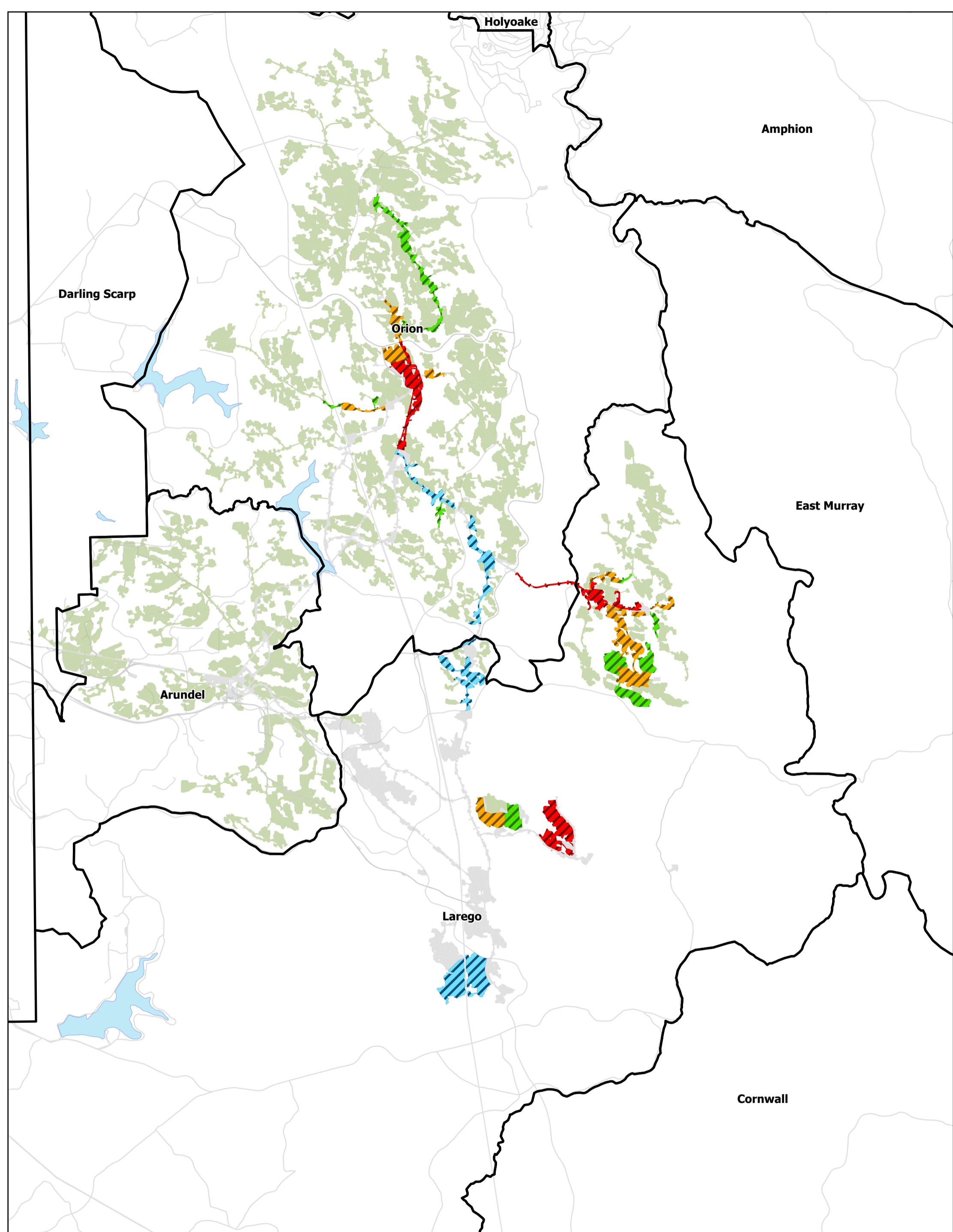
Risk	Details
Pit complexity	This drives total resource hours that are required to be applied in rehabilitation design and execution.
Recruitment and training of sufficient labour resources and equipment procurement	Increasing rehabilitation will require more specialised personnel, to design and execute the rehabilitation, and equipment. Alcoa is still facing supply chain constraints, which have not fully recovered from COVID pandemic impacts.
Current and future mine approval delays	<p>To ensure ongoing refinery operations and maintain the active open area, Alcoa will be required to extend the life of the existing pits.</p> <p>Approval delays also impact the ability to strip sufficient topsoil during optimal months. Fresh topsoil is a critical initial step in the rehabilitation program to aid achievement of biodiversity targets.</p>



Legend		
Proposed Rehabilitation Schedule	Rehabilitation	Mining Regions
2024	Cleared Areas	National Parks
2025		Major Dams
2026		
2027		



2023 – 2027 Mining and Management Plan	
Figure 3-14: Indicative rehabilitation plan –Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023

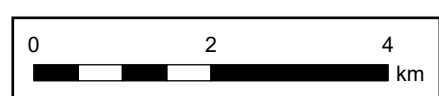


Legend

- Mining Regions
- Major Dams
- Rehabilitation
- Cleared Areas

Proposed Rehabilitation Schedule

- 2024
- 2025
- 2026
- 2027



2023 – 2027 Mining and Management Plan

Figure 3-15: Indicative rehabilitation plan -Willowdale

Scale: 1:85,380

Date Printed: 1/11/2023

4 Community Engagement and Consultation

4.1 Background

Alcoa has developed and maintains strong and mutually beneficial relationships with stakeholders and engages with stakeholders both formally and informally on an ongoing basis.

Alcoa undertakes annual consultation on its mine plans for Huntly and Willowdale as part of the development of the MMP with landowners, and local and state government stakeholders.

As outlined in the MMP Approvals Cycle, stakeholder consultation is an important part of the annual review process.

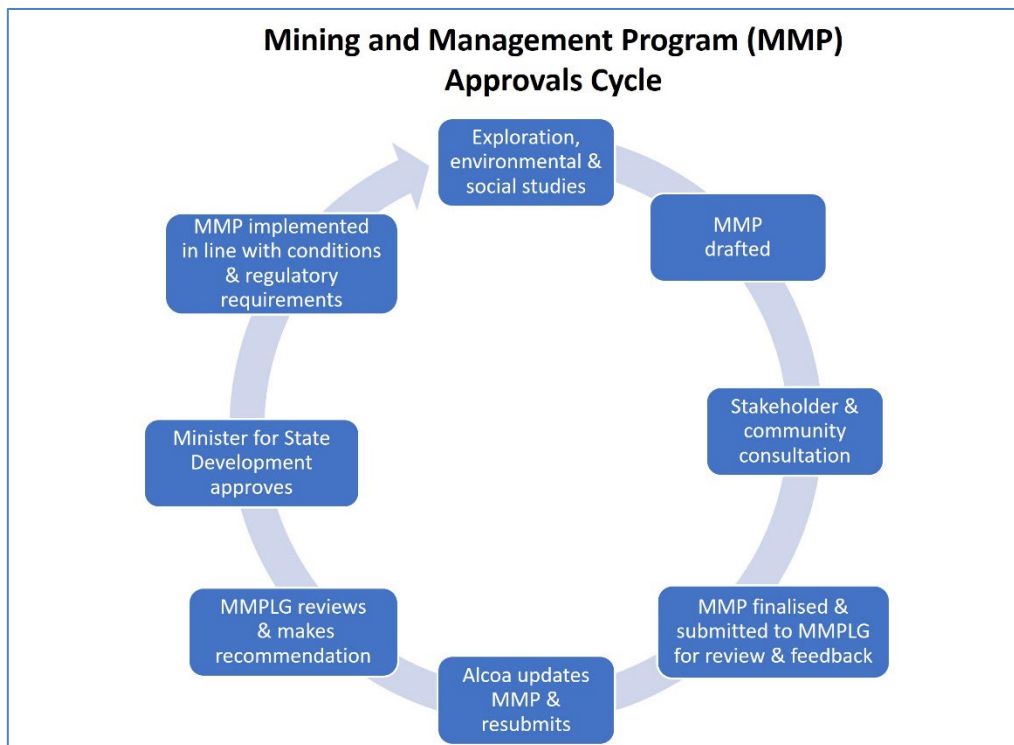


Figure 4-1: Mining and Management Program (Approvals Cycle)

The MMP consultation process involved:

- Writing to identified stakeholders to offer an opportunity to consult with Alcoa as it updates the MMP.
- One-on-one consultation meetings with stakeholders who responded to the invitation to meet.
- Sharing and discussing the rolling five year MMP plan map and inviting stakeholders to provide feedback.
- Considering feedback to inform the annual updating process.

4.2 2023 Consultation

In 2023, Alcoa consulted with a number of stakeholders, a summary of which is provided below. A detailed register of stakeholder consultation is provided in Appendix 7 and provides further detail in regard to specific feedback received.

The feedback received from landowners primarily focussed on proximity of current and future mining activities in relation to dust and/or noise (blasting and mining) impacts, with some discussions around Alcoa's management practices when operating in water catchment areas.

4.2.1 Landowners

Alcoa identified landowners by undertaking noise modelling to determine properties which may be impacted by the proposed mining operations.

A letter was sent to landowners inviting them to contact Alcoa should they wish to meet and consult on the draft MMP. The letter included a request for landowners to extend this invitation if they had tenants living on their property. Landowners (and tenants) are also offered the opportunity to participate in an annual personal tour of the respective mine site.

4.2.1.1 Huntly Landowners

Noise modelling identified properties within the 35 dB(A) noise contour of Huntly mine's Myara mine region along with properties within a 4km radius of the proposed mining operations. Approximately 90 property owners were identified, as shown in Figure 4-2.

4.2.1.2 Willowdale Landowners

Noise modelling identified properties within the 35 dB(A) contour of the Orion and Larego mine regions. Approximately 90 property owners were identified, as shown in Figure 4-3.

4.2.2 Local Government Consultation

Alcoa wrote to the following local government authorities (LGA) covering its MMP activities to meet and consult on the plan:

Huntly Mine	Willowdale Mine
Shire of Serpentine Jarrahdale	Shire of Waroona
Shire of Murray	Shire of Harvey

4.2.3 State Government Agencies

A comprehensive engagement process with the relevant agencies was completed. These agencies also have representation on the MMPLG:

- Department of Mines, Industry Regulation and Safety
- Department of Planning, Lands and Heritage
- Department of Water and Environmental Regulation

- Department of Biodiversity, Conservation and Attractions
- Water Corporation

4.2.4 Other Consultation

The following stakeholders were also contacted to consult on the MMP:

- Gnaala Karla Booja Aboriginal Corporation
- Local State and Federal Members of Parliament
- Department of Justice (Karnet Prison)
- Wagerup /Willowdale Community Consultation Network
- Munda Bididi Trails Foundation
- Bistro on the Dam

4.3 Community Consultation Refinements

4.3.1 Enhancing Consultation

To support the MMP approval process, Alcoa proposes enhancements to its annual consultation program for discussion with the MMPLG.

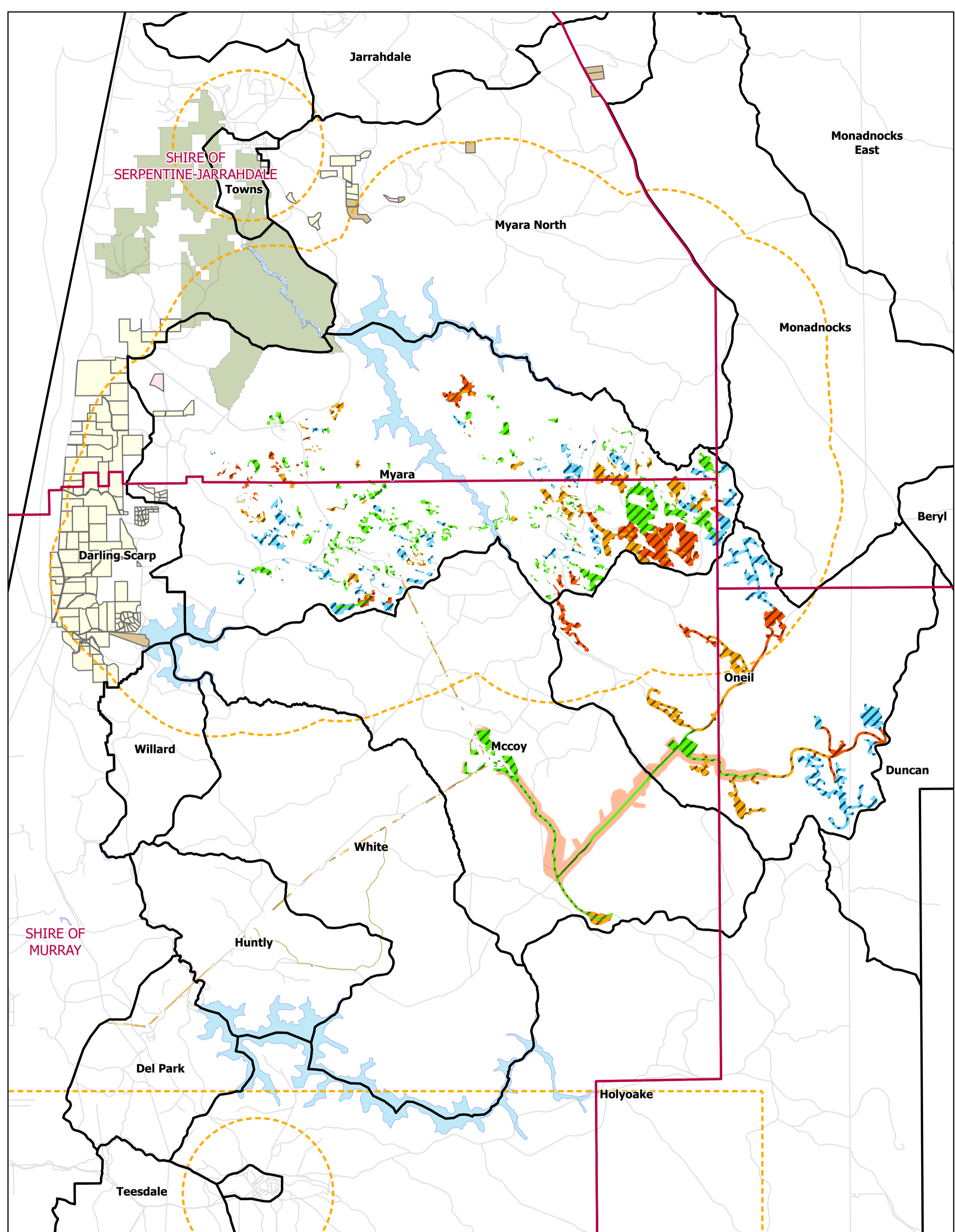
These enhancements include:

- Extended consultation to include other interested and relevant stakeholders.
- Increased information sharing during consultation.

4.3.2 Greater Transparency of Information

In response to feedback received during MMP consultation, Alcoa will publish current and future approved MMPs and associated Management Plans on the Alcoa website within 7 days of Alcoa receiving written notice of approval by the Minister for State Development. (Commitment 10). This includes the 2024-2028 MMP.

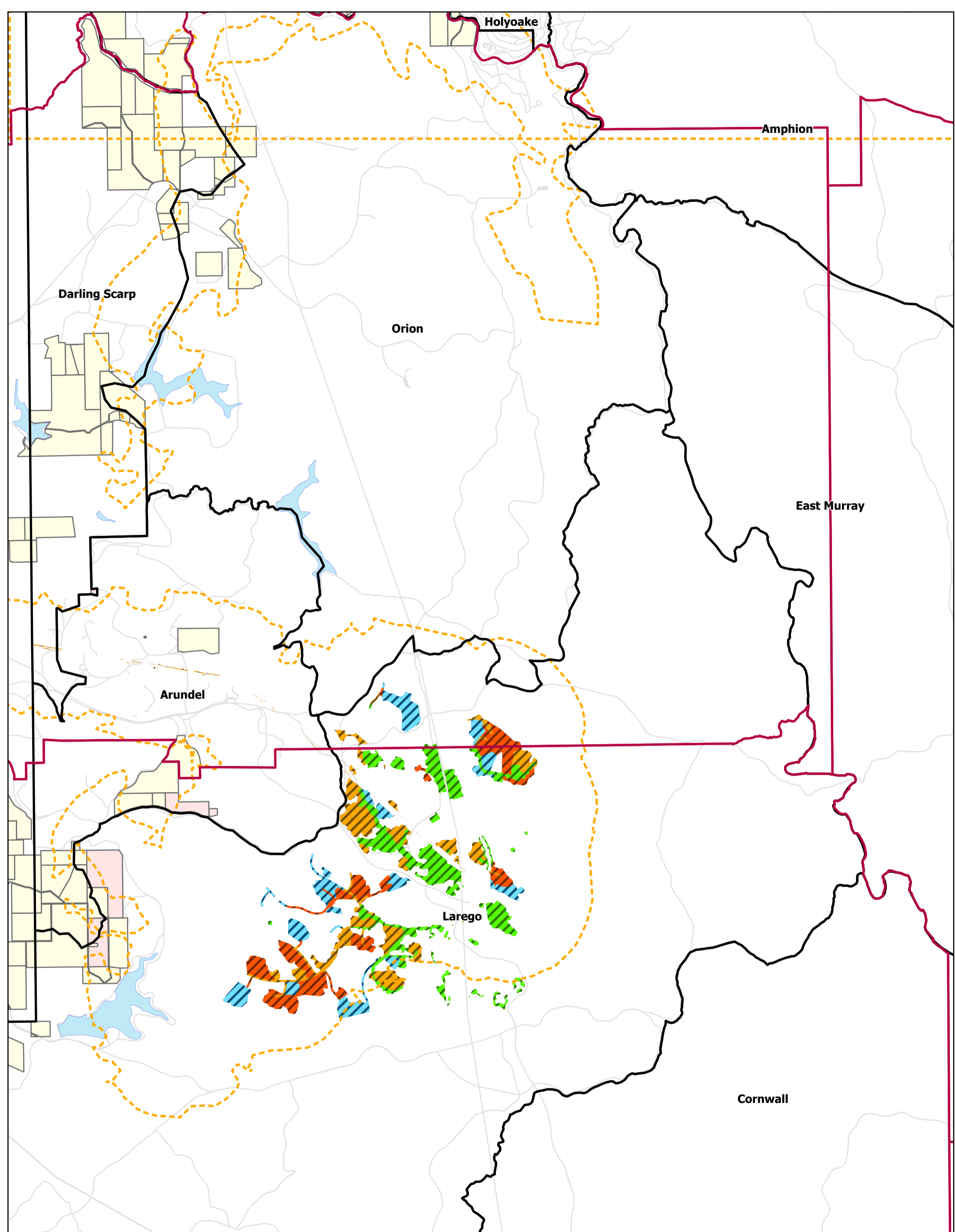
In addition, future Annual Environmental Review documents prepared as part of Alcoa's reporting requirements to the MMPLG will also be published on Alcoa's website.



Legend		
Proposed Clearing Schedule	Conceptual Clearing Buffer	Shire Boundaries
2024	Community Consultation Properties	Mining Regions
2025	Alcoa	Community Consultation Zones
2026	Government	National Parks
2027	Private	Major Dams

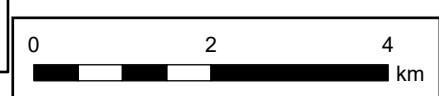


2023 – 2027 Mining and Management Plan	
Figure 4-2: Community consultation locations -Huntly	
Scale: 1:129,352	Date Printed: 2/11/2023



Legend

Proposed Clearing Schedule	Conceptual Clearing Buffer	Shire Boundaries
2024	Community Consultation Properties	Community Consultation Zones
2025	Alcoa	Mining Regions
2026	Government	National Parks
2027	Private	Major Dams



2023 – 2027 Mining and Management Plan

Figure 4-3: Community consultation locations -Willowdale

Scale: 1:85,380

Date Printed: 2/11/2023

5 Flora and Vegetation

5.1 Receiving environment

5.1.1 Baseline studies

A summary of Alcoa's key flora and vegetation studies is presented in Table 5-1. Study reports relevant to the 24 Month Clearing Schedule are presented in Appendix 8.

In accordance with MS728 (as amended 1157) Commitment 4, Alcoa undertakes baseline vegetation mapping of communities for operational sections of the Larego region at Willowdale. The surveys are used to identify and map the vegetation types and indicate the presence of potential suitable habitat for conservation of significant flora and fauna. Vegetation mapping has also been undertaken for the operational areas within the Huntly Mine.

Havel vegetation mapping is undertaken in all areas prior to clearing, including a desktop assessment and field surveys based on a 120 m grid system with site assessments. Site assessment includes recording soil, topography, outcropping, logging and fire history, dieback and species according to Havel (1975). Some targeted work is undertaken between sites and in specific areas such as granite outcrops and stream zones. Vegetation mapping is then completed in combination with aerial imagery.

Alcoa has a well-defined understanding of flora and vegetation values within the current Myara, O'Neil and Larego regions, as the Havel vegetation mapping is considered a robust baseline assessment methodology. Future baseline surveys will be expanded to include ground-water dependent ecosystems and vegetation condition.

Conservation significant flora species are predominately associated with stream zones and granite outcrops (Section 5.1.4) and mining is avoided, and infrastructure impacts minimised, in these areas.

Future vegetation mapping and targeted flora surveys will be undertaken as per the Flora and Vegetation Management Plan (FVMP; Appendix 9). Further details on improvement programs are included in Section 5.3.

Table 5-1: Flora and vegetation baseline studies

Year	Author	Project / Study region	Summary of methods / results
1983, 1992, 1993	E.M. Mattiske & Associates	Jarrahdale, Chandler and Kingsbury Drive, Cobiac	<p>Baseline Flora and Vegetation and Monitoring studies.</p> <p>Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs.</p> <p>Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah forest.</p> <p>Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.</p>

Year	Author	Project / Study region	Summary of methods / results
1985, 1988, 1991, 1992, 1993	E.M. Mattiske & Associates	Del Park, Bates, Jones, Huntly	<p>Baseline Flora and Vegetation and Monitoring studies.</p> <p>Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs.</p> <p>Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah forest.</p> <p>Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.</p>
1994, 2009, 2012, 2019, 2021, 2022	Mattiske Consulting	Huntly, O'Neill, Myara, Myara North	<p>Baseline Flora and Vegetation and Monitoring studies.</p> <p>Baseline studies based on desktop studies and detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs and representative permanent plots.</p> <p>Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah forest.</p> <p>Post 1998, references to Mattiske and Havel vegetation complexes were also assessed in the regional context for vegetation representation in managed forest and conservation areas.</p> <p>Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species</p>
1993, 1994	E.M. Mattiske & Associates	Willowdale	<p>Baseline Flora and Vegetation and Monitoring studies.</p> <p>Baseline studies based on detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs.</p> <p>Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah forest.</p>
1994, 1996, 1997, 2001, 2011, 2012, 2015, 2018, 2019, 2020, 2021, 2022	Mattiske Consulting	Willowdale, Keats, Larego, Vaquita, Holyoake	<p>Baseline Flora and Vegetation and Monitoring studies.</p> <p>Baseline studies based on desktop studies and detailed surveys on 120m x 120m grid systems as a minimum to align with drilling programs and representative permanent plots.</p> <p>Studies highlighted flora and site-vegetation types in respective areas. Site-vegetation types were based on earlier work of Havel (1975a, 1975b) for the northern Jarrah forest.</p> <p>Post 1998, references to Mattiske and Havel vegetation complexes were also assessed in the regional context for vegetation representation in managed forest and conservation areas.</p> <p>Studies included targeted flora searches with an emphasis on novel species, range extensions and threatened and priority species.</p>

Year	Author	Project / Study region	Summary of methods / results
2005 to 2014, 2016 to 2021	Mattiske Consulting	Huntly, Myara and Willowdale	Assessment of rehabilitation areas at 9 months and 15 months (2005 to 2014). Assisting in data collection (2016 to 2021). Alcoa assisting in monitoring permanent plots as requested in spring months.
1988 to 1994 and 1996 to 2006	E.M. Mattiske & Associates, Mattiske Consulting	Monitoring transects	Assessment of creeklines and valley systems near Urbrae, Cameron, Gordon and Jayrup.

5.1.2 Regional Vegetation

The Huntly and Willowdale mines are located within the Southwest Botanical Province as mapped by Beard (1990), within the Jarrah Forest bioregion and Northern Jarrah Forest (NJF) subregion as described by the Interim Biogeographic Regionalisation of Australia (IBRA) and shown in Figure 5-1. The NJF subregion comprises a total of approximately 1.90 million ha and is broadly characterised by Jarrah (*Eucalyptus marginata*) forest on ironstone gravels and Marri-Wandoo (*Corymbia calophylla* – *Eucalyptus wandoo*) woodlands on loamy soils, with sclerophyll understorey.

Dell and Havel (1989) broadly classified the Jarrah Forest as an open forest in its northern extent and as a tall forest in its southern extent. In lower rainfall areas towards the east trees decrease in size (height), forming woodlands or low forests.

The NJF subregion retains native vegetation over approximately 1.11 million ha (58%). Approximately 69% of the remaining vegetation is within DBCA managed lands in the west and south. Substantial clearing has occurred for agriculture in the north and east, as well as urban rural residential in the Perth Hills (e.g. Gidgegannup, Mundaring, Roleystone, Kalamunda)

5.1.2.1 Vegetation associations

Beard (1990) mapped the pre-European vegetation (1:250,000 scale) with three vegetation associations (as presented in Table 5-2 and shown in Figure 5-1) occurring within proximity of the Huntly and Willowdale mines:

- Vegetation association 3 - Medium forest, Jarrah-marri
- Vegetation association 4 – Woodland south-west
- Vegetation association 128 - Bare areas, rock outcrops.

Vegetation association 3 is widespread across the NJF subregion, with the pre-European extent comprising approximately 48% of the subregion. Approximately 80% of the pre-European vegetation extent remains, with approximately 15% of the current extent protected for conservation.

Vegetation association 4 is widespread across the NJF subregion. Approximately 32% of the pre-European vegetation extent remains, with approximately 20% of the current extent protected for conservation.

Vegetation association 128 is comparatively restricted in extent, being limited to larger granite outcrops mapped at the 1:250,000 scale, with the pre-European extent covering approximately 0.25% of the subregion. Approximately 87% of the pre-European extent remains, with approximately 33% of the current extent protected for conservation.

Table 5-2: Vegetation Associations

Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	Percentage (%) of Pre-European Extent Remaining	Percentage (%) of Current Extent protected by conservation reserves
3	908,100	723,446	79.7	15.4
4	614,201	197,904	32.2	20.1
128	4,757	4,124	86.7	32.7

5.1.2.2 Vegetation complexes

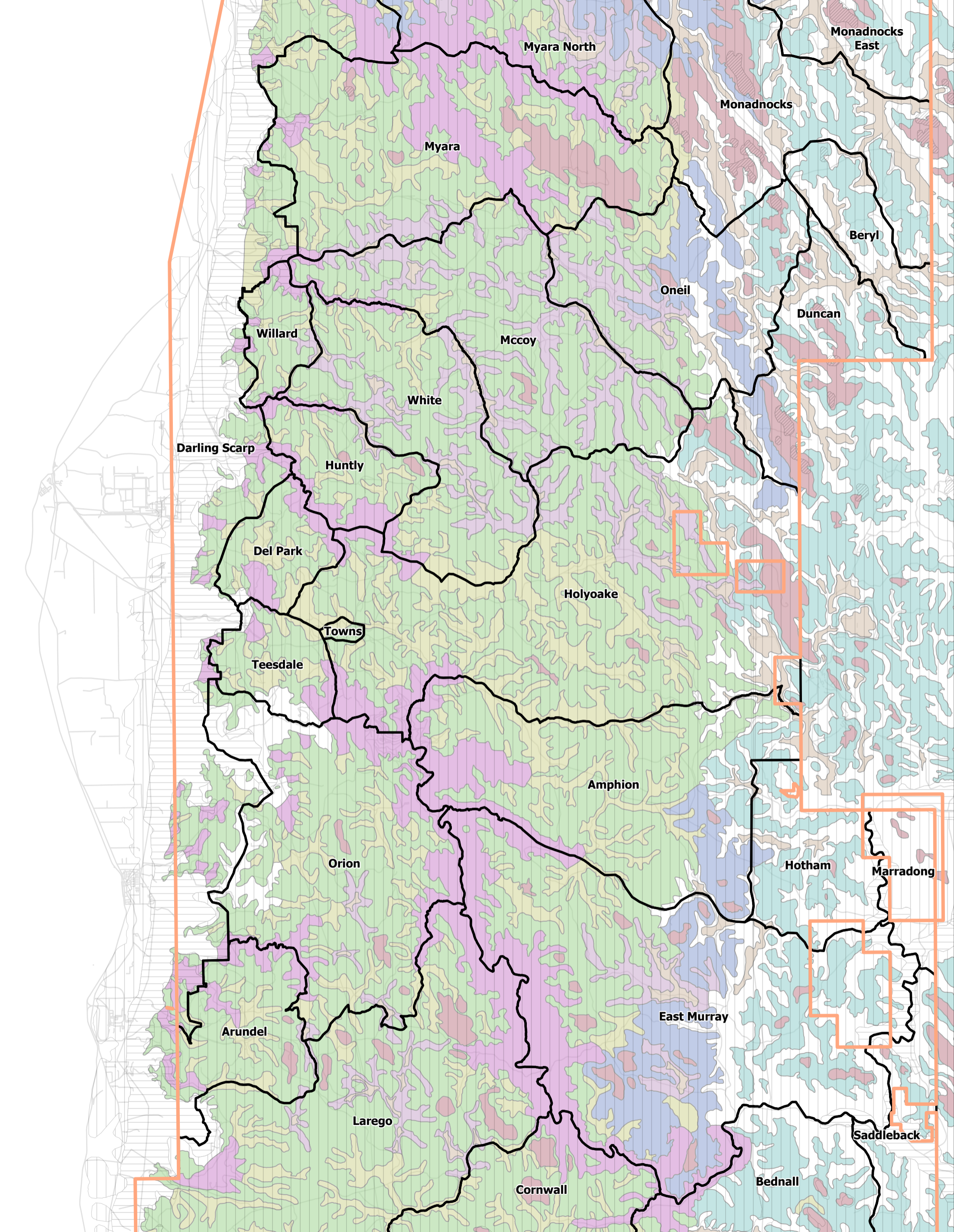
Hedde et al. (1980) defined and described the dominant pre-European vegetation of the Darling System in a series of vegetation complexes, which was updated by Matiske and Havel (1998) as part of a biodiversity assessment to inform the RFA. The vegetation complexes provide a more detailed definition of vegetation over the NJF subregion than the state-wide mapping of vegetation associations.

There are 12 vegetation complexes impacted within the Huntly and Willowdale regions, as presented in Table 5-3 and Figure 5-1. The vegetation complexes are retained at above 75% of pre-European extent, and their reservation is generally at less than 20% of their current extent.

Table 5-3: Vegetation Complexes

Vegetation Complex	Description	Pre-European Extent (ha)	Current Extent (ha)	Percentage (%) of Pre-European Extent Remaining	Percentage (%) of Current Extent Protected for Conservation
Cooke (Ce)	Mosaic of open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> (subhumid zone) and open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> (semiarid and arid zones) and on deeper soils adjacent to outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on granite rocks and associated soils in all climate zones, with some <i>Eucalyptus laeliae</i> (semiarid), and <i>Allocasuarina huegeliana</i> and <i>Eucalyptus wandoo</i> (mainly semiarid to perarid zones).	36,778.9	30,003.5	81.6%	18.6
Dwellingup (D1)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> on lateritic uplands in mainly humid and subhumid zones.	208,489.1	180,617.8	86.6%	8.3
Dwellingup (D2)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> on lateritic uplands in subhumid and semiarid zones.	86,127.4	71,310.5	82.8%	19.3
Dwellingup (D4)	Open forest to woodland of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> on lateritic uplands in semiarid and arid zones.	132,413.7	115,545.2	87.3%	12.0
Goonaping (G)	Mosaic of open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (humid zones) and <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> (semiarid to perarid zones) on the sandy-gravels, low woodland of <i>Banksia attenuata</i> on the drier sandier sites (humid to perarid zones) with some <i>Banksia menziesii</i> (northern arid and perarid zones) and low open woodland of <i>Melaleuca preissiana</i> - <i>Banksia littoralis</i> on the moister sandy soils (humid to perarid zones).	27,466.9	21,817.5	79.4%	50.6
Helena 1 (He1)	Mosaic of open forest of <i>Corymbia calophylla</i> - <i>Eucalyptus patens</i> - <i>Eucalyptus marginata</i> subsp. <i>marginata</i> with some <i>Eucalyptus rudis</i> on	15,890.0	12,044.8	75.8%	30.0

Vegetation Complex	Description	Pre-European Extent (ha)	Current Extent (ha)	Percentage (%) of Pre-European Extent Remaining	Percentage (%) of Current Extent Protected for Conservation
	the deeper soils ranging to closed heath and lithic complex on shallow soils associated with granite on steep slopes of valleys in humid and subhumid zones.				
Murray 1 (My1)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> - <i>Eucalyptus patens</i> on valley slopes to woodland of <i>Eucalyptus rudis</i> - <i>Melaleuca raphiophylla</i> on the valley floors in humid and subhumid zones.	68,694.6	52,307.2	76.1%	25.7
Pindalup (Pn)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> on slopes and open woodland of <i>Eucalyptus wandoo</i> with some <i>Eucalyptus patens</i> on the lower slopes in semiarid and arid zones.	167,149.2	128,685.2	77.0%	0.0
Swamp (S)	Mosaic of low open woodland of <i>Melaleuca preissiana</i> - <i>Banksia littoralis</i> , closed scrub of <i>Myrtaceae</i> spp., closed heath of <i>Myrtaceae</i> spp. and sedgeland of <i>Baumea</i> and <i>Leptocarpus</i> spp. on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones.	53,657.6	40,503.7	75.5%	14.3
Yarragil 1 (Yg1)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> on slopes with mixtures of <i>Eucalyptus patens</i> and <i>Eucalyptus megacarpa</i> on the valley floors in humid and subhumid zones.	80,202.3	64,985.7	81.0%	9.9
Yarragil (Yg2)	Open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> on slopes, woodland of <i>Eucalyptus patens</i> - <i>Eucalyptus rudis</i> with <i>Hakea prostrata</i> and <i>Melaleuca viminea</i> on valley floors in subhumid and semiarid zones.	50,258.8	46,483.6	92.5%	10.6



Legend

MLSISA	Cooke	Murray 1
Mining Regions	Dwellingup 1	Swamp
3: Forest	Dwellingup 2	Yarragil 1
4: Woodland southwest	Dwellingup 3	Yarragil 2
128: Rock		

0 4 8 km

2023 – 2027 Mining and Management Plan

Figure 5-1: Regional Vegetation setting

Scale: 1:191,784

Date Printed: 6/09/2023

5.1.3 Vegetation Types

5.1.3.1 Huntly

Mattiske Consulting conducted flora and vegetation surveys over the Huntly mine area collecting field data between 2008 to 2019, mapping 36 vegetation types (VTs). The VTs were mapped based on a grid survey, using key indicator species and site conditions adapted from the method of Havel (1975a, 1975b), to differentiate vegetation across the continuum of Jarrah-Marri overstorey. The VTs are presented in Table 5-4 and Figure 5-2 to Figure 5-4. The VTs comprise combinations of the 21 site vegetation types (SVTs) developed by Havel (1975a, 1975b), with the first letter reflecting the dominant SVT and the second letter the subdominant SVT. In addition, rehabilitation, cleared areas and open water were also mapped.

Approximately 50% of the uncleared vegetation within the Huntly mine area comprises VTs with P, S and T as the dominant SVTs. These three SVTs are relatively widespread and primarily associated with the upland areas in the high to medium rainfall zone (>900 mm/year), and T also associated with the Murray complex (Heddle et al 1980). The uplands are dominated by the P and S SVTs. These upland SVTs vary substantially with respect to soil texture from coarse sandy gravels (P) to loamy gravels (S) and sandy loams (T) (Bell and Heddle 1989).

Approximately 10% of the uncleared vegetation within the Huntly mine area comprises VTs with C, D, E and W dominant, which are less widespread SVTs found in lower slopes associated with creeklines (Heddle et al 1980).

Approximately 2% of the Huntly mine area comprises VTs with G and R dominant, which are restricted in extent to granite outcrops and associated with the Cooke complex. Less than 5% comprises VT with A dominant, which is an SVT restricted to swamps and associated with the Swamp and Yarragil 2 complexes. The VTs with G, R and A dominant provide habitat for conservation significant flora and VTs with G and R dominant are potentially associated with a priority ecological community.

Approximately 19% of the entire region comprises cleared land and mine rehabilitation. Approximately 1% comprises open water of the reservoirs. Approximately 15% of the mine region is un-surveyed.

5.1.3.2 Willowdale

Mattiske Consulting conducted flora and vegetation surveys over the Larego and Orion regions, during 2008 and 2022, mapping 20 vegetation types (VTs). The VTs were mapped based on a grid survey, using key indicator species and site conditions adapted from the method of Havel (1975a, 1975b), to differentiate vegetation across the continuum of Jarrah-Marri overstorey. The VTs are presented in Table 5-4 and Figure 5-5 to Figure 5-7. The VTs comprise combinations of the 21 site vegetation types (SVTs) developed by Havel (1975a, 1975b), with the first letter reflecting the dominant SVT and the second letter the subdominant SVT. In addition, cleared areas and open water were also mapped.

Approximately 20% of the mapped, uncleared vegetation within the Willowdale mine area comprises VTs with P, S and T as the dominant SVTs. These three SVTs are relatively widespread and primarily associated with the upland areas in the high to medium rainfall zone (>900 mm/year), (Heddle et al 1980). The uplands are dominated by the P and S SVTs. These upland SVTs vary substantially with respect to soil texture from coarse sandy gravels (P) to loamy gravels (S) and sandy loams (T) (Bell and Heddle 1989).

Approximately 12% of the uncleared vegetation within the Willowdale mine area (Larego and Orion regions) comprises VTs with C, D, E and W dominant, which are less widespread SVTs found in lower slopes and creeklines (Heddle et al 1980).

Approximately 4% of the Willowdale mine area comprises VTs with G and R dominant, which are restricted in extent to granite outcrops and associated with the Cooke complex. Approximately 1% comprises VT with A dominant, which is an SVT restricted to swamps and associated with the Swamp and Yarragil 2 complexes. The VTs with G, R and A dominant provide habitat for conservation significant flora.

Approximately 12% of the entire region comprises cleared land and mine rehabilitation and approximately 62% of the mine region is un-surveyed.

Table 5-4: Vegetation types recorded

Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
A	Tall shrubland of <i>Melaleuca lateritia</i> , <i>Hakea varia</i> , <i>Melaleuca viminea</i> and <i>Melaleuca incana</i> subsp. <i>incana</i> on clay-loams in seasonally wet valley floors.	336.9	327.9	0.3%	5.6	0.0%
AC	Open Woodland of <i>Eucalyptus rudis</i> – <i>Melaleuca preissiana</i> – <i>Eucalyptus patens</i> – <i>Banksia littoralis</i> with dense <i>Taxandria linearifolia</i> and <i>Astartea scoparia</i> in understorey on broad swamps and water-courses	3,549.3	2,894.5	2.9%	446.3	0.8%
AD	Low open woodland of <i>Eucalyptus rudis</i> and <i>Eucalyptus marginata</i> over <i>Banksia littoralis</i> , <i>Hakea prostrata</i> and <i>Pericalymma ellipticum</i> over low shrubs and herbs on leached sands over sandy-gravel on lower slopes.	302.9	302.9	0.3%	-	-
AW	Low open woodland of <i>Eucalyptus patens</i> and <i>Melaleuca preissiana</i> over <i>Banksia littoralis</i> , <i>Hakea prostrata</i> and <i>Pericalymma ellipticum</i> over low shrubs and herbs on leached sands over sandy-gravel on lower slopes.	138.0	136.6	0.1%	1.3	0.0%
AW/AX	Localised patchy mosaic of AW and AX.	21.2	21.2	0.0%	-	-
AW/CW	Localised patchy mosaic of AW and CW.	20.3	20.3	0.0%	-	-
AX	Open woodland of <i>Eucalyptus rudis</i> over <i>Acacia saligna</i> , <i>Melaleuca incana</i> subsp. <i>incana</i> and <i>Hypocalymma angustifolium</i> on clay- loams on valley floors.	75.5	75.5	0.1%	-	-
B	Dunal sands usually formed when sand from insitu weathering gets trapped in a shallow valley, often forming ridges and swales.	1.0		0.0%	1.0	0.0%
C	Woodland to Open Forest of <i>Eucalyptus patens</i> – <i>Corymbia calophylla</i> – <i>Banksia littoralis</i> and <i>Banksia seminuda</i> with dense <i>Taxandria linearifolia</i> and <i>Astartea scoparia</i> in understorey on creek-lines and water-courses.	423.4	374.3	0.4%	6.3	0.0%
CA	Woodland to Open Forest of <i>Eucalyptus patens</i> , <i>Corymbia calophylla</i> , <i>Banksia littoralis</i> , and <i>Banksia seminuda</i> with mixed understorey species including	34.3		0.0%	34.3	0.1%

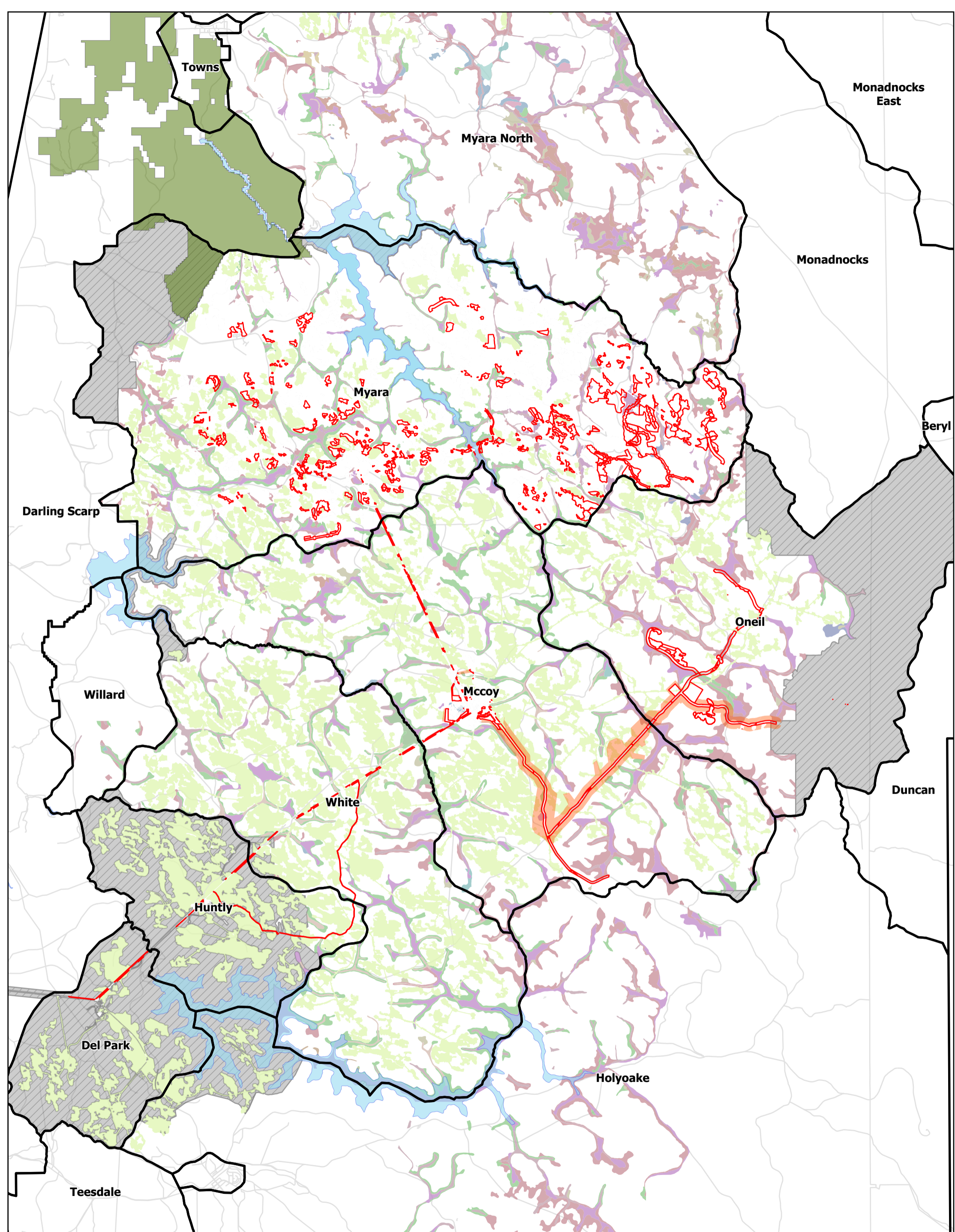
Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
	<i>Taxandria linearifolia</i> , <i>Astartea scoparia</i> , and <i>Trymalium floribundum</i> on loam soils on lower slopes, near creek-lines and water-courses.					
CQ	Woodland to Open Forest of <i>Eucalyptus patens</i> , <i>Corymbia calophylla</i> , <i>Banksia littoralis</i> , and <i>Banksia seminuda</i> with mixed understorey species including <i>Taxandria linearifolia</i> , <i>Astartea scoparia</i> , and <i>Trymalium floribundum</i> on loam soils on lower slopes, near creek-lines and water-courses.	281.4	7.5	0.0%	268.8	0.5%
CW	Woodland to Open Forest of <i>Eucalyptus patens</i> – <i>Eucalyptus megacarpa</i> – <i>Corymbia calophylla</i> – <i>Banksia littoralis</i> with dense <i>Taxandria linearifolia</i> and <i>Astartea scoparia</i> in understorey on creek-lines and water-courses	,3074.7	2,230.8	2.3%	647.3	1.1%
D	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Hakea prostrata</i> on lower slopes with mixed low understorey species, including <i>Babingtonia camphorosmae</i> and <i>Acacia extensa</i> on clay loams to gravelly clay-loams	4,139.2	3,747.5	3.8%	219.1	0.4%
DA	Woodland of <i>Eucalyptus marginata</i> – <i>Banksia littoralis</i> – <i>Hakea prostrata</i> on lower slopes with mixed low understorey species, including <i>Babingtonia camphorosmae</i> and <i>Acacia extensa</i> on moister sandy-loams	302.8	300.9	0.3%	1.8	0.0%
DG	Woodland of <i>Eucalyptus marginata</i> - <i>Corymbia calophylla</i> on lower slopes with mixed low understorey species, including <i>Grevillea bipinnatifida</i> , <i>Hypocalymma angustifolium</i> , <i>Babingtonia camphorosmae</i> and <i>Acacia extensa</i> on sandy-loams over shallow outcropping.	80.8	80.2	0.1%	0.7	0.0%
E	Open Forest to Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Kingia australis</i> , <i>Adenanthos barbiger</i> and low shrubs, herbs and sedges on sandy gravels.	495.5	429.8	0.4%	59.6	0.1%
G	Mosaic of Open Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> on the fringes of outcrops ranging to open heath communities of Proteaceae-Myrtaceae species and lithic complexes on the outcrop areas.	348.1	311.0	0.3%	34.6	0.1%

Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
G1	Mosaic of Open Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> on the fringes of outcrops ranging to open heath communities of Proteaceae-Myrtaceae species and lithic complexes on the outcrop areas.	407.4	407.2	0.4%	-	-
G2	Woodland of <i>Allocasuarina huegeliana</i> and associated herbs and lowshrubs on shallow granite outcrops.	1.0	1.0	0.0%	-	-
J	Open Woodland to open forest of <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> and <i>Eucalyptus patens</i> over <i>Mesomelaena tetragona</i> , <i>Leptocarpus scariosus</i> , <i>Babingtonia camphorosmae</i> and <i>Stirlingia latifolia</i> on broad sandy-loam flats valley slopes.	46.4	45.9	0.0%	-	-
M	Open woodland of <i>Eucalyptus wandoo</i> over <i>Trymalium ledifolium</i> , <i>Macrozamia riedlei</i> and <i>Hakea lissocarpha</i> on clay loams with some gravel on mid to upper slopes and ridges.	3.4	3.4	0.0%	-	-
P	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Grevillea wilsonii</i> , <i>Adenanthos barbiger</i> and low shrubs, herbs and sedges on sandy gravels	1,783.8	1,557.6	1.6%	185.2	0.3%
PG	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Grevillea wilsonii</i> , <i>Adenanthos barbiger</i> and <i>Grevillea bipinnatifida</i> on sandy-loams over shallow outcropping.	0.3	0.3	0.0%	-	-
PL	Plantation	193.6	162.2	0.2%	-	-
PS	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Banksia grandis</i> with scattered understorey, including <i>Adenanthos barbiger</i> , <i>Leucopogon capitellatus</i> on gravels and sandy gravels.	8,382.2	6,962.3	7.0%	953.2	1.7%
PT	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Banksia grandis</i> with scattered understorey, including <i>Adenanthos</i>	1,620.2	1,101.0	1.1%	475.8	0.8%

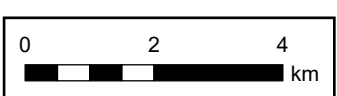
Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
	<i>barbiger</i> , <i>Leucopogon verticillatus</i> , <i>Pteridium esculentum</i> and <i>Bossiaea aquifolium</i> subsp. <i>Aquifolium</i> on sandy-loam gravels					
PW	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Grevillea wilsonii</i> , <i>Adenanthos barbiger</i> , <i>Babingtonia camphorosmae</i> and <i>Hypocalymma angustifolium</i> on sandy gravels	1,846.1	1,475.9	1.5%	210.5	0.4%
Q	Open Forest of <i>Eucalyptus patens</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> on lower slopes with mixed low understorey species, including <i>Trymalium odoratissimum</i> subsp. <i>Odoratissimum</i> , <i>Hypocalymma angustifolium</i> and <i>Pteridium esculentum</i> on seasonally moister loamy soils.	444.1	122.8	0.1%	299.1	0.5%
R	Open Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> on fringes of granite outcrops or shallow soils over mixed understorey species reflecting shallow soils over granite.	845.0	788.7	0.8%	43.7	0.1%
R/G	Localised patchy mosaic of R and G site-vegetation types.	14.3	5.6	0.0%	8.7	0.0%
S	Open Forest of <i>Eucalyptus marginata</i> – <i>Banksia grandis</i> – <i>Allocasuarina fraseriana</i> with scattered understorey, including <i>Adenanthos barbiger</i> , <i>Leucopogon capitellatus</i> and <i>Styphelia tenuiflora</i> on gravels and sandy- gravels.	17,587.2	14,058.2	14.2%	2,803.6	4.9%
SP	Open Forest of <i>Allocasuarina fraseriana</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Banksia grandis</i> with scattered understorey, including <i>Adenanthos barbiger</i> , <i>Grevillea wilsonii</i> and <i>Leucopogon capitellatus</i> on sandy-gravels to gravelly soils.	5706.2	4674.0	4.7%	547.9	1.0%
SP-D	Localized patchy mosaic of SP and D	10.1	10.1	0.0%	-	-
S-SP	Localized patchy mosaic of S and SP	0.7	0.7	0.0%	-	-

Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
ST	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Leucopogon capitellatus</i> , <i>Leucopogon verticillatus</i> , <i>Pteridium esculentum</i> , <i>Lasiopetalum floribundum</i> and <i>Styphelia tenuiflora</i> on sandy-gravelly soils.	6,931.1	4,356.9	4.4%	2,274.8	4.0%
SW	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Banksiagrandis</i> with scattered understorey, including <i>Adenanthos barbiger</i> , <i>Hypocalymma angustifolium</i> and <i>Styphelia tenuiflora</i> on seasonally moister sandy-gravelly soils.	3,404.3	2,745.7	2.8%	423.2	0.7%
SW-D	Localized patchy mosaic of SW and D.	9.4	9.4	0.0%	-	-
T	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with scattered understorey, including <i>Leucopogon verticillatus</i> , <i>Pteridium esculentum</i> , <i>Clematis pubescens</i> and <i>Bossiaea aquifolium</i> subsp. <i>Aquifolium</i> on sandy-loam gravelly soils.	5,345.7	4,258.1	4.3%	802.7	1.4%
TP	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Allocasuarina fraseriana</i> – <i>Banksia grandis</i> on sandy-loams to sandy- gravels with scattered understorey, including <i>Clematis pubescens</i> , <i>Adenanthos barbiger</i> , <i>Leucopogon verticillatus</i> , <i>Pteridium esculentum</i> and <i>Bossiaea aquifolium</i> subsp. <i>Aquifolium</i> on sandy-loam gravels.	202.7	14.1	0.0%	188.6	0.3%
TS	Open Forest of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> – <i>Banksia grandis</i> with scattered understorey, including <i>Leucopogon verticillatus</i> , <i>Pteridium esculentum</i> , <i>Clematis pubescens</i> and <i>Bossiaea aquifolium</i> subsp. <i>Aquifolium</i> on sandy-loam gravelly to gravelly soils.	10,133.3	7,259.7	7.3%	2,481.0	4.4%
W	Open Forest of <i>Eucalyptus megacarpa</i> – <i>Eucalyptus patens</i> – <i>Corymbia calophylla</i> on lower slopes with mixed low understorey species, including	4,607.0	3,284.5	3.3%	1,248.5	2.2%

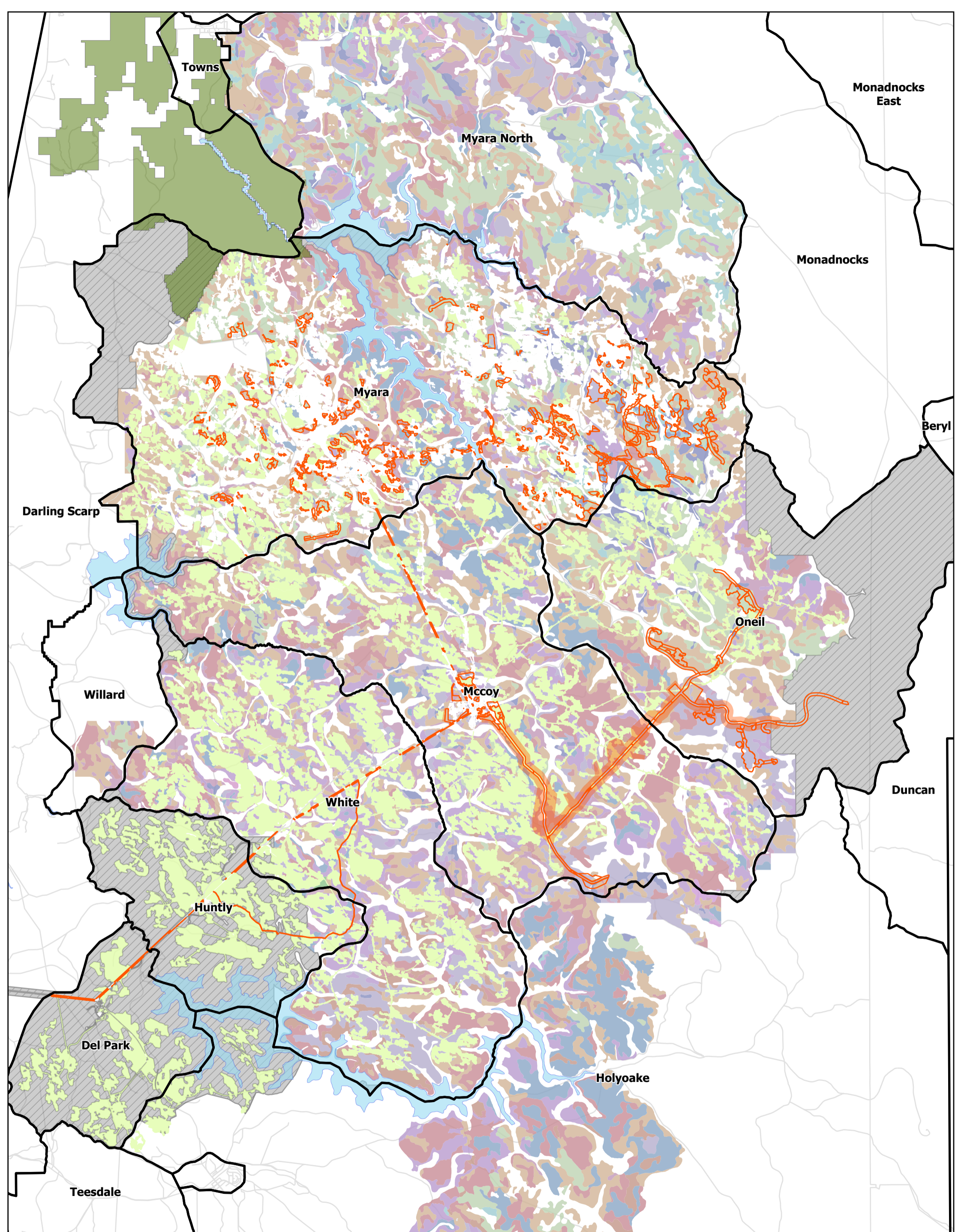
Code	Description	Mapped extent (ha)	Huntly		Willowdale	
			Area (ha)	% mine region	Area (ha)	% mine region
	<i>Acacia extensa</i> and <i>Hypocalymma angustifolium</i> on seasonally moister sandy-loam gravelly soils.					
WA	Open woodland of <i>Eucalyptus patens</i> – <i>Corymbia calophylla</i> – <i>Eucalyptus marginata</i> – <i>Banksia littoralis</i> including <i>Hypocalymma angustifolium</i> and range of Myrtaceae species on sandy loam lower slopes.	35.7	32.7	0.0%	1.2	0.0%
WD	Open Forest of <i>Eucalyptus patens</i> , <i>Corymbia calophylla</i> , <i>Eucalyptus megacarpa</i> , and <i>Hakea prostrata</i> on lower slopes with mixed low understorey species, including <i>Hypocalymma angustifolium</i> , <i>Babingtonia camphorosmae</i> , and <i>Acacia extensa</i> on seasonally moister sandy-clay loams.	1.4	1.4	0.0%	-	-
Z	Open forest of <i>Eucalyptus marginata</i> - <i>Corymbia calophylla</i> with scattered understorey, including <i>Macrozamia riedlei</i> , <i>Xanthorrhoea preissii</i> , <i>Hakea lissocarpha</i> and <i>Phyllanthus calycinus</i> on sandy-loam gravelly soils.	93.2	59.3	0.1%	-	-
Dam		329.0	329.0	0.3%	-	-
Rehabilitation Areas		22,526.6	13,767.3	13.9%	5082.9	8.9%
Cleared Areas		7068.7	4622.5	4.7%	1657.2	2.9%
Un-surveyed		589,791.4	15,400.7	15.6%	35,597.6	62.4%
Total Area		702,966.9	98,779.0	100.0%	57,012.1	100.0%



Legend	
24 Month Clearing Schedule	Lower Slope & Swamp Vegetation Types
Conceptual Clearing Buffer	B
Mining Regions	C
National Parks	CA
Major Dams	CQ
Un-surveyed Area	CW
	D
	DA
	DG
	E
	W
	WA
	WD
	DAM
	Rehabilitation
	Cleared Area
	A
	AC
	AD
	AW
	AW/AX
	AW/CW
	AX



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Figure 5-2: Lower slopes & swamps Vegetation Types - Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023



24 Month Clearing Schedule	Upland Area Vegetation Types	Legend	SW-D
Conceptual Clearing Buffer	J	PW	T
Mining Regions	M	Q	TP
National Parks	P	S	TS
Major Dams	PG	S-SP	Z
Un-surveyed Area	PL	SP	DAM
	PS	SP-D	Rehabilitation
	PT	ST	Cleared Areas
		SW	

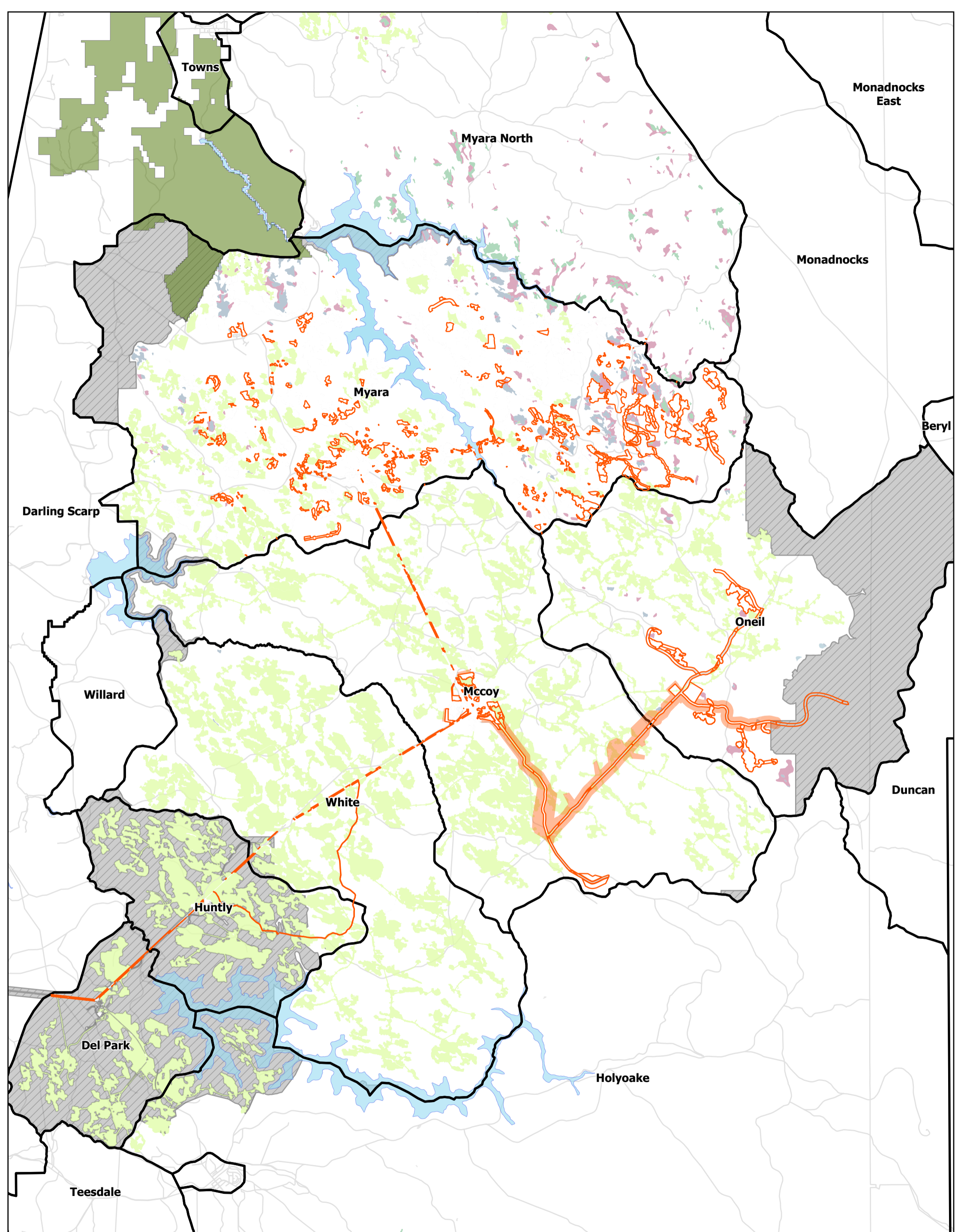
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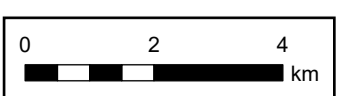
Figure 5-3: Upland areas Vegetation Types - Huntly

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Legend

24 Month Clearing Schedule	Granite Outcrop Vegetation Types	R/G
Conceptual Clearing Buffer	G	DAM
Mining Regions	G1	Rehabilitation
National Parks	G2	Cleared Area
Major Dams	R	
Un-surveyed Area		

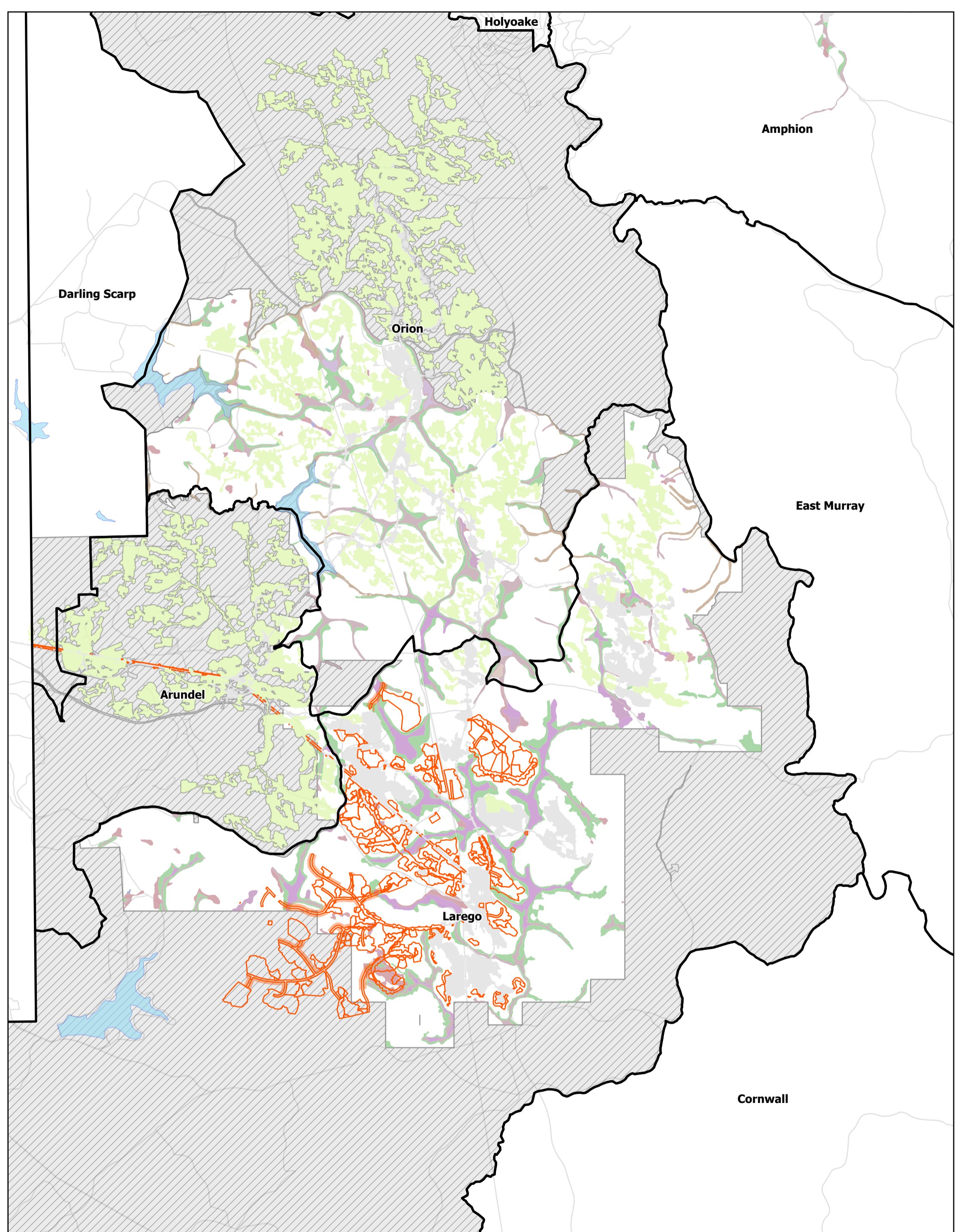


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Figure 5-4: Granite outcrops Vegetation Types - Huntly

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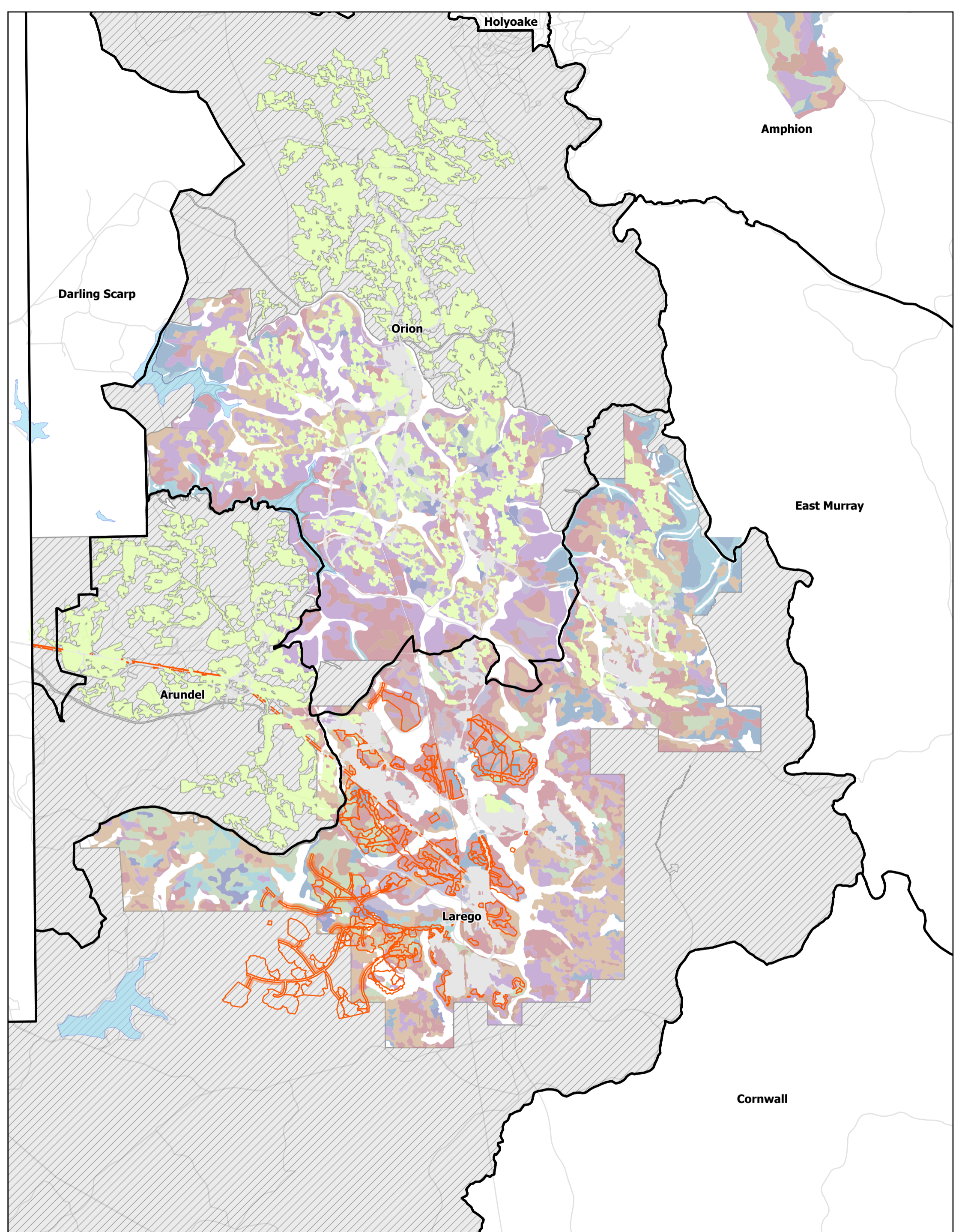
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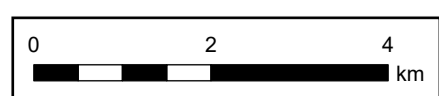
Legend	
24 Month Clearing Schedule	Lower Slope & Swamp Vegetation Types
Mining Regions	SpeciesCode
Major Dams	A
Un-surveyed Area	AC
	AD
	AW
	AW/AX
	AW/CW
	AX
	B
	C
	CA
	CQ
	CW
	D
	DA
	DG
	E
	W
	WA
	WD
	DAM
	Rehabilitation
	Cleared Area



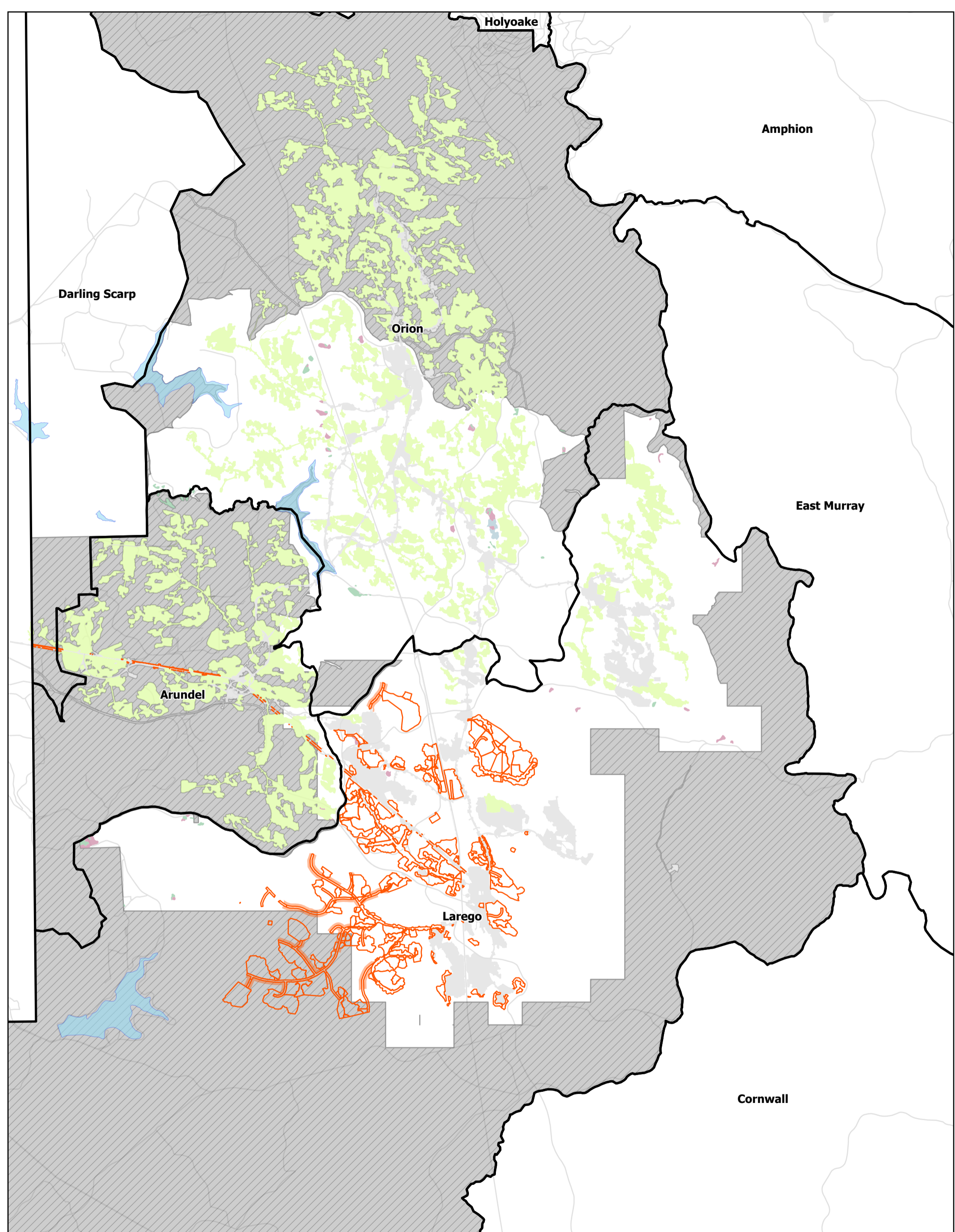
2023 – 2027 Mining and Management Plan	
Figure 5-5: Lower slopes & swamps Vegetation Types - Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023



24 Month Clearing Schedule	Upland Area Vegetation Types	Legend	SW-D
Mining Regions	J	PW	T
Major Dams	M	Q	TP
Un-surveyed Area	P	S	TS
	PG	S-SP	Z
	PL	SP	DAM
	PS	SP-D	Rehabilitation
	PT	ST	Cleared Areas
		SW	



2023 – 2027 Mining and Management Plan	
Figure 5-6: Upland areas Vegetation Types - Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023



Legend		
24 Month Clearing Schedule	Granite Outcrop Vegetation Types	R/G
Conceptual Clearing Buffer	G	DAM
Mining Regions	G1	Rehabilitation
Major Dams	G2	Cleared Area
Un-surveyed Area	R	



2023 – 2027 Mining and Management Plan	
Figure 5-7: Granite outcrops Vegetation Types - Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

5.1.4 Conservation Significant Flora

An assessment of likelihood of occurrence was undertaken (Appendix 10) for conservation significant flora, based on database searches (EPBC Act Protected Matters Search Tool, DBCA and Herbarium), species distribution, species habitat requirements, potential suitable habitat indicated by VT mapping and vegetation survey reports.

To generate the likely habitats of each species, information from four sources was utilised:

- Descriptions provided on the Florabase (WA Herbarium) website,
- Description provided by Matiske Consulting in their Revised Proposal desktop assessments,
- Aggregation of DBCA site descriptions of each known population of each species within 20 km of Alcoa's operations,
- Aggregation of Herbarium site descriptions of each collected specimens within 20 km of Alcoa's operations.

Between these four sources, a consensus was taken of the most likely associated Northern Jarrah Forest landform/topography, soil type, hydrology, and Havel vegetation type.

Optimal timeframe is taken from WA Herbarium descriptions, DBCA record descriptions and Matiske consulting reports to work out when reproductive material is available. If no obvious description is available, any month that is listed in a DBCA or WA Herbarium record where flowering or fruiting is mentioned. As such, Optimal Timeframe is when those specific material will most likely be available. Critical timeframe has now been included and refers to species that may only be 'above ground' during certain months of year. Historic records are based on DBCA and WA Herbarium results. Future LOOs can differentiate between these records and Alcoa's.

Alcoa operates within proximity of the boundary of two bioregions. As such, species may have exceedingly close records to WA mining, but on the Swan Coastal Plain. These species are highly unlikely to occur in the Northern Jarrah Forest. For every species with a '-' for the LOO ranking, known populations have been reviewed to ensure they are not found in Northern Jarrah Forest and are restricted to the Swan Coastal Plain.

Assessing likelihood of occurrence uses a multitude of characteristics. The absolute distance of any population to a mining region is considered, but it has to be understood in the context of habitat characteristics such as bioregion, rainfall, etc. Additionally, species often form very clear distribution patterns, and although no records may be near, the mining region might be inside that distribution pattern. For *Pimelea rara*, the assessment ranking is 'High' for all mining regions where it is specifically found and moderate if located to the outside of its known distribution.

The likelihood of occurrence assessment determined that four threatened and 27 priority flora species (Priority 2, Priority 3 and Priority 4 or P2/P3/P4) are either moderately likely or highly likely to occur within the Huntly and Willowdale mine areas (listed and grouped by their habitat preference in Table 5-5). Preference for three habitat types were considered: granites, swamps and creeks, and lateritic hills and slopes.

Table 5-5: Conservation Significant Flora

Granites (R and G SVTs):	Swamps and creeks (A, B, C, D, E and W SVTs):	Lateritic hills and slopes (P, S and T SVTs):
<i>Andersonia sp. Saxatilis</i> (F. & J. Hort 3324) (Threatened, Critically Endangered)	<i>Darwinia hortiorum</i> (P1)	<i>Caladenia leucochila</i> (Threatened, Endangered)
<i>Anthocercis gracilis</i> (Threatened, Vulnerable)	<i>Netrostylis sp. Nannup</i> (P.A. Jurjevich 1133) (P1)	<i>Morelotia australiensis</i> (Threatened, Vulnerable)
<i>Darwinia hortiorum</i> (P1)	<i>Grevillea ornithopoda</i> (P2)	<i>Darwinia hortiorum</i> (P1)
<i>Hibbertia acrotoma</i> (P1)	<i>Lepyrodia curvescens</i> (P2)	<i>Deyeuxia inaequalis</i> (P1)
<i>Paracaleana gracilicordata</i> (P1)	<i>Schizaea rupestris</i> (P2)	<i>Hibbertia hortiorum</i> (P1)
<i>Paracaleana granitica</i> (P1)	<i>Actinotus repens</i> (P3)	<i>Tetratheca phoenix</i> (P2)
<i>Tetratheca phoenix</i> (P2)	<i>Andersonia sp. Audax</i> (F. Hort, B. Hort & J. Hort 3179) (P3)	<i>Acacia drummondii subsp. affinis</i> (P3)
<i>Andersonia sp. Audax</i> (F. Hort, B. Hort & J. Hort 3179) (P3)	<i>Cyathochaeta teretifolia</i> (P3)	<i>Grevillea dissectifolia</i> (P3)
<i>Tetratheca parvifolia</i> (P3)	<i>Grevillea dissectifolia</i> (P3)	<i>Tetratheca parvifolia</i> (P3)
<i>Cyanothamnus tenuis</i> (P4)	<i>Grevillea prominens</i> (P3)	<i>Tetratheca pilifera</i> (P3)
<i>Eucalyptus x granitica</i> (P4)	<i>Hakea oldfieldii</i> (P3)	<i>Cyanothamnus tenuis</i> (P4)
<i>Senecio leucoglossus</i> (P4)	<i>Lepyrodia heleocharoides</i> (P3)	<i>Pimelea rara</i> (P4)
	<i>Meionectes tenuifolia</i> (P3)	<i>Senecio leucoglossus</i> (P4)
	<i>Stylidium ireneae</i> (P4)	<i>Stylidium ireneae</i> (P4)

Table 5-6: Conservation significant flora considered likely to occur

Species	SCC	FCC	Associated Havel Site Types	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION
<i>Andersonia sp. Saxatilis</i> (F. & J. Hort 3324)	T	CR	G/R	High	High	Low	Low	Low
<i>Anthocercis gracilis</i>	T	VU	G/R	High	Moderate	Moderate	Moderate	High
<i>Caladenia leucochila</i>	T	EN	P	Low	Low	High	High	High
<i>Morelotia australiensis</i>	T	VU	P	High	High	High	High	High
<i>Darwinia hortiorum</i>	P1	-	S/T /A/C /W /D/G/R	High	High	Low	Low	Low
<i>Deyeuxia inaequalis</i>	P1	-	S/T	Low	Low	Moderate	High	High
<i>Hibbertia acrotoma</i>	P1	-	G/R	High	Low	High	High	High
<i>Hibbertia hortiorum</i>	P1	-	P	High	High	Low	Low	Low
<i>Netrostylis sp. Nannup</i> (P.A. Jurjevich 1133)	P1	-	A/C/W/D	Low	Low	High	High	High
<i>Paracaleana gracilicordata</i>	P1	-	G/R	High	High	Low	Low	Low
<i>Paracaleana granitica</i>	P1	-	G/R	High	High	Low	Low	Low
<i>Grevillea ornithopoda</i>	P2	-	A/C/W/D	Moderate	Low	Moderate	Moderate	High
<i>Lepyrodia curvescens</i>	P2	-	A/C/W/D	High	High	Low	Low	Moderate
<i>Schizaea rupestris</i>	P2	-	A/C/W/D	Low	Low	High	High	High
<i>Tetratheca phoenix</i>	P2	-	S/T/G/R	High	High	Low	Low	Low
<i>Acacia drummondii subsp. affinis</i>	P3	-	S/T	High	High	Low	Low	Low
<i>Actinotus repens</i>	P3	-	A/C/W/D	Low	Low	High	High	High
<i>Andersonia sp. Audax</i> (F. Hort, B. Hort & J. Hort 3179)	P3	-	A/C/W/D/G/R	High	High	Low	Low	Low

Species	SCC	FCC	Associated Havel Site Types	MYARA	O'NEIL	LAREGO	ARUNDEL	ORION
<i>Cyathochaeta teretifolia</i>	P3	-	A/C/W/D	High	High	High	High	High
<i>Grevillea dissectifolia</i>	P3	-	P/S/T/A/C/W/D	Moderate	High	Low	Moderate	Low
<i>Grevillea prominens</i>	P3	-	A/C/W/D	Low	Low	High	High	High
<i>Hakea oldfieldii</i>	P3	-	A/C/W/D	Low	High	Moderate	Moderate	Moderate
<i>Lepyrodia heleocharoides</i>	P3	-	A/C/W/D	High	Moderate	Moderate	Moderate	Moderate
<i>Meionectes tenuifolia</i>	P3	-	A/C/W/D	Moderate	Moderate	Moderate	Moderate	Moderate
<i>Stackhousia sp. Red-blotched corolla (A. Markey 911)</i>	P3	-	P/S/T/G/R	Low	-	Low	-	Low
<i>Tetratheca parvifolia</i>	P3	-	S/T/G/R	Low	-	High	-	Low
<i>Tetratheca pilifera</i>	P3	-	P/S/T	Moderate	-	-	-	-
<i>Cyanothamnus tenuis</i>	P4	-	P/S/T/G/R	High	-	High	-	High
<i>Eucalyptus x graniticola</i>	P4	-	G/R	Low	-	Moderate	-	Moderate
<i>Grevillea pimeleoides</i>	P4	-	G/R	Low	-	Low	-	Low
<i>Hemigenia platyphylla</i>	P4	-	P/S/T/G/R	Low	-	Low	-	Low
<i>Parsonsia diaphanophleba</i>	P4	-	A/C/W/D	Low	-	Low	-	Low
<i>Pimelea rara</i>	P4	-	P/S/T	High	-	High	-	High
<i>Senecio leucoglossus</i>	P4	-	P/S/T/G/R	High	-	High	-	High
<i>Stylidium ireneae</i>	P4	-	P/S/T/A/C/W/D	High	-	High	-	High

5.1.5 Conservation Significant Vegetation

5.1.5.1 Old Growth Forest

The NJF subregion has been subject to widespread timber harvesting since the 1870s. Approximately 0.77 million ha (69.2%) of the approximately 1.11 million ha of native vegetation within the NJF subregion lies within DBCA managed lands, of which 0.52 million ha (46.9%) is covered by ML1SA. approximately 22,097 ha (3.8%) of this 0.52 million ha is mapped as old growth forest and the remaining 96.2% has been subject to timber harvesting of varying frequency and intensity.

Approximately 0.42 million ha (80.8%) of the native vegetation within ML1SA lies within DBCA managed State Forests and Timber Reserves that may be subject to ongoing timber harvesting operations.

Table 5-7 presents the approximate ranges of forest age across the NJF subregion within ML1SA, based on DBCA timber harvesting data and old growth forest mapping. The mapped forest age for Huntly and Willowdale are shown in Figure 5-9 and Figure 5-11, respectively. The NJF subregion within ML1SA is predominantly (74% of total) at a juvenile to immature stage of forest structure (assuming maturity as early as 70 years), reflecting the widespread timber harvesting over the last century. The NJF subregion within ML1SA contains up to 22% mature forest and approximately 4% old growth forest.

Table 5-7: Forest age across the NJF within ML1SA

Structural stage of harvesting regrowth	Time since last harvest (years)	Area (ha)	Proportion of total (%)	Area in state forest / timber reserves (ha)	Proportion in state forest / timber reserves (%)	Area in conservation reserves (ha)	Proportion in conservation reserves (%)
Establishment to Juvenile	0-20	89,543	15	88,963	18	458	0
Immature	21-70	341,097	58	299,250	62	40,573	41
Mature	70+	129,826	22	83,446	17	45,503	46
No record of harvesting	n/a	24,272	4	11,029	2	13,243	13
Total	n/a	584,738	100	482,689	100	99,776	100
Old growth forest	n/a	22,097	-	10,458	2	11,639	12

5.1.5.2 Ecological Communities

There are two priority ecological communities (PECs), as listed at State level by DBCA (2022a) that could potentially occur within the Huntly and Willowdale mine regions:

Granite communities of the Northern Jarrah Forest (P3) Jarrahdale area – Monadnocks, Blue Rock; insufficient information to distinguish discrete community type/s (DBCA 2020a). This PEC is potentially associated with R and G vegetation types with the current extent shown within Table 5-8 and mapped in

- Figure 5-8 and Figure 5-10 for Huntly and Willowdale, respectively.
- Litter Dependant Invertebrate Community of the northern Jarrah Forest (P2) Chandler Block, Northern Jarrah Forest; insufficient evidence that this is a discrete community type (DBCA 2020a). This community has no further defining characteristics and as such, it is not possible to define potential extent within the Huntly and Willowdale mine areas.

Based on database searches and vegetation type mapping, no threatened ecological communities (TECs) listed at Commonwealth level pursuant to sections 181 and 182 of the EPBC Act and listed by the DAWE (2022e) or at State level pursuant to Part 2 of the BC Act and as listed by DBCA (2018b) have the potential to occur within the Huntly and Willowdale mine areas.

Table 5-8: Potential PEC present within the Huntly and Willowdale mine areas

Vegetation Code	Mapped extent (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of Mapped Extent (%)	Area (ha)	Proportion of Mapped Extent (%)
G	348.1	53.5	3.3%	6.4	0.4%
G1	407.4	3.6	0.2%	0.0	0.0%
G2	1.0	0.0	0.0%	0.0	0.0%
R	845.0	355.0	22.0%	100.9	6.6%
R/G	14.3	12.7	0.8%	58.3	3.6%
Total	1,615.9	424.9	26.3%	165.6	10.3%

5.1.5.3 Potential Groundwater Dependent Vegetation

Based on vegetation mapping undertaken by Mattiske (2012; 2019), potential groundwater dependent vegetation (GDVs) were identified (Table 5-9) using key indicator species that prefer and occur on seasonally moister and wetter soils on the swamps, valley floors and lower slopes.

Key plant species that are indicative of potential GDVs include *Banksia littoralis*, *Hakea varia*, *Acacia divergens*, *Pultenaea skinneri*, *Boronia molloyae*, *Thomasia paniculata*, *Astartea scoparia*, *Babingtonia camphorosmae*, *Calothamnus lateralis*, *Eucalyptus rudis*, *Hypocalymma angustifolium*, *Hypocalymma cordifolium*, *Melaleuca preissiana*, *Melaleuca raphiophylla*, *Melaleuca lateritia*, *Melaleuca viminea*, *Regelia ciliata* and *Taxandria linearifolia* (Mattiske 2020).

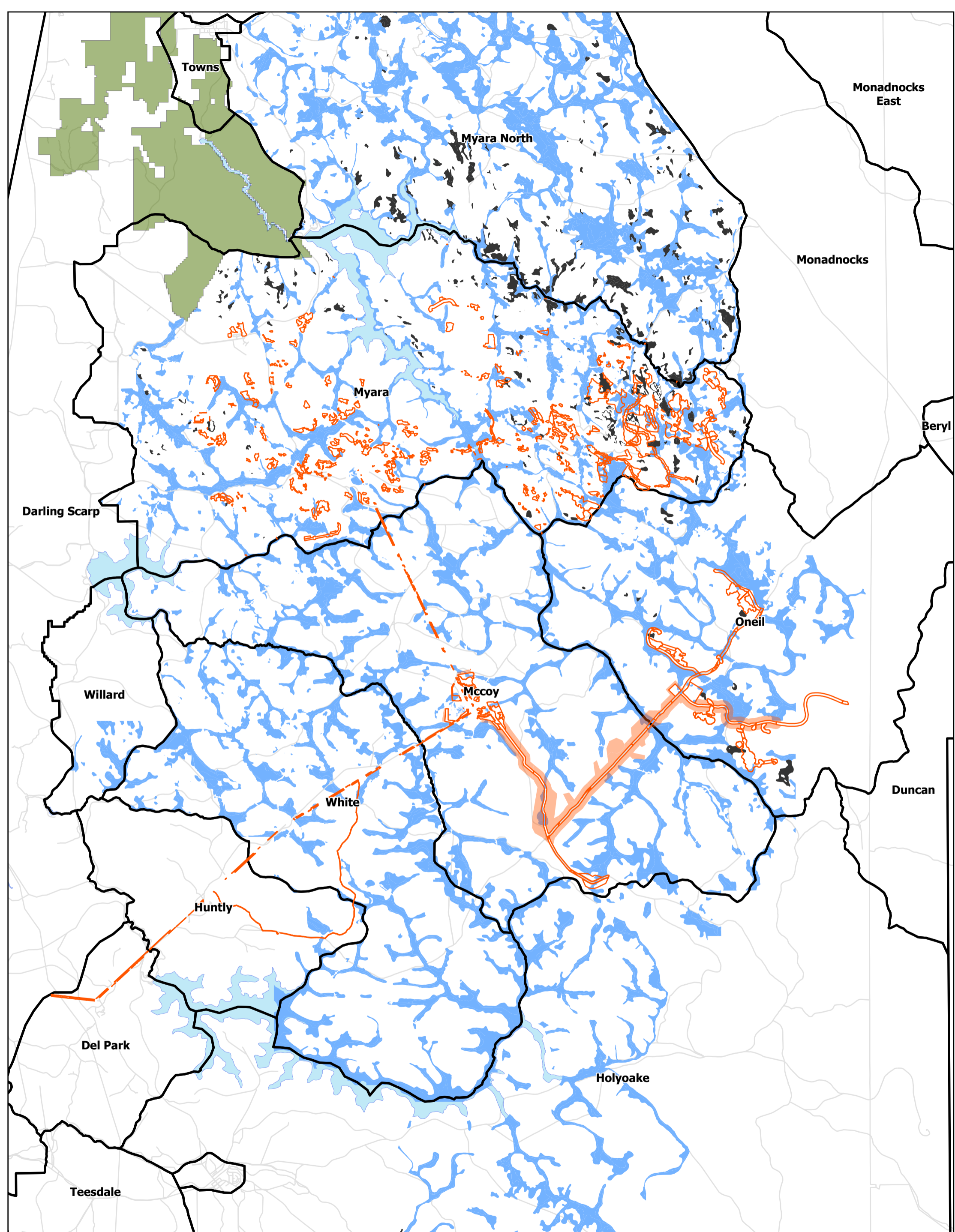
The potential GDVs are expected to be subject to seasonal inundation and/or waterlogging due to groundwater and/or surface water flows.

A total of 12,466 ha of the mapped area of the Huntly mine area and 4,321 ha of the mapped area of the Willowdale mine area comprise potential GDVs. Mapped extent is shown in

Figure 5-8 and Figure 5-10 for Huntly and Willowdale, respectively.

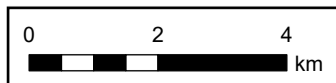
Table 5-9: Groundwater dependent vegetation present within the Huntly and Willowdale mine area

Vegetation Code	Mapped extent (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of Mapped Extent (%)	Area (ha)	Proportion of Mapped Extent (%)
A	336.9	327.9	1.4%	5.6	0.0%
AC	3549.3	2894.5	12.3%	446.3	1.9%
AD	302.9	302.9	1.3%	-	-
AW	138	136.6	0.6%	1.3	0.0%
AW/AX	21.2	21.2	0.1%	-	-
AW/CW	20.3	20.3	0.1%	-	-
AX	75.5	75.5	0.3%	-	-
B	1	-	-	1	0.0%
C	423.4	374.3	1.6%	6.3	0.0%
CA	34.3	-	-	34.3	0.2%
CQ	281.4	7.5	0.0%	268.8	1.1%
CW	3074.7	2230.8	9.5%	647.3	2.7%
D	4139.2	3747.5	15.9%	219.1	0.9%
DA	302.8	300.9	1.3%	1.8	0.0%
DG	80.8	80.2	0.3%	0.7	0.0%
E	495.5	429.8	1.8%	59.6	0.3%
PW	1846.1	1475.9	6.3%	210.5	0.9%
Q	444.1	122.8	0.5%	299.1	1.3%
SW	3404.3	2745.7	11.6%	423.2	1.8%
W	4607	3284.5	13.9%	1248.5	5.3%
WA	35.7	32.7	0.1%	1.2	0.0%
Total	23614.4	18611.5	78.8%	3874.6	16.4%



Legend

- 24 Month Clearing Schedule
- Mining Regions
- Conceptual Clearing Buffer
- National Parks
- Groundwater Dependent Vegetation
- Major Dams
- Priority Ecological Communities

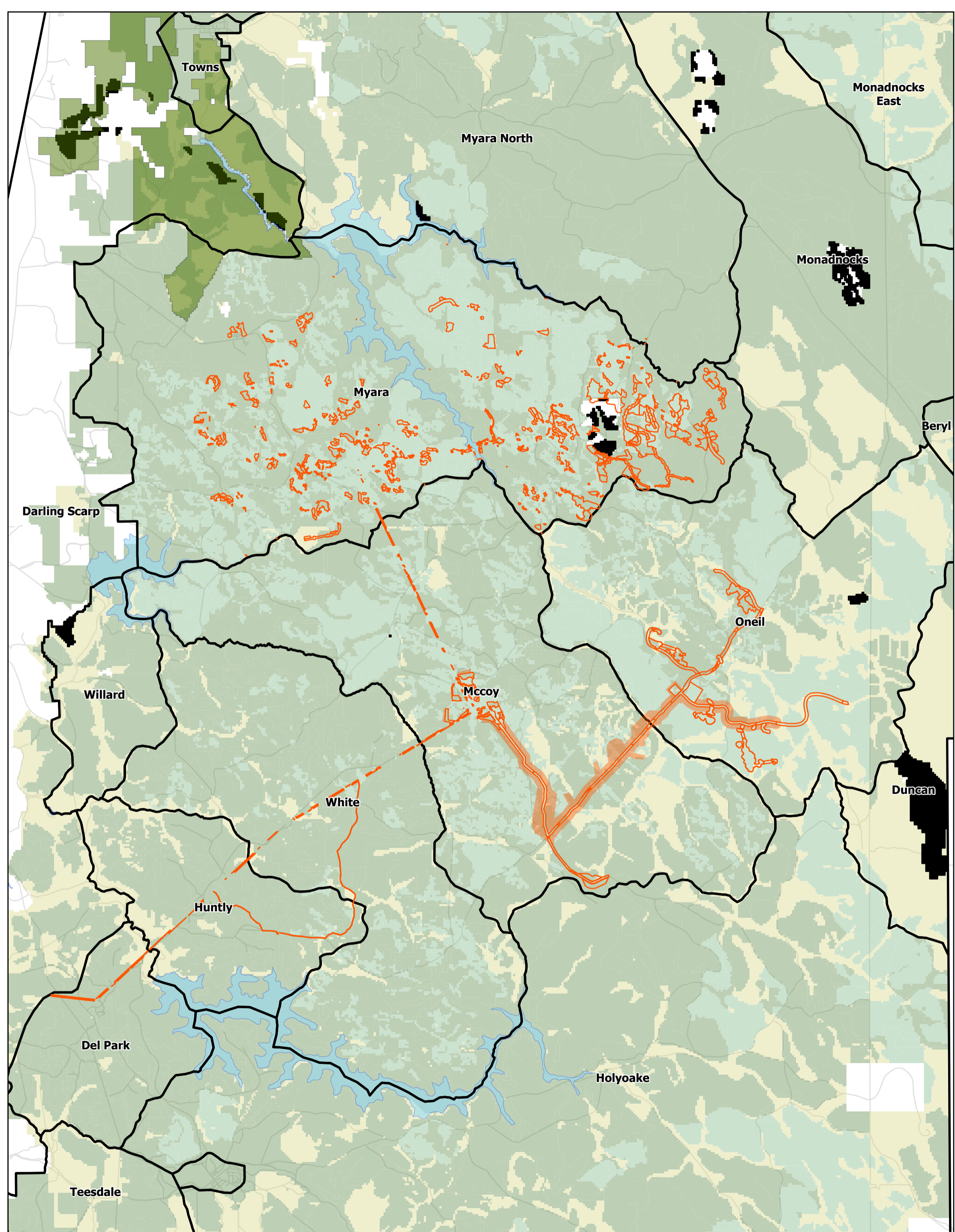


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Figure 5-8: Potential PECs and GDV - Huntly

Scale: 1:117,413

Date Printed: 30/10/2023



Legend

24 Month Clearing Schedule	Mature Forest
Conceptual Clearing Buffer	Establishment to Juvenile
Mining Regions	Immature
Major Dams	Mature
National Parks	Old Growth Forest

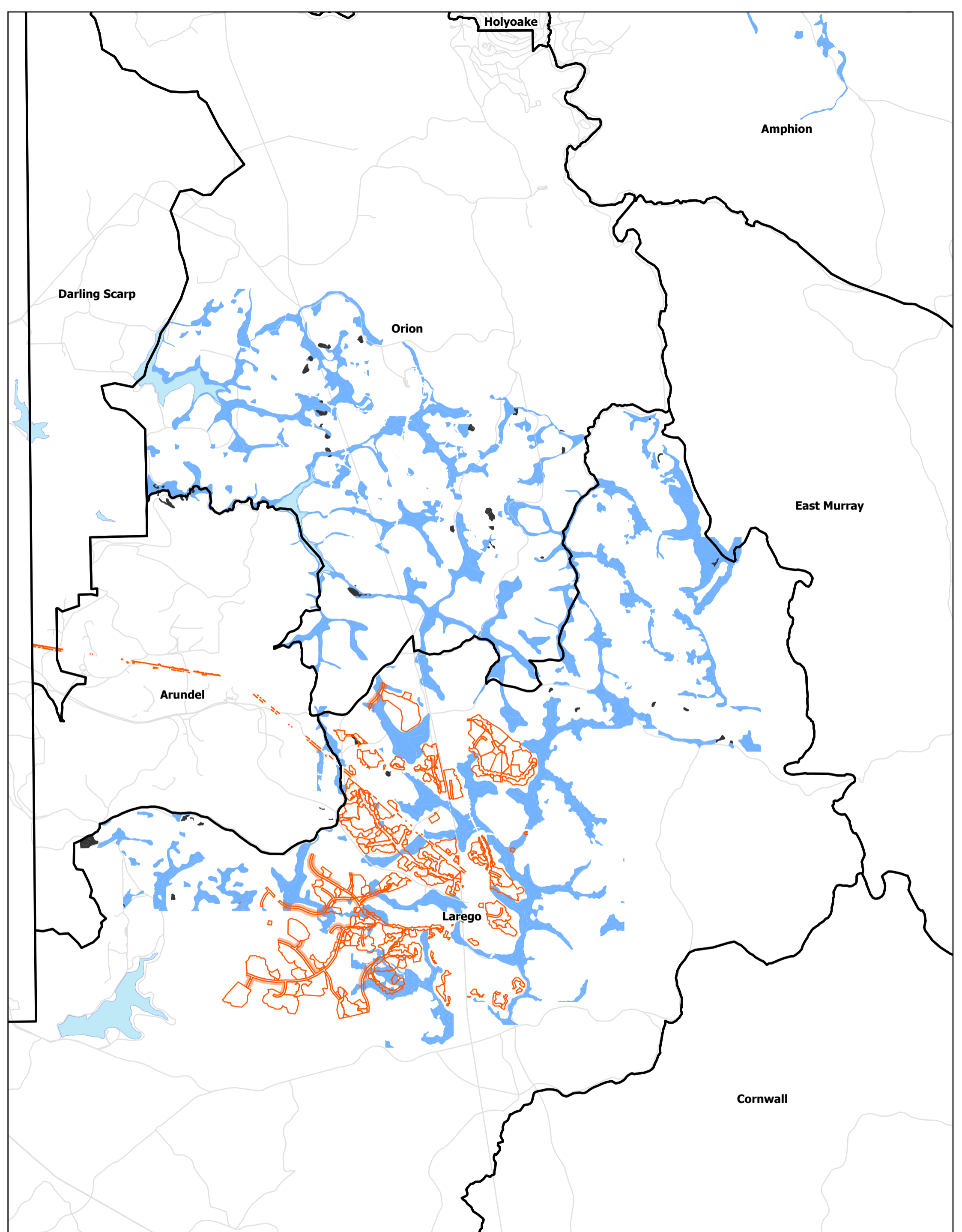


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Figure 5-9: Timber Harvesting Status - Huntly

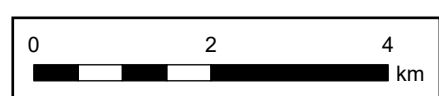
Scale: 1:117,413

Date Printed: 30/10/2023



Legend

24 Month Clearing Schedule	Groundwater Dependent Vegetation
Conceptual Clearing Buffer	Mining Regions
Priority Ecological Communities	Major Dams

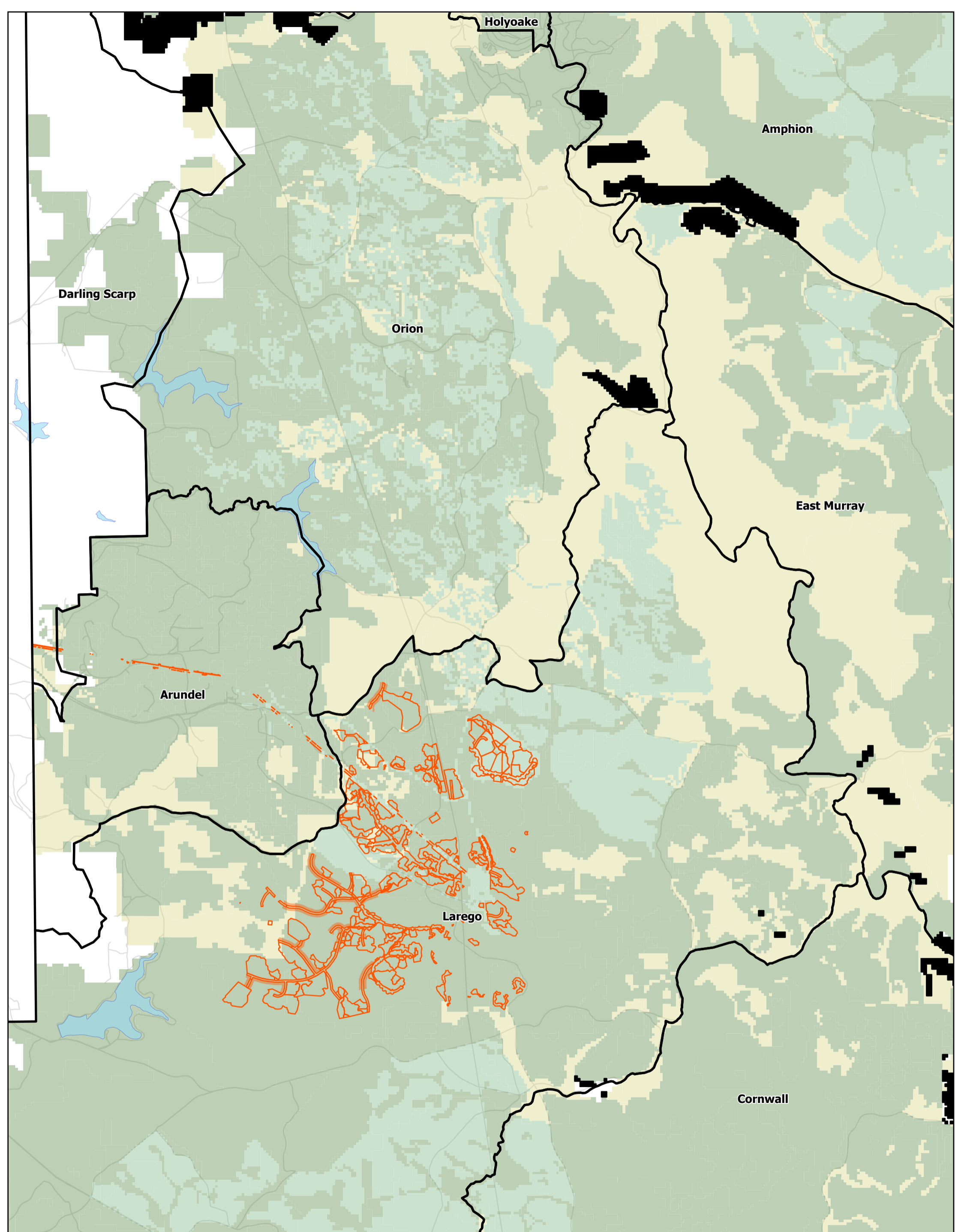


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Figure 5-10: Potential PECs and GDV - Willowdale

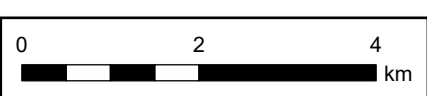
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Date Printed: 1/11/2023



Legend

- 24 Month Clearing Schedule
- Conceptual Clearing Buffer
- Mining Regions
- Major Dams
- Mature Forest
- Establishment to Juvenile
- Immature
- Mature
- Old Growth Forest



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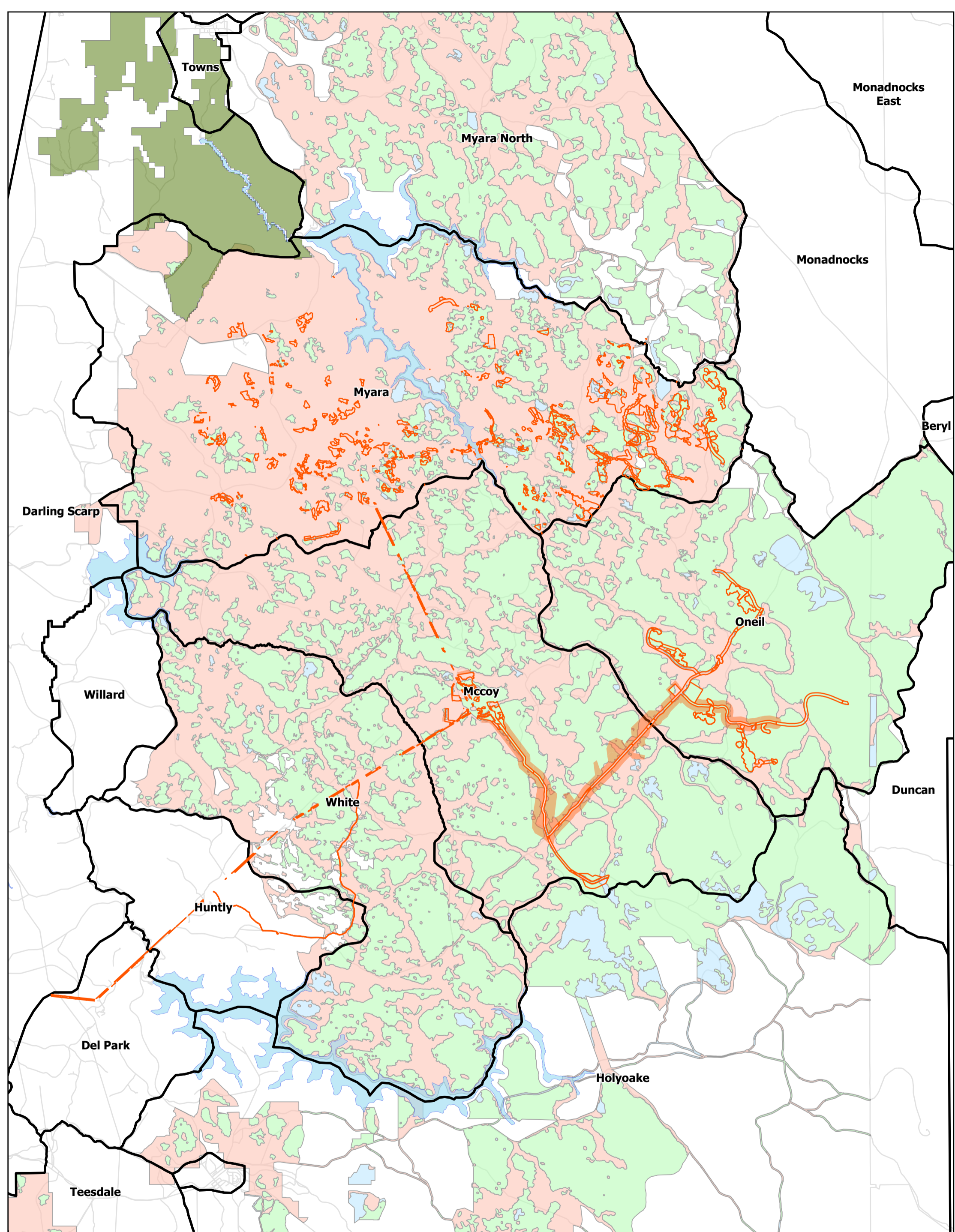
Figure 5-11: Timber Harvesting Status - Willowdale

Scale: 1:85,380

Date Printed: 1/11/2023

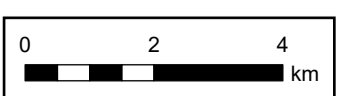
5.1.6 Dieback and other forest diseases

Dieback surveys have occurred over 79% of the Huntly mine area and 56% of the Willowdale mine area (Figure 5-12 and Figure 5-13). Dieback mapping may be considered historical, however revised dieback mapping of un-interpreted, un-mapped and dieback free areas occurs at least 12 months prior to clearing.

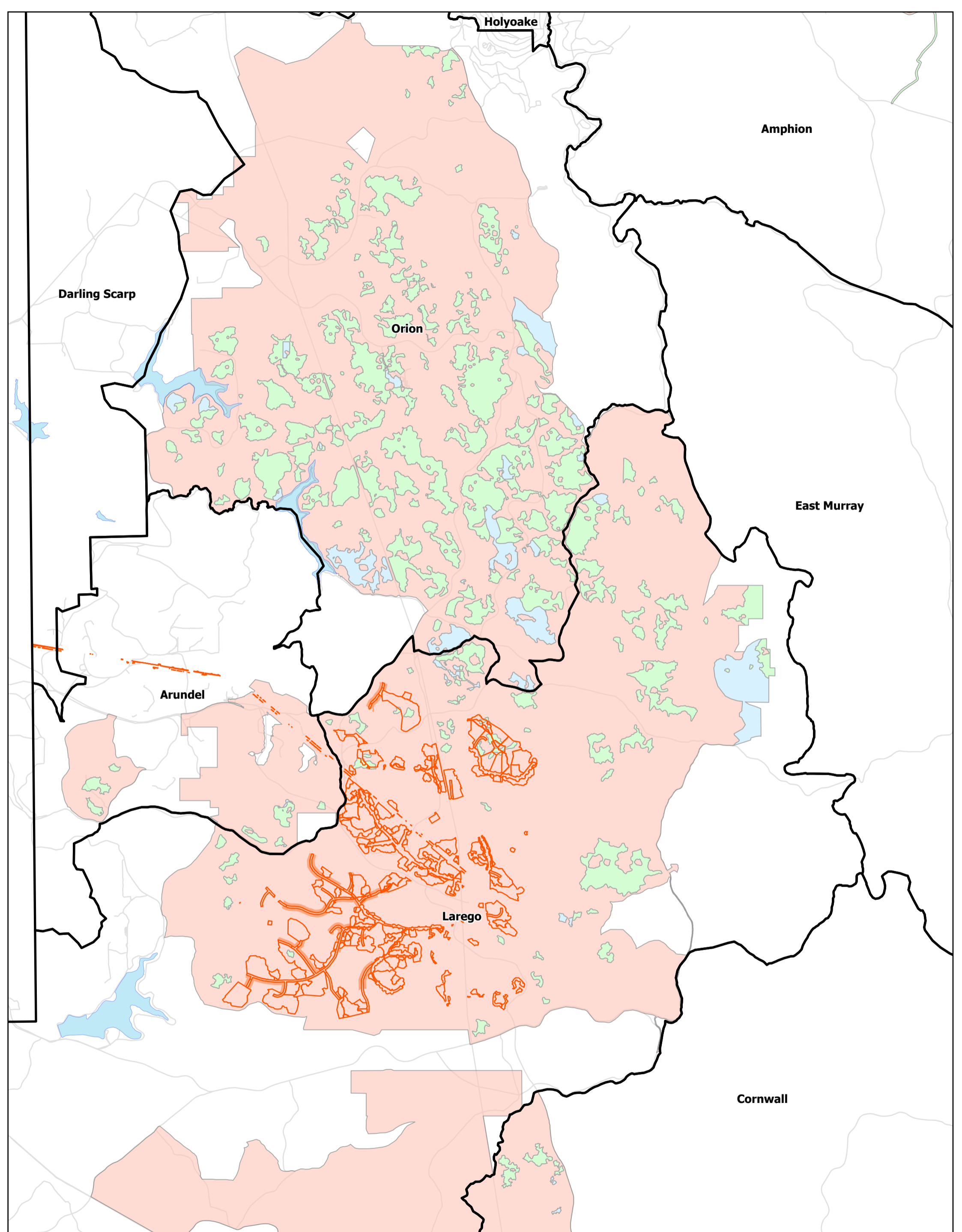


Legend

24 Month Clearing Schedule	Dieback
Conceptual Clearing Buffer	Dieback Free
Mining Regions	Un-Interpretable
National Parks	
Major Dams	



2023 – 2027 Mining and Management Plan	
Figure 5-12: Dieback mapping - Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023



Legend

24 Month Clearing Schedule	Dieback
Conceptual Clearing Buffer	Dieback
Mining Regions	Dieback Free
Major Dams	Un-Interpretable



2023 – 2027 Mining and Management Plan	
Figure 5-13: Dieback mapping - Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

5.2 Potential Environmental Impacts

Proposed clearing areas have been provided (24 Month Clearing Schedule) for areas of ore bodies and associated mining infrastructure, including haul roads and stockpile locations. Haul road boundaries are conceptual and include the haul road bunding, haul road running surface and drainage sumps. Final haul road clearing will be within these boundaries.

The following activities have the potential to impact flora and vegetation:

- Construction of mine access and haul roads, conveyors and facilities.
- Extension of mining and operation of mining and haulage equipment.

The following potential direct and indirect impacts may occur to flora and vegetation:

- Direct impacts to flora and vegetation as a result of clearing.
- Indirect impacts to flora and vegetation as a result of:
 - Introduction and/or spread of weeds.
 - Introduction and/or spread of dieback.
- Spills and/or leaks from storage and handling of hazardous materials and waste.
- Dust emissions.
- Altered hydrology/groundwater regimes.

5.2.1 Direct loss of native vegetation on a local and regional scale - Huntly

The proposed direct clearing impacts associated with the 24 Month Clearing Schedule are summarised in the following tables:

- Table 5-10 – state wide vegetation associations, as shown in Figure 5-1.
- Table 5-11 – vegetation complexes, as shown in Figure 5-1.
- Table 5-12 – mapped vegetation types, as shown in Figure 5-2 to Figure 5-4.

The 24 Month Clearing Schedule impacts to state-wide vegetations associations would result in a decrease of less than 0.2% to current extent.

Impacts to vegetation complexes are all less than a 1% decrease in current extent. All vegetation complexes have greater than 70% of pre-European extent remaining.

The greatest proportion of clearing is proposed to occur within P, S and T dominant vegetation types, which are relatively widespread and primarily associated with the upland areas in the high to medium rainfall zone (>900 mm/year), (Hedde et al 1980). The 24 Month Clearing Schedule will not impact more than 7% of the current mapped extent of any vegetation type.

Vegetation surveys have not occurred over 50 ha of the 24 Month Clearing Schedule, which includes the previously mentioned conveyor clearing and a small portion of the O'Neil haul road and water pipeline (and associated conceptual clearing Buffer). Havel vegetation surveys will be undertaken prior to inclusion in an FCA with a revised impact assessment. The O'Neil surveys are scheduled for late 2023.

Table 5-10: Potential direct impacts to State-wide vegetation association - Huntly

Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	Proportion of Pre-European Extent Remaining (%)	24 Month Clearing Schedule (ha)	Current Extent Remaining after Clearing (%)	Reduction of Current Extent due to 24 Month Clearing Schedule (%)
3	908,100	723,446	79.7%	1,687.6	79.5%	0.2%

Table 5-11: Indicative estimates of direct impacts to vegetation complexes - Huntly

Vegetation Complex	Pre-European Extent (ha)	Current Extent (ha)	Proportion of Pre-European Extent Remaining (%)	24 Month Clearing Schedule (ha)	Current Extent Remaining after Clearing (%)	Reduction of Current Extent due to 24 Month Clearing Schedule (%)
Cooke (Ce)	36,778.9	30,003.5	81.58%	319.2	80.7%	0.9%
Dwellingup (D1)	208,489.1	180,617.8	86.63%	941.4	86.2%	0.5%
Dwellingup (D2)	86,127.4	71,310.5	82.80%	74.5	82.7%	0.1%
Murray 1 (My1)	68,694.6	52,307.2	76.14%	35.8	76.1%	0.1%
Pindalup (Pn)	167,149.2	128,685.2	76.99%	26.5	77.0%	0.0%
Swamp (S)	53,657.6	40,503.7	75.49%	15.0	75.5%	0.0%
Yarragil 1 (Yg1)	80,202.3	64,985.7	81.03%	105.1	80.9%	0.1%
Yarragil 2 (Yg2)	50,258.8	46,483.6	92.49%	170.2	92.1%	0.3%
Total	751,357.8	614,897.3	81.84%	1,687.7	80.2%	0.2%

Table 5-12: Indicative estimates of direct impacts to vegetation types - Huntly

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of GDE mapped
A	336.9	1.1	0.1%	0.3%			1.1	0.3%
AC	3,549.3	5.4	0.3%	0.2%			5.4	0.2%

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of GDE mapped
A	336.9	1.1	0.1%	0.3%			1.1	0.3%
AC	3549.3	5.4	0.3%	0.2%			5.4	0.2%
AW	138.0	0.0	0.0%	0.0%			0.0	0.0%
C	423.4	4.9	0.3%	1.2%			4.9	1.2%
CW	3074.7	7.7	0.5%	0.2%			7.7	0.2%
D	4139.2	38.4	2.3%	0.9%			38.4	0.9%
DA	302.8	2.9	0.2%	1.0%			2.9	1.0%
E	495.5	18.5	1.1%	3.7%			18.5	3.7%
G	348.1	0.2	0.0%	0.1%	0.2	0.1%		
G1	407.4	0.9	0.1%	0.2%	0.9	0.2%		
P	1783.8	78.0	4.6%	4.4%				
PS	8382.2	354.9	21.0%	4.2%				
PT	1620.2	12.0	0.7%	0.7%				
PW	1846.1	114.3	6.8%	6.2%			114.2	6.2%
R	845.0	7.3	0.4%	0.9%	7.3	0.9%		
S	17587.2	455.7	27.0%	2.6%				
SP	5706.2	186.9	11.1%	3.3%				
ST	6931.1	31.4	1.9%	0.5%				
SW	3404.3	30.6	1.8%	0.9%			30.6	0.9%
T	5345.7	24.3	1.4%	0.5%				

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of GDE mapped
TS	10133.3	135.5	8.0%	1.3%				
W	4607.0	20.5	1.2%	0.4%			20.5	0.4%
Rehab	22526.6	96.8	5.7%	0.4%				
CL	7068.7	9.1	0.5%	0.1%				
Sub-total	111002.6	1637.5	97.0%	1.5%	8.5	0.5%	244.3	0.2%
Unsurveyed	589791.4	50.2	3.0%	0.0%				
Total	700,794.0	1,687.6	100.0%	0.2%	8.5	0.5%	244.3	1.1%

5.2.2 Direct loss of conservation significant flora and vegetation - Huntly

5.2.2.1 Old growth forest

No clearing of old growth forest will occur. Areas with no record of harvesting will be mapped to confirm harvesting regrowth stage and if old growth forest is identified, it will be avoided.

The 24 Month Clearing Schedule includes clearing of predominantly establishment, juvenile or immature stage of forest structure (Table 5-13). Approximately 0.2% (200 ha) of the mapped extent of mature forest will be cleared. Mapped forest age and potential impacts from the 24 Month Clearing Schedule are shown in Figure 5-9.

Table 5-13: Clearing footprint Forest age

Structural stage of harvesting regrowth	Time since last harvest (years)	Mapped extent (ha)	24 Month Clearing Schedule (ha)	Proportion of mapped extent (%)
Establishment to Juvenile	0-20	89,543	710.2	0.8%
Immature	21-70	341,097	758.1	0.2%
Mature	70+	129,826	200.2	0.2%
No record of harvesting	n/a	24,272	19.1	0.1%
Total		584,738	1,687.6	0.3%
Old growth forest		22,097	-	-

5.2.2.2 Conservation Significant Ecological Communities

One PEC, Granite communities of the northern Jarrah Forest (P3), has the potential to occur within the Huntly mine area, potentially in conjunction with Granites (R and G SVTs). Less than 0.5% (9 ha) of the mapped extent is located within the proposed 24 month clearing areas (Table 5-12). The potential impacts from the 24 Month Clearing Schedule are shown in

Figure 5-8.

5.2.2.3 Potential GDVs

The proposed 24 month clearing areas will directly impact 1% (244 ha) of the mapped, uncleared extent of potential GDVs within the Huntly mine area (Table 5-12). The potential impacts from the 24 Month Clearing Schedule are shown in

Figure 5-8.

5.2.2.4 Potential Conservation Significant Flora Habitats

A summary of potential impacts to potentially suitable habitats for conservation significant flora is provided in Table 5-14. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 5-2 to Figure 5-4.

Table 5-14: Proposed clearing by flora habitat – Huntly mine area

Flora Habitat	Potential Conservation Significant Flora	Proposed Clearing Area	% of Mapped Area
Granites (R and G SVTs):	<ul style="list-style-type: none"> – <i>Andersonia sp. Saxatilis</i> (F. & J. Hort 3324) (Threatened, Critically Endangered) – <i>Anthocercis gracilis</i> (Threatened, Vulnerable) – <i>Darwinia hortiorum</i> (P1) – <i>Hibbertia acrotoma</i> (P1) – <i>Paracaleana gracilicordata</i> (P1) – <i>Paracaleana granitica</i> (P1) – <i>Tetratheca phoenix</i> (P2) – <i>Andersonia sp. Audax</i> (F. Hort, B. Hort & J. Hort 3179) (P3) – <i>Cyanothamnus tenuis</i> (P4) – <i>Senecio leucoglossus</i> (P4) 	8.5	0.5%
Swamps and creeks (A, B, C, D, E and W SVTs):	<ul style="list-style-type: none"> – <i>Darwinia hortiorum</i> (P1) – <i>Grevillea ornithopoda</i> (P2) – <i>Lepyrodia curvescens</i> (P2) – <i>Schizaea rupestris</i> (P2) – <i>Actinotus repens</i> (P3) – <i>Andersonia sp. Audax</i> (F. Hort, B. Hort & J. Hort 3179) (P3) – <i>Cyathochaeta teretifolia</i> (P3) – <i>Grevillea dissectifolia</i> (P3) – <i>Hakea oldfieldii</i> (P3) – <i>Lepyrodia heleocharoides</i> (P3) – <i>Meionectes tenuifolia</i> (P3) – <i>Stylidium ireneae</i> (P4) 	99.4	0.6%
Lateritic hills and slopes (P, S and T SVTs):	<ul style="list-style-type: none"> – <i>Morelotia australiensis</i> (Threatened, Vulnerable) – <i>Darwinia hortiorum</i> (P1) – <i>Hibbertia hortiorum</i> (P1) – <i>Tetratheca phoenix</i> (P2) – <i>Acacia drummondii subsp. affinis</i> (P3) – <i>Grevillea dissectifolia</i> (P3) – <i>Tetratheca pilifera</i> (P3) – <i>Cyanothamnus tenuis</i> (P4) – <i>Pimelea rara</i> (P4) – <i>Senecio leucoglossus</i> (P4) – <i>Stylidium ireneae</i> (P4) 	1,309.3	2.2%

The potential impacts to conservation significant flora species within the Granite and Swamp Creeks consists less than 1% of mapped extents (9 ha and 99 ha respectively). Potential impacts will occur to 2% (1, 309 ha) of the mapped area of lateritic hills and swamps.

Direct impacts from clearing are not expected to occur for Threatened flora populations as there are no recorded Threatened flora populations within the 24 month clearing areas. Targeted surveys will occur in all areas prior to clearing and any Threatened flora species will be avoided, as detailed in the Flora and Vegetation Management Plan (FVMP; Appendix 9).

It is expected that there will be substantial areas of similar potential habitat for the Threatened flora species remaining in the subregion.

Clearing of potential conservation significant flora habitat will occur (Table 5-14), however all vegetation types are widespread and common across the mine regions and wider mapped area.

Two Threatened flora species (*Andersonia sp. Saxatilis* (F. & J. Hort 3324) and *Anthocercis gracilis* (Slender Tailflower)) may occur in granite outcrops, which is not associated with lateritic soils, and will have limited impacts from mining. Targeted surveys will be undertaken in September and October, at optimal times, for recording these species. Further information of the species as is follows:

- *Andersonia sp. Saxatilis* (F. & J. Hort 3324) has historic records within Myara North with the O'Neil and Myara regions considered to be within its projected distribution.
- Slender Tailflower has historic records within the Myara region and is considered to be within its projected distribution.

A total of eight Priority species (four P1, one P2, one P3, two P4) are restricted to habitats associated with granite outcrops. The 24 Month Clearing Schedule is expected to clear approximately 0.5% of the mapped extent (9 ha) of these habitats. The potential habitats are expected to be associated with the Cooke vegetation complex and clearing represents approximately 0.9% of the complex remaining in the NJF subregion.

One Threatened flora species (*Morelotia australiensis* (Southern Tetraria)) may occur in lateritic hills and slopes. The Southern Tetraria is considered to be observed at any time of the year. Historic records occur in the Myara North mine region and within 10 km of Huntly mine, therefore Huntly mine is considered to be within its projected distribution. However, its distribution is almost exclusively on the Swan Coastal Plan, with historic records to the far east of Alcoa's mine regions.

A total of ten Priority flora species (two P1, one P2, three P3 and four P4) and one Threatened species may occur in lateritic habitats with a widespread distribution across the mine region (Table 5-14). Some of these species may also occur in restricted habitats such as granite outcrops, valleys and swamps. As lateritic habitats are widely distributed throughout the mine regions and wider sub-region, larger areas of clearing are expected. However, the 24 Month Clearing Schedule represents clearing of only 2% (1,309 ha) of the mapped extent.

This potential habitat is expected to be associated with the Dwellingup vegetation complexes, which is relatively widespread within the NJF and clearing represents approximately 0.5% of the complexes remaining in the subregion. Accordingly, it is expected that there will be substantial areas of similar potential habitat for the species remaining in the subregion.

A total of 12 Priority species (one P1, three P2, seven P3, one P4) are restricted to habitats associated with swamps, valley floors and lower slopes. The 24 Month Clearing Schedule is expected to clear approximately 0.6% of the mapped extent (99 ha) of these habitats. The potential habitats are expected to be associated with the Swamp vegetation complex and clearing represents approximately 0.03% of complex remaining in the NJF subregion.

5.2.3 Direct loss of native vegetation on a local and regional scale - Willowdale

The proposed direct clearing impacts associated with the 24 Month Clearing Schedule are summarised in the following tables:

- Table 5-15 – state wide vegetation associations, as shown in Figure 5-1.
- Table 5-16 - vegetation complexes, as shown in Figure 5-1.
- Table 5-17 – mapped vegetation types, as shown in Figure 5-5 to Figure 5-7.

The 24 Month Clearing Schedule impacts to state-wide vegetations association 3 would result in a decrease of less than 0.1% to current extent. Vegetation association 3 has 80% of pre-European extent remaining.

Impacts to vegetation complexes are all less than a 0.5% decrease in current extent. All vegetation complexes have greater than 70% of pre-European extent remaining.

The greatest proportion of clearing is proposed to occur within P, S and T dominant vegetation types, which are relatively widespread and primarily associated with the upland areas in the high to medium rainfall zone (>900 mm/year), (Heddle et al 1980). The 24 Month Clearing Schedule will not impact more than 4% of the current mapped extent of any vegetation type. The exception is to the TP vegetation type, whereby 28% (57 ha) of the current mapped extent may be impacted. This vegetation type has been mapped on a local scale in the Huntly mine area.

Vegetation surveys have not occurred over 67 ha of the 24 Month Clearing Schedule, which includes the previously mentioned conveyor clearing and areas to the south-western extent of Largeo. These areas are schedule to be cleared in 2025 and vegetation surveys will be undertaken prior to inclusion in a FCA with a revised impact assessment.

Table 5-15: Potential direct impacts to State wide vegetation association - Willowdale

Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	Proportion of Pre-European Extent Remaining (%)	24 Month Clearing Schedule (ha)	Current Extent Remaining after Clearing (%)	Reduction of Current Extent due to 24 Month Clearing Schedule (%)
3	908,100	723,446	79.7%	780.2	79.6%	0.1%

Table 5-16: Indicative estimates of direct impacts to vegetation complexes - Willowdale

Vegetation Complex	Pre-European Extent (ha)	Current Extent (ha)	Proportion of Pre-European Extent Remaining (%)	24 Month Clearing Schedule (ha)	Current Extent Remaining after Clearing (%)	Reduction of Current Extent due to 24 Month Clearing Schedule (%)
Cooke (Ce)	36,778.9	30,003.5	81.6%	61.7	81.4%	0.2%
Dwellingup (D1)	208,489.1	180,617.8	86.6%	645.5	86.3%	0.3%
Murray 1 (My1)	68,694.6	52,307.2	76.1%	1.8	76.1%	0.0%
Swamp (S)	53,657.6	40,503.7	75.5%	1.1	75.5%	0.0%
Yarragil 1 (Yg1)	80,202.3	64,985.7	81.0%	45.6	81.0%	0.1%
Yarragil 2 (Yg2)	50,258.8	46,483.6	92.5%	24.5	92.4%	0.0%
Total	498,081.2	414,901.6	83.3%	780.2	80.2%	0.1%

Table 5-17: Indicative estimates of direct impacts to vegetation type – Willowdale

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of Potential GDE mapped
A	336.9	1.1	0.1%	0.3%			1.1	0.3%
AC	3,549.3	2.6	0.3%	0.1%			2.6	0.1%

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of Potential GDE mapped
A	336.9	1.1	0.1%	0.3%			1.1	0.3%
AC	3549.3	2.6	0.3%	0.1%			2.6	0.1%
CW	3074.7	0.7	0.1%	0.0%			0.7	0.0%
D	4139.2	31.4	4.0%	0.8%			31.4	0.8%
P	1783.8	10.4	1.3%	0.6%				
PS	8382.2	90.5	11.5%	1.1%				
PT	1620.2	60.4	7.7%	3.7%				
PW	1846.1	9.1	1.2%	0.5%			9.1	0.5%
R	845.0	0.7	0.1%	0.1%	0.7	0.1%		
S	17587.2	108.3	13.9%	0.6%				
SP	5706.2	48.1	6.2%	0.8%				
ST	6931.1	19.0	2.4%	0.3%				
T	5345.7	61.1	7.8%	1.1%				
TP	202.7	56.8	7.2%	28.0%				
TS	10133.3	206.8	26.5%	2.0%				
W	4607.0	6.7	0.9%	0.1%			6.7	0.1%

Vegetation Type	Mapped Extent (ha)	24 Month Clearing Schedule (ha)	Proportion of total clearing	Proportion of VT mapped	Potential PEC (ha)	Proportion of PEC mapped	Potential GDE (ha)	Proportion of Potential GDE mapped
CL	7068.7	0.0	0.0%	0.0%				
Sub-total	86563.4	713.7	91.5%	0.6%	0.7	0.0%	51.6	0.05%
Unsurveyed	589791.4	66.6	8.5%	0.0%				
Total	676,354.9	780.2	100.0%	0.1%	0.7	0.0%	51.6	0.2%

5.2.4 Direct loss of conservation significant flora and vegetation - Willowdale

5.2.4.1 Old growth forest

No clearing of old growth forest will occur. Areas with no record of harvesting will be mapped to confirm harvesting regrowth stage and if old growth forest is identified, it will be avoided.

The 24 Month Clearing Schedule includes clearing of predominantly establishment, juvenile or immature stage of forest structure (Table 5-18). Approximately 0.03% (38 ha) of the mapped extent of mature forest will be cleared. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 5-11.

Table 5-18: Clearing footprint Forest age

Structural stage of harvesting regrowth	Time since last harvest (years)	Mapped extent (ha)	24 Month Clearing Schedule (ha)	Proportion of mapped extent (%)
Establishment to Juvenile	0-20	89,543	62.6	0.1%
Immature	21-70	341,097	679.4	0.2%
Mature	70+	129,826	37.7	0.03%
No record of harvesting	n/a	24,272	0.0	0.0%
Total		584,738	779.7	0.1%
Old growth forest		22,097	-	-

5.2.4.2 Conservation Significant Ecological Communities

One PEC, *Granite communities of the northern Jarrah Forest* (P3), has the potential to occur within the Willowdale mine area, potentially in conjunction with Granites (R and G SVTs), of which 0.05% (0.7 ha) of the mapped extent is located within the proposed 24 month clearing areas (Table 5-17). The potential impacts from the 24 Month Clearing Schedule are shown in Figure 5-10.

5.2.4.3 Potential GDEs

The proposed 24 month clearing will directly impact 0.2% (52 ha) of the mapped, uncleared extent of potential GDVs within the mine area (Table 5-17). The potential impacts from the 24 Month Clearing Schedule are shown in Figure 5-10.

5.2.4.4 Potential Conservation Significant Flora Habitats

A summary of potential impacts to potentially suitable habitats for conservation significant flora is provided in Table 5-19.

Table 5-19: Proposed clearing by flora habitat – Willowdale

Flora Habitat	Potential Conservation Significant Flora	Proposed Clearing Area	% of Mapped Area
Granites (R and G SVTs):	<ul style="list-style-type: none"> – <i>Anthocercis gracilis</i> (Threatened, Vulnerable) – <i>Hibbertia acrotoma</i> (P1) – <i>Tetratheca parvifolia</i> (P3) – <i>Cyanothamnus tenuis</i> (P4) – <i>Eucalyptus x graniticola</i> (P4) – <i>Senecio leucoglossus</i> (P4) 	0.7	0.0%
Swamps and creeks (A, B, C, D, E and W SVTs):	<ul style="list-style-type: none"> – <i>Netrostylis sp. Nannup</i> (P.A. Jurjevich 1133) (P1) – <i>Grevillea ornithopoda</i> (P2) – <i>Lepyrodia curvescens</i> (P2) – <i>Schizaea rupestris</i> (P2) – <i>Actinotus repens</i> (P3) – <i>Cyathochaeta teretifolia</i> (P3) – <i>Grevillea dissectifolia</i> (P3) – <i>Grevillea prominens</i> (P3) – <i>Hakea oldfieldii</i> (P3) – <i>Lepyrodia heleocharoides</i> (P3) – <i>Meionectes tenuifolia</i> (P3) – <i>Stylidium ireneae</i> (P4) 	42.5	0.2%
Lateritic hills and slopes (P, S and T SVTs):	<ul style="list-style-type: none"> – <i>Caladenia leucochila</i> (Threatened, Endangered) – <i>Morelotia australiensis</i> (Threatened, Vulnerable) – <i>Deyeuxia inaequalis</i> (P1) – <i>Hibbertia hortiorum</i> (P1) – <i>Grevillea dissectifolia</i> (P3) – <i>Tetratheca parvifolia</i> (P3) – <i>Cyanothamnus tenuis</i> (P4) – <i>Pimelea rara</i> (P4) – <i>Senecio leucoglossus</i> (P4) – <i>Stylidium ireneae</i> (P4) 	670.4	1.1%

The potential impacts to conservation significant flora species, within the Granite and Swamp Creeks, consists of less than 1% of mapped extents (1 ha and 43 ha respectively). Potential impacts to lateritic hills and swamps is 1% of the mapped area (677 ha).

Direct impacts from clearing are not expected to occur for Threatened flora populations. There are no recorded Threatened flora populations within the 24 month clearing areas. Targeted surveys will occur in all areas prior to clearing and any Threatened flora species will be avoided, as detailed in the Flora and Vegetation Management Plan (FVMP; Appendix 9).

It is expected that there will be substantial areas of similar potential habitat for the Threatened flora species remaining in the subregion. Clearing of potential conservation significant flora habitat will occur (Table 5-19), however all vegetation types are widespread and common across the mine region and wider mapped area.

One Threatened flora species, *Anthocercis gracilis* (Slender Tailflower), may occur in granite outcrops, which is not associated with lateritic soils, and will have limited impacts from mining. Targeted surveys will be undertaken in September and October, at optimal times, for recording these species. Slender Tailflower has historic records within 10 km of Willowdale (Orion) and Willowdale mine is considered to be within its projected distribution.

A total of five Priority species (one P1, one P3, three P4) are restricted to habitats associated with granite outcrops. The 24 Month Clearing Schedule is expected to clear approximately 0.05% of the mapped extent of these habitats (1 ha). The potential habitats are expected to be associated with the Cooke vegetation complex and clearing represents approximately 0.2% of the complex remaining in the NJF subregion.

Two Threatened flora species (*Caladenia leucochila* (Collie Spider Orchid) and *Morelotia australiensis* (Southern Tetraria)) may occur in lateritic hills and slopes:

- Targeted surveys will be undertaken in August to October, at optimal times, for recording the Collie Spider Orchid. Historic records occur within the Orion and Larego regions with a 60 km range extension identified at Larego, with the Willowdale mine considered to be within its projected distribution.
- The Southern Tetraria is considered to be observed at any time of the year. Historic records are within 10 km of Willowdale mines, therefore Willowdale is considered to be within its projected distribution. However, its distribution is almost exclusively on the Swan Coastal Plan, with historic records to the far west of Alcoa's mine regions.

A total of eight Priority flora species (two P1, two P3 and four P4) and two Threatened species may occur in lateritic habitats with a widespread distribution across the mine regions (Table 5-19). Some of these species may also occur in restricted habitats such as granite outcrops, valleys and swamps. Lateritic habitats are widely distributed throughout the mine regions and wider sub-region, accordingly clearing of only 1% of the current mapped extent (670 ha) is expected as part of the 24 Month Clearing Schedule.

This potential habitat is expected to be associated with the Dwellingup vegetation complexes, which is relatively widespread within the NJF and clearing represents approximately 0.3 % of the complexes remaining in the subregion. Accordingly, it is expected that there will be substantial areas of similar potential habitat for the species remaining in the subregion.

A total of 12 Priority species (one P1, three P2, seven P3, one P4) are restricted to habitats associated with swamps, valley floors and lower slopes. The 24 Month Clearing Schedule is expected to clear approximately 0.2% of the mapped extent of these habitats (43 ha). The potential habitats are expected to be associated with the Swamp vegetation complex and clearing represents approximately 0.002% of complex remaining in the NJF subregion.

5.2.5 Indirect impacts

5.2.5.1 Introduction and/or spread of weeds

Weeds may impact the biodiversity of an area through competition with native understory species and influence the fire regime. The associated mitigation measures are detailed in Section 5.3.

There will be limited potential for the introduction of weeds with vehicles and equipment. Workforce commuting and heavy vehicle deliveries will terminate at the mine facilities, with movements within the mine regions predominantly undertaken by mine specification vehicles and equipment that will remain within the regions.

Valley and swamp habitats (SVTs A, C, D, E and W) are considered vulnerable to weed invasion as they are restricted in distribution, retain soil moisture and provide habitat for threatened and priority flora. Granite outcrops (SVTs R and G) are also restricted in distribution and provide habitat for threatened and priority flora.

A limited (less than 1%) amount of clearing will occur within swamp and valley vegetation types and very limited (less than 0.2%) clearing in granite outcrops (Table 5-12 and Table 5-17). This indicates a limited direct interface with swamps, valleys and granite outcrops and that the greatest potential for weeds to spread into these restricted distribution communities will be via stormwater runoff and creek flow.

5.2.5.2 Introduction and/or spread of dieback

The effects of dieback on Jarrah forest vegetation have been described by Shearer and Tippet (1989) and Shearer (1994). Dieback spread is characterised by an infection front of dead and dying susceptible understorey species of *Proteaceae*, *Myrtaceae*, *Papilionaceae* and *Epacridaceae* families. *Banksia grandis* is a notable indicator of infestations due to its size, widespread occurrence and rapid mortality. Jarrah (*E. marginata*) dies after the understorey, most commonly on poorly drained and infertile soils, and may persist in some areas. Other eucalypt canopy species (*C. calophylla*, *E. patens*, *E. rudis*, *E. megacarpa*) are resistant to dieback.

Dieback impact in the Jarrah forest results in a loss of floristic diversity and change in community structure and function (Shearer 1994). Jarrah dominant forest with a diverse understorey is characteristically replaced by open woodlands with Marri dominant canopy and sedge dominant understorey. The loss of floristic diversity can include loss of conservation significant flora, either through direct vulnerability or loss of community structure / habitat.

Mining activities have the potential to spread Dieback throughout the mine pits and haul road network, through the movement of earthmoving machinery and topsoil between clearing areas (which may be Dieback infested) and other areas such as topsoil stockpiles and rehabilitation. Spread of Dieback with stormwater runoff to uninfested sites downstream is unlikely as the majority of creek and swamp areas are already mapped as infested. The associated mitigation measures are detailed in Section 5.3.

Dieback status of the mine plan is summarised in Table 5-20 and shown in Figure 5-12 and Figure 5-13. Dieback assessments conducted by DBCA and Glevan indicate there is equal portions of infested (39%) and uninfested (39%) within Huntly. Willowdale has 49% infested and 6% uninfested areas.

Mine pits will be situated over uplands that have a higher proportion of uninfested areas and Dieback vulnerable vegetation. Progressive development of haul roads and movement of vehicles and equipment may result in the spread of Dieback from infested areas in valleys and swamps, to uninfested areas in the mine pits.

Table 5-20: Dieback status

Dieback Status	Huntly mine area			Willowdale mine area		
	Mine area (ha)	Proportion of Mine Area (%)	24 Month Clearing Schedule area (ha)	Mine Area (ha)	Proportion of Mine Area (%)	24 Month Clearing Schedule area (ha)
Dieback	38,010.0	38.5%	909.0	27,657.3	48.5%	767.2
Dieback free	38,256.1	38.7%	729.9	3,345.6	5.9%	8.2
Uninterpretable	1,725.6	1.7%	25.1	664.9	1.2%	-
Unmapped	20,792.6	21.0%	23.7	25,343.7	44.5%	4.9
Total	98,784.3	100.0%	1,687.7	57,011.4	100.0%	780.2

5.2.5.3 Spills and/or leaks from storage and handling of hazardous materials and waste

All storage, and the majority of handling, of hazardous materials and wastes will occur at the mine facilities, within bunded and sealed areas. However, refuelling and maintenance of earthmoving equipment will occur in the field and may result in spills or leaks outside of bunded areas, most likely at cleared mine pits or haul roads. Spills could also occur in the field as a result of vehicle accidents.

If they occur, spills and/or leaks of hazardous materials or wastes have potential to cause localised impact to vegetation condition and potentially die-off in the vicinity of the soil or water contamination. The associated mitigation measures are detailed in Section 5.3.

5.2.5.4 Dust emissions

Dust emissions are generated from mine development, bauxite mining and rehabilitation operations, and from open mine pits in the period between clearing and completion of rehabilitation. The associated mitigation measures are detailed in Section 5.3.

Dust deposition has potential to impact native vegetation, primarily through reduced photosynthesis and increased leaf temperature (Doley 2006, Doley and Rossato 2010). Farmer (1993) demonstrated that inert mineral dusts cause impaired plant growth at surface loads exceeding 7 g/m². Doley (2006) noted that the surface loading did not account for the net rate of dust accumulation on leaf surfaces, which were influenced by leaf orientation, age, roughness and wettability. Doley (2006) concluded:

‘Critical dust loads that result in significant alterations in the most sensitive plant functions vary with the particle size distribution and colour of the dust, from about 1 g m⁻² for carbon black with a median diameter of about 0.15 µm to about 8 g m⁻² for coarse road or limestone dusts with median diameters greater than about 50 µm. The critical loads vary with the plant function and it has not been possible to predict precisely the nature of one plant response from the knowledge of another’.

Doley (2013) modelled the potential effects of quarry dust on native vegetation, indicating a greater effect on ground cover species, with a predicted 20% reduction in dry matter production at dust deposition of approximately 7 g/m², supporting earlier findings by Farmer (1993). Effects on overstorey and understorey trees/shrubs were predicted as substantially lower (less than 5% reduction at 7 g/m²) due to more vertically oriented leaves and higher wind exposure that reduces dust accumulation, as well as less sensitivity to shading by dust. Doley (2013) noted that dust is expected to be effectively removed by heavy rain events (> 5mm) and strong wind events (> 5 m/s).

Dust accumulation is expected to be highest during summer and autumn seasons when there is limited frequency of high rainfall events, though reduced by high wind events. Climatic data for the Dwellingup BOM station (site 009538) indicates summer and autumn winds on average exceed 20 kmph (5.6 m/s) for approximately 20% of the time, indicating potential for dust removal over this period.

The net dust deposition on Jarrah forest vegetation will depend on individual vegetation characteristics, including (Doley 2013):

- branching habit and stiffness
- foliage density and element size (e.g. needles vs large leaves)
- leaf orientation, smoothness, hairs or resin.

Understorey vegetation is potentially more susceptible to dust accumulation and impact as predicted by Doley (2013). However, the Jarrah forest understorey is likely to have lower photosynthetic activity during summer and autumn due to shallower roots and access to limited soil moisture compared to deeper rooted overstorey species. Accordingly, dust accumulation that occurs during summer and autumn between wind events may result in limited impacts to understorey vegetation. Following winter and spring rains and the recharge of shallow soil moisture the understorey vegetation will become more active, however this will be concurrent with rainfall events causing dust wash-off and reduce dust accumulation.

5.2.5.5 Altered hydrology/groundwater regimes

Groundwater mounding beneath and in the vicinity of mine pits is expected due to the clearing of native vegetation and increased recharge of rainfall. The highest groundwater rise is predicted to occur in the vicinity of mined areas, with more limited groundwater rise in valleys where potential GDEs are located. Greater mounding is predicted for wetter climatic conditions. The associated mitigation measures are detailed in Section 5.3.

5.2.6 Cumulative Impacts

5.2.6.1 Past and present activities

The NJF subregion has been subject to environmental impacts from a range of past and present activities, with the key activities in order of area of disturbance as follows:

- Agriculture.
- Timber harvesting.
- Prescribed burning.
- Bauxite and gold mining.
- Plantations.
- Water supply reservoirs.

Agriculture and timber harvesting have caused widespread impacts including:

- Loss of biodiversity and habitat from permanent clearing.
- Long term loss of mature trees and associated hollows from timber harvesting.
- Spread of *Phytophthora* Dieback in forested areas from timber harvesting.
- Agricultural impacts to soils including erosion, salinity, compaction and acidification.
- Secondary salinity impacts to the Murray and Avon rivers from permanent clearing.
- Conversion of natural landscape to rural character and conversion of old growth forest to juvenile to immature forest age.

Mining has caused impacts as follows:

- Short to medium term ecological and amenity impacts during operations and until rehabilitation establishes.

- Long term loss of fauna habitats.
- Rehabilitation restoring varying biodiversity, ecological integrity and landscape quality.

Prescribed burning is undertaken to reduce the severity and extent of wildfires, which can have significant ecological, water quality and amenity impacts.

Water supply reservoirs have caused localised loss of incised river valley landforms and vegetation and widespread disruption to aquatic fauna migrations and dispersal, however they have created perennial waterbodies that provide refuges for aquatic fauna.

5.2.6.2 Reasonably foreseeable future activities

Reasonably foreseeable future activities within the NJF subregion include approved and proposed mining. The majority of Jarrah forest cleared for mining is expected to be rehabilitated.

The WA Government has announced an end to native forest logging in 2024, at which point FPC will continue its independent logging activities within areas that have been approved for mining.

Prescribed burning is expected to continue within the subregion in accordance with the WA Government's strategy to reduce fuel loads and minimise the likelihood and severity of large scale wildfires.

Other future activities within the subregion may include urban or rural residential development, infrastructure development and agriculture, which are expected to be relatively minor and subject to regulation under Part V of the EP Act.

5.2.6.3 Vegetation Cumulative Impacts

Alcoa has considered cumulative impacts of the MMP and other developments and processes to flora and vegetation in the NJF subregion (Table 5-21). The NJF subregion is selected as the system boundary for cumulative impact assessment, as it is ecologically distinct from surrounding IBRA subregions.

Cumulative impacts on the flora and vegetation within the NJF subregion may be due to the following:

- Mining and rehabilitation.
- Fragmentation.
- Timber harvesting.
- Climate change and wildfire.
- Disease and weed invasions.

The most widespread impact to flora and vegetation has been historic clearing for agriculture, rural development and timber harvesting, approximately 58% of the subregion and 1% of old growth forest. Approximately 2% of the subregion has been cleared within DBCA managed lands, and the remaining 39% is cleared outside DBCA managed lands, predominantly for agriculture and rural development. Timber harvesting is expected to cease from 2024 onwards, at which point FPC will continue its independent logging activities within areas that have been approved for mining.

Wildfires and *Phytophthora* dieback have impacted DBCA managed lands within the subregion by approximately 86% and 34%, respectively. No data is available for wildfire or Dieback impacts outside DBCA managed lands.

There is a lack of data to accurately predict the magnitude of climate change impacts; however, impacts may potentially be widespread given the reduction in rainfall and increased temperatures across the NJF subregion.

Mining and rehabilitation combined currently comprise approximately 2% of the subregion and with additional proposed clearing will increase to approximately 4% by 2035 (of which 2% is attributed to Alcoa). Rehabilitation has occurred to varying prescriptions and practice, with Alcoa rehabilitating about 78% of their bauxite mining.

Table 5-21: Overview of indicative cumulative impacts to Flora and Vegetation

Impacting development / process	Indicative magnitude of existing disturbance		Indicative magnitude of future disturbance	
	Area within NJF (ha)	Proportion of subregion (%)	Area within NJF (ha)	Proportion of subregion (%)
Mining				
Huntly Mine	17,376	0.9	29,322	1.5
Willowdale Mine	6,726	0.33	9,256	0.5
Jarrahdale Mine	4,030	0.21	4,030	0.2
Subtotal – Alcoa mining	28,132	1.5%	42,605	2.2%
South 32 Worsley Bauxite Mine	6,467	0.34	20,206	1.1
Newmont Boddington Goldmine	4,374	0.23	5,435	0.3
Subtotal – total mining	38,973	2.1%	68,249	3.6%
Rural and urban development	~ 740,000 ¹⁸	~ 39	estimates not available	~ 39
Timber harvesting	~ 786,000 ¹⁹	~ 41	~ 17,500 to 2024 ²⁰	~ 41
Plantations (softwood, hardwood)	12,550	0.66	estimates not available	n/a
Water supply reservoirs	8037	0.42	estimates not available	n/a
Other clearing within DBCA managed lands	14,687	0.77	estimates not available	n/a
Subtotal –DBCA managed lands	35,274	1.86	n/a	n/a

¹⁸ Clearing outside DBCA managed lands, excluding Boddington mines.

¹⁹ All DBCA managed lands except old growth forest.

²⁰ Based on 17,500 ha over 2021-2023 harvest plan.

Impacting development / process	Indicative magnitude of existing disturbance		Indicative magnitude of future disturbance	
	Area within NJF (ha)	Proportion of subregion (%)	Area within NJF (ha)	Proportion of subregion (%)
Dieback	> 108,100 ²¹	~ 34 ²²	> 123,900 ²³	~ 39
Wildfires, intensifying under European land activities	> 698,810 ²⁴	> 86	estimates not available	n/a
Climate change, declining rainfall, increasing temperature	estimates not available	n/a	estimates not available	n/a
Rabbits, feral pigs	estimates not available	n/a	estimates not available	n/a

A breakdown of Alcoa's existing and future clearing impacts²⁵ is included in Table 5-22, Table 5-23 and Table 5-24. The Huntly Ten Year Mine Plan consists of the Revised Proposal clearing within Myara North and Holyoake. The Willowdale Ten Year Mine Plan predominately consists of ore shells, which may under-estimate clearing requirements. The conceptual clearing buffer and areas historically endorsed under FCAs, which are not considered likely to be cleared are shown, however are excluded from future mine area totals.

The potential cumulative impacts to state-wide vegetation associations (Table 5-22) is predominately associated with vegetation association 3, with a total reduction of 4% of the current remaining extent from Alcoa's activities. This vegetation association has a large extent and also occurs within other IBRA sub-regions.

The potential cumulative impacts to vegetation complexes (Table 5-23) could result in a decrease of up to 13% of mapped extent. The largest decrease (13%) is associated with the Dwellingup (D1) vegetation complex, which has a resulting remaining extent of 74%.

Table 5-24 summarises the potential cumulative impacts to conservation significant vegetation from existing and future Alcoa mining activities. Future mine areas could impact up to 4% of potential PECs, GDVs, granites and swamps. The majority of these impacts are associated with the Ten Year Mine Plan, in particular the Revised Proposal. Up to 16% of the mapped extent of lateritic hills and slopes, which contains conservation significant flora species, could be impacted. However, these vegetation types are considered to be widespread throughout the NJF.

²¹ Assessed as infested for DBCA managed lands in ML1SA.

²² Proportion of assessed area within DBCA managed lands in ML1SA.

²³ Based on spread of 1050 ha/yr over 2021-2035.

²⁴ Data available for DBCA managed lands in ML1SA

²⁵ includes all potential clearing associated with Alcoa's mining activities

Table 5-22: Overview of Alcoa cumulative impacts to vegetation associations within NJF sub-region

Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Buffer ²⁶ (ha)		24 Month Clearing Schedule (ha)		Open Areas (ha)		Rehab area (ha)		FCA Endorsed Clearing (ha)		Five Year Mine Plan (ha)		Ten Year Mine Plan (ha)		Total future mine areas (ha)	Portion of extent remaining (%)	Total decrease in remaining extent (%)
				HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL			
3	908,100	723,446	79.7%	726	103	1,688	780	3,997	1,687	13,375	5,038	792	281	1,391	628	8,075	841	38,574	75.4%	4.2%
4	614,201	197,904	32.2%	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	32.2%	0.0%
128	4,757	4,124	86.7%	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	86.7%	0.0%
Total	1,527,058	925,474	60.6%	726	103	1,688	780	3,998	1,687	13,378	5,038	792	281	1,391	628	8,075	841	38,577	58.1%	2.5%

Table 5-23: Overview of Alcoa cumulative impacts to vegetation complexes

Vegetation Complex	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Buffer (ha)		24 Month Clearing Schedule (ha)		Open Areas (ha)		Rehab area (ha)		FCA Endorsed Clearing (ha)		Five Year Mine Plan (ha)		Ten Year Mine Plan (ha)		Total future mine areas (ha)	Portion of extent remaining (%)	Total decrease in remaining extent (%)
				HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL			
Cooke (Ce)	36,779	30,004	81.6%	2	0	319	62	388	169	375	240	65	3	266	114	262	42	2,305	75.3%	6.3%
Dwellingup (D1)	208,489	180,618	86.6%	550	80	941	646	2,757	1,214	10,514	4,258	585	216	453	463	4,164	692	26,904	73.7%	12.9%
Dwellingup (D2)	86,127	71,310	82.8%	0	0	75	0	0	0	243	0	0	0	335	0	1,758	0	2,411	80.0%	2.8%
Dwellingup (D4)	132,414	115,545	87.3%	0	0	0	0	0	0	3	0	0	0	46	0	0	0	49	87.2%	0.0%
Goonaping (G)	27,467	21,818	79.4%	0	0	0	0	0	0	0	0	0	0	0	0	14	0	14	79.4%	0.1%
Helena 1 (He1)	15,890	12,045	75.8%	0	0	0	0	0	0	0	8	0	0	0	0	0	0	8	75.7%	0.1%
Murray 1 (My1)	68,695	52,307	76.1%	0	0	36	2	322	36	342	137	34	2	11	0	191	8	1,121	74.5%	1.6%
Pindalup (Pn)	167,149	128,685	77.0%	5	0	26	0	0	0	17	0	0	0	83	0	0	0	127	76.9%	0.1%
Swamp (S)	53,658	40,504	75.5%	14	0	15	1	8	11	23	0	0	4	3	0	94	0	160	75.2%	0.3%
Yarragil 1 (Yg1)	80,202	64,986	81.0%	1	13	105	46	364	129	729	330	88	22	99	37	440	78	2,468	78.0%	3.1%
Yarragil 2 (Yg2)	50,259	46,484	92.5%	155	11	170	25	158	128	1,133	65	19	33	94	14	1,152	20	3,012	86.5%	6.0%
Total	927,128	764,305	80.3%	726	103	1,688	780	3,998	1,687	13,378	5,038	792	281	1,391	628	8,075	841	38,577	78.3%	2.0%

²⁶ Buffer and Historically FCA Approved is not included in future mine areas, as clearing may not occur

Table 5-24: Overview of Alcoa cumulative impacts to conservation significant vegetation

Conservation Significant Vegetation	Mapped Extent (ha)	Buffer (ha)		24 Month Clearing Schedule (ha)		FCA Endorsed Clearing (ha)		Five Year Mine Plan (ha)		Ten Year Mine Plan (ha)		Total future mined areas (ha)	Proportion of mapped extent (%)
		HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL		
Clearing amount	-	1,687.7	780.2	1,687.7	780.2	791.7	280.8	1,390.5	628.1	8,075.4	841.2	12,007.7	
Potential PEC	1,615.9	8.5	0.7	8.5	0.7	22.5	0.1	0.8	-	60.5	-	83.8	5.2%
Potential GDV	23,614.5	244.3	51.6	244.3	51.6	78.9	18.9	116.6	17.9	560.4	25.3	818.0	3.5%
Granites	1,615.9	8.5	0.7	8.5	0.7	22.5	0.1	0.8	-	60.5	-	83.8	5.2%
Swamps & Creeks	17,921.3	99.4	42.5	99.4	42.5	25.7	17.8	32.6	12.2	306.6	15.5	410.3	2.3%
Lateritic Hills & Slopes	62,963.2	1,423.6	670.4	1,423.6	670.4	709.5	217.8	909.8	377.3	7,587.3	401.0	10,202.8	16.2%

5.3 Mitigation

Alcoa's environmental management incorporates the mitigation hierarchy, which is in order of priority:

- Impact avoidance.
- Impact minimisation.
- Rehabilitation.

A risk-based approach has been taken to align with Alcoa's environmental management system and management plans. Associated mitigation actions are provided in Table 5-25 as a risk register and risk assessment methodology is provided in Appendix 3 .

Key mitigations include:

- Targeted flora surveys are undertaken in suitable habitat, prior to clearing.
- Haul road alignments have been selected with consideration to dieback distribution, swamp and stream zone protection.
- Field verification of old-growth forest boundaries are undertaken in accordance with DBCA's *'Procedures for the assessment, identification, and demarcation of old-growth forests'* (DBCA 2017).
- Implement Mining Avoidance Zones for:
 - a. Threatened species (unless regulatory consultation and appropriate approvals obtained).
 - b. DBCA Old growth forest.
 - c. National Park and formal conservation reserves.
- Implement Mining Exclusion Zones for:
 - a. Rock outcrops greater than one hectare and biologically diverse areas fringing granite outcrops.
 - b. Stream Zone vegetation and a 100m buffer.
 - c. Threatened species (unless regulatory consultation and appropriate approvals obtained).
 - d. Conservation significant flora (as far as practicable).
 - e. DBCA Old growth forest.
 - f. National Park and formal conservation reserves.

Alcoa remains focussed on opportunities to continue to improve understanding of flora and vegetation impacts and obtain further data in that regard. One of these opportunities is gaining more baseline survey data, to further develop mitigation measures and monitoring, to further minimise impacts. Alcoa intends to achieve this opportunity by implementing an improvement plan (Figure 5-14) which includes the following:

- Develop and implement a Flora and Vegetation Management Plan (FVMP; Appendix 9) which details management objectives and targets, with associated management measures. Alcoa is committed to implementing the FVMP as per improvement plan timeframes by 31 December 2024 (Commitment 17). Any revisions to the FVMP will be done in consultation with DBCA to ensure expected mitigations and methodologies are included (Commitment 19).
- Undertake baseline (desktop and field) and pre-clearance survey requirements, as shown in Table 3-3 of the FVMP. This includes:
 - a. undertake Havel vegetation mapping for all conceptual clearing areas, including recording old growth forests, groundwater dependent ecosystems and vegetation condition. Reports will be included in future MMPs.
 - b. Undertake targeted surveys and associated risk avoidance & management for all future clearing under the MMP where reasonably practicable as per the FVMP (Commitment 18). Reports will be included in future FCAs.
 - c. future surveys will be submitted as per the Index of Biodiversity Surveys for Assessment (IBSA) program.
 - d. Havel vegetation mapping survey reports will be provided in future MMPs and Targeted flora survey reports in future FCAs.
- Include environmental impact assessment as part of this MMP, based on information available.

The Havel vegetation mapping survey methodology is considered a robust baseline assessment methodology as there is a well defined understanding of flora and vegetation values within the current Myara, O'Neil and Larego regions.

Historically, targeted surveys have not been implemented prior to clearing, as conservation significant flora species are predominately associated with stream zones and granite outcrops of which mining is avoided and infrastructure is minimised.

Implementation of the FVMP has commenced, however implementation will be staggered as per the Improvement Plan (Figure 5-14), following approval as part of this submission. This includes the following:

- Targeted flora survey reports will not be available until Q1 2024, therefore any FCAs submitted before then will not include these reports. However, Alcoa will ensure Mining Avoidance Zones will be implemented for any possible Threatened flora individuals. Clearing will not occur until consultants have confirmed no Threatened flora individuals are within the proposed clearing area.
- Havel vegetation mapping is not available for 117 ha within the 24 Month Clearing Schedule, consisting of the following areas:
 - Willowdale turbidity monitors, which may occur in 2024.
 - Willowdale and Huntly conveyor clearing (in an extreme fire situation) along the western extents.

- The conceptual clearing buffer associated with O'Neil water infrastructure to Banksiadale Dam.
- Haul road development in the eastern portion of O'Neil, which is scheduled to occur in 2025.
- Haul road and pit development in the south-western portion of Larego, which is scheduled to occur in 2025.

Havel vegetation mapping for the above proposed clearing areas is planned to occur in late 2023 and outcomes will be included in relevant FCAs. Targeted flora surveys will be undertaken prior to clearing.

Figure 5-14: Flora and Vegetation Improvement Plan

		Indicative Schedule	2023											
			2023			2024				2025				
		Expected Completion	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Flora and Vegetation	Flora and Vegetation													
	Flora & Vegetation Management Plan	Complete												
	Vegetation Dust Monitoring Program	Q4 2024												
	Myara Central													
	Baseline Survey - Desktop Assessment	Complete												
	Baseline Field Survey	Complete												
	Pre-Clearance Survey - (Threatened flora & declared weeds)	Q1 2024												
	Pre-Clearance Survey (Dieback and other forest diseases)	Complete												
	Willowdale													
	Baseline Survey - Desktop Assessment	Complete												
	Baseline Field Survey	Complete												
	Pre-Clearance Survey - (Threatened flora & declared weeds)	Q1 2024												
	Pre-Clearance Survey (Dieback Mapping)	Complete												
	O'Neil													
	Baseline Survey - Desktop Assessment	Complete												
	Baseline Field Survey	Q2 2024												
	Pre-Clearance Survey (Targeted)	Q2 2024												
	Pre-Clearance Survey (Dieback Mapping)	Complete												

Table 5-25: Avoidance and minimisation of potential impacts to flora and vegetation

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Direct loss of conservation significant vegetation, communities and conservation significant flora habitat from clearing	Significant impacts to conservation significant flora habitat, vegetation or communities as a result of clearing activities	<ul style="list-style-type: none"> Implement Mining Avoidance Zones for: <ul style="list-style-type: none"> Threatened species (unless regulatory consultation and appropriate approvals obtained) DBCA Old growth forest National Park, formal conservation reserves Implement Mining Exclusion Zones for: <ul style="list-style-type: none"> Rock outcrops greater than one hectare and biologically diverse areas fringing granite outcrops. Stream Zone vegetation Threatened species (unless regulatory consultation and appropriate approvals obtained) Conservation significant flora (as far as practicable) DBCA Old growth forest National Park, formal conservation reserves Mining Avoidance and Exclusion Zones will be demarcated in construction spatial data to guide construction personnel and included on construction maps. 	<ul style="list-style-type: none"> Clearing activities undertaken as per Vegetation Management Plan (CDS 2053-5517) Minimise infrastructure clearing of stream zone vegetation and rock outcrops. Minimise clearing of mature growth forest. Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted. Conduct baseline flora surveys as per Flora and Vegetation Management Plan Conduct pre-clearance surveys in suitable habitat as determined by baseline flora surveys as per Flora and Vegetation Management Plan Reduce as far as practicable the creation of vegetation islands <10ha in size. Reduce as far as practicable the creation of vegetation with single connection to larger remnants (peninsulas) Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted. Increase the area (ha) in which rehabilitation activities are being undertaken each year over the next 4 years on a rolling basis, achieving a minimum of 3,159 ha of rehabilitation (cumulative) over this period (2024-2027) (Commitment 11) 	<ul style="list-style-type: none"> Rehabilitation to meet Completion Criteria Rehabilitation to re-instate potential flora habitat 	Medium
Direct loss of conservation significant flora individuals from clearing	<p>Significant impacts to conservation significant flora populations as a result of clearing activities</p> <p>Clearing of threatened flora individuals without regulatory consultation and appropriate approvals</p>	<ul style="list-style-type: none"> Implement Mining Avoidance Zones for: <ul style="list-style-type: none"> Threatened species (unless regulatory consultation and appropriate approvals obtained) DBCA Old growth forest National Park, formal conservation reserves Implement Mining Exclusion Zones for: <ul style="list-style-type: none"> Rock outcrops greater than one hectare and biologically diverse areas fringing granite outcrops. 	<ul style="list-style-type: none"> Clearing activities undertaken as per Vegetation Management Plan (CDS 2053-5517) Minimise infrastructure clearing of stream zone vegetation and rock outcrops. Minimise clearing of mature growth forest. Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. 	<ul style="list-style-type: none"> Rehabilitation to meet Completion Criteria Rehabilitation to re-instate potential flora habitat 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		<ul style="list-style-type: none"> ○ Stream Zone vegetation ○ Threatened species (unless regulatory consultation and appropriate approvals obtained) ○ Conservation significant flora (as far as practicable) ○ DBCA Old growth forest ○ National Park, formal conservation reserves ● Mining Avoidance and Exclusion Zones will be demarcated in construction spatial data to guide construction personnel and included on construction maps. 	<ul style="list-style-type: none"> ● Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted. ● Conduct baseline flora surveys as per Flora and Vegetation Management Plan ● Conduct pre-clearance surveys in suitable habitat as determined by baseline flora surveys as per Flora and Vegetation Management Plan ● Spatial data of conservation significant flora and communities retained and review as Surface Disturbance Procedure to ensure clearing impacts are not significant. ● If clearing of threatened species is required, then management options will be developed in consultation with DBCA and DCCEEW with appropriate approval obtained under the BC Act and EPBC Act. ● Design and construct haul road creek crossings, perpendicular to the creek flow to minimise the area of habitat impacted. ● Training for all personnel around requirements for licences to handle/remove flora. 		
Rehabilitated areas do not meet relevant completion criteria.	<p>Rehabilitation does not provide flora and fauna habitat that aligns with the Northern Jarrah Forest</p> <p>Rehabilitation does not align with post-mining land use.</p> <p>Rehabilitation erosion impacting on water resources</p>	<ul style="list-style-type: none"> ● 	<ul style="list-style-type: none"> ● Integrate rehabilitation into mining planning and operational activities. ● Undertake rehabilitation activities in a timely and committed way to enable maximisation of progress on rehabilitation areas. ● Undertake adaptive management based on research to encourage the return of native species and a self-sustaining forest ecosystem. ● Maintain monitoring and assessment to enable rapid responses to invasive weeds and erosion within local areas within the rehabilitation areas. ● Maximise the use of all materials used in clearing and rehabilitation practices to minimize waste and utilise resources as available (including overburden/topsoil, native seeds, clearing debris, timber logs and waste) ● Maintain regular monitoring program at 9 months, 15 months, and ongoing permanent plots to substantiate progress and respond to any issues that arise that 	<ul style="list-style-type: none"> ● 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			will inform adaptive management choices to continually improve outcomes. <ul style="list-style-type: none"> • Conduct ongoing benchmarking against best practice options. • Active research program for continual improvement. 		
Dust deposition impacting upon flora and vegetation	Loss of biodiversity. Loss of flora individuals and/or communities. Loss of conservation significant flora or communities. Decline in health and/or change in fauna habitat composition. Decline in health and/or change in vegetation composition.	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Undertake dust suppression activities during high level use of haul roads and conveyors as per internal dust management procedure. • Maximise efficiency of loads when transporting ore (including haul trucks and conveyers). • Use dust suppressants on exposed areas where possible. • Investigate alternatives for the wood waste burning of clearing residues to reduce the particulate emissions in the local airshed. • Induction packages – the workforce will be made aware of dust generation and control measures. • Routine housekeeping practices around central facilities and workshops will be implemented to reduce dust generation. • Optimising blast charge sizing and spaces to avoid unnecessary energy releases which has the potential to generate dust. • The location of haul roads, conveyors, mine pits and other infrastructure gives consideration to separation distance from receptors to reduce air quality impacts. • Maximise efficiency of loads when transporting ore or concentrate (including haul trucks and conveyers). 	<ul style="list-style-type: none"> • Minimise open area footprint and rehabilitate or cover (using vegetation, rock, water and/or dust suppressant) exposed areas as soon as practicable 	Medium
Introduction / spread of plant disease to previously un-infested areas outside of approved clearing boundaries, resulting from operations	Loss of biodiversity. Reduction in dieback free soil available for rehabilitation. Decline in health and/or change in vegetation composition. Decline in health and/or change in fauna habitat composition.	<ul style="list-style-type: none"> • Infrastructure design to avoid dieback areas, where possible. 	<ul style="list-style-type: none"> • Dieback mapping prior to clearing. • Vehicle clean-down procedures. • Soil Handling procedures - Topsoil, overburden and vegetative material (e.g. coarse woody debris) from uninterpretable or infested areas are not to be moved to uninfested areas. • dieback line (infested, uninfested and uninterpretable areas) demarcation in-field and on GIS and within work packs. • Stockpile signage (demarcating Dieback vs Dieback Free area). 	<ul style="list-style-type: none"> • Following of some dieback areas prior to infrastructure construction 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	<p>Impacts to surface water dependent ecosystems (i.e. stream zone vegetation) and water logging sensitive ecosystems.</p> <p>Surface water mechanical impacts on vegetation e.g. surface water runoff washing plants away, turbid water smothering plants etc.</p>		<ul style="list-style-type: none"> • Training for all personnel on Dieback Management System. • Weed and seed checks prior to new machinery mobilisation. • Containment of stormwater runoff from identified Dieback infested areas to prevent discharge into uninfested areas. • Revalidation of Dieback assessment every 12 months where construction or operations planned for greater than a 12-month duration. • Rehabilitation plants will only be sourced from nursery suppliers with appropriate dieback control management 		
Spread of weeds to previously un-infested areas resulting from operations	<p>Loss of biodiversity.</p> <p>Spread of weed species/impact private residences.</p> <p>Injury from unstable weed management locations.</p> <p>Exposure to weed management chemicals.</p> <p>Decline in health and/or change in vegetation composition.</p> <p>Decline in health and/or change in fauna habitat composition.</p>	<ul style="list-style-type: none"> • Undertake dieback mapping. 	<ul style="list-style-type: none"> • Weed and seed procedure prior to mobilisation. • Weed monitoring occurs periodically, particularly in high-risk areas (stream zones and existing roads), so that any infestations that establish can be eradicated before the plants can flower and set seed. • All identified Weeds of National Significance (WoNS) and environmental weeds treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • Inspection of construction and operational vehicles and equipment for soil and vegetative material prior to entry to undisturbed areas. • implementation of a vehicle hygiene procedure, dieback management procedure and weed control. • Construction and operational vehicle and equipment movements limited to designated roads, access tracks and cleared areas. • Conceptual Clearing Area will be surveyed for Weeds of National Significance (WoNS), Declared and invasive weeds prior to clearing as part of Targeted surveys. • Weed monitoring will occur periodically, particularly in high-risk areas (stream zones and existing roads) and recorded weed infestations, so that any infestations 	<ul style="list-style-type: none"> • Management of infested soil after clearing activities 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			that establish can be eradicated before the plants can flower and set seed <ul style="list-style-type: none"> • All identified WoNS and environmental weeds treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • Rehabilitation plants will only be sourced from nursery suppliers with appropriate weed control management. 		
Changes to fire regimes due to accidental fire or impacts DBCA prescribed burns schedule	Reduction in quality of conservation significant flora or communities resulting from changes in fire regime. Loss of biodiversity Loss or decline in fauna habitat quality	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Fire ban procedures - obey local enforcement and legislation. • Clearing around powerlines. • Emergency response process - Fire crews trained and equipment at hand (fire trucks etc.). • All heavy machinery has an in-built fire suppressant system. 	<ul style="list-style-type: none"> • 	Low

5.4 Assessment of impacts

Alcoa proposes substantial avoidance, mitigation and rehabilitation to reduce the residual impacts to a low as reasonably practicable. The effectiveness of rehabilitation and of dieback and weed hygiene has been demonstrated through long-term research and operations and is at a high level of confidence. Clearing predominately occurs in areas which have been FPC harvested and targeted flora surveys will occur to ensure impacts to Threatened species are avoided. A FVMP (Appendix 9) details key mitigation measures.

The 24 Month Clearing Schedule is considered to have a low impact to threatened flora populations in the NJF subregion. No threatened flora have been recorded within the 24 month clearing areas and targeted surveys will occur prior to clearing, with avoidance of any identified individuals. Whilst direct impacts to potential Threatened flora habitat may occur, the impact is considered medium as potential habitats are widespread and well represented through the sub-region.

The 24 Month Clearing Schedule is unlikely to result in any State listed priority flora becoming threatened as avoidance of Priority populations will occur, where possible. There are substantial populations of priority species recorded outside the 24 month clearing areas. Whilst direct impacts to potential Priority flora habitat may occur, the impact is considered medium as potential habitats are widespread and well represented through the sub-region.

The 24 Month Clearing Schedule impacts to state-wide vegetations associations would result in a decrease of less than 0.3% of current extent. Impacts to vegetation complexes are all less than a 1% decrease in current extent. All vegetation complexes have greater than 70% of pre-european extent remaining.

The greatest proportion of clearing is proposed to occur within P, S and T dominant vegetation types, which are relatively widespread. The 24 Month Clearing Schedule will not impact more than 5% of the current mapped extent of any vegetation type, with the exception of 28% impacts to the TP vegetation type.

In addition, the 24 Month Clearing Schedule impacts represent an insignificant portion of current clearing in the context of more widespread cumulative impacts from historic timber harvesting, historic mine rehabilitation, climate change, fire and dieback. Consideration of the five and ten year plan in these cumulative impacts represent an increase of 0.7% of clearing to the NJF subregion, which is considered to have a medium risk.

No TECs have been recorded within the mine region and limited clearing to potential PECs and GDEs will occur and is considered medium impact. Indirect impacts to potential PECs or GDEs related to hydrological changes, contaminant discharges or the spread of weeds is considered to be low.

6 Terrestrial Fauna

6.1 Receiving environment

6.1.1 Baseline studies

Baseline assessments have been undertaken in selected survey areas within Huntly and Willowdale mines. Where baseline assessments are absent, preliminary fauna desktop habitat mapping has been undertaken. Extrapolation of habitats was made using available historical site Havel vegetation type mapping, undertaken by Mattiske Consulting.

The Long Term Fauna Monitoring Programme (LTFMP) is undertaken to understand the extent to which the vertebrate fauna assemblage in 5 year old, 10 year old and 15 year old rehabilitated areas are approaching that in the unmined forest. Surveys are undertaken across two seasons (summer and winter) at both mines, every 5 years. Permanent monitoring sites in three rehabilitation areas and the analogue unmined forest are established, including three replicate sites in each: totalling 12 trapping sites. In addition, eight camera traps will be deployed at three stream zones targeting Quokka and Water Rats.

Since 2021, each LTFMP site will also be searched for representative specimens of the invertebrates from the taxonomic groups mygalomorphs, isopods, diplopods, opiliones, scorpions and pseudoscorpions. Active searches are carried out at each site, in addition to dry pitfall trapping. Three different ages of rehabilitation (5, 10 and 15 year old), unmined forest reference sites and streamzones are surveyed, with three replicates/sites for each category.

In addition, mygalomorph spider research to better understand species diversity has been ongoing since 2021. Genetic samples are taken from spiders across the lease and sent for sequencing, to create a database of species and their distribution. Following that, an ethical trap was developed to capture mygalomorph spiders in their burrows.

Black Cockatoo surveys are undertaken, by a suitably qualified consultant, through visual inspection for the presence of habitat trees. If suitability of a hollow cannot be determined from the ground, a pole camera or drone is used to obtain a better visual. The current extent of Black Cockatoo surveys are shown in Figure 6-1 and Figure 6-2.

The current surveys are considered adequate to determine impacts to fauna, due to:

- A high level of existing regional knowledge of the Northern Jarrah Forest and associated fauna habitat and species.
- The LTFMP is adequate to confirm species considered likely to occur.
- Ongoing clearing has been contained within mine regions, limiting the level of fragmentation.
- Conservation significant fauna species habitat extent and distribution occurs outside of mine regions.
- Alcoa will undertake detailed and targeted fauna surveys in new mine regions, where minimal impacts had previously occurred, and previous ecological information is limited.

A summary of the key historical terrestrial fauna studies are presented in Table 6-1.

Future fauna surveys will be included in approval submissions and submitted in alignment with the IBSA program and EPA Technical Guidance for Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020). Further details on improvement programs are included in Section 6.2.7.

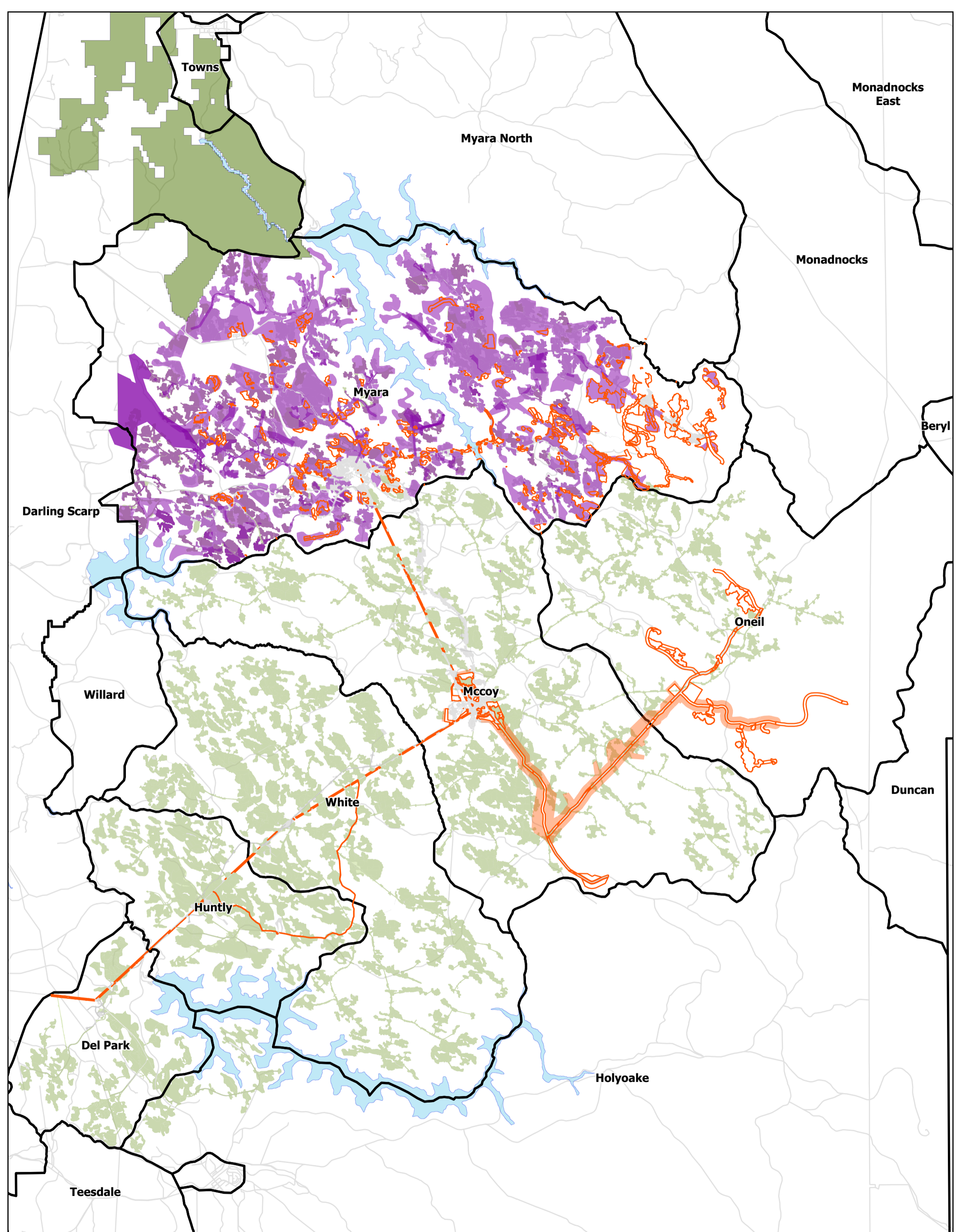
Table 6-1: Terrestrial fauna studies

Year	Author	Area	Study Name	Survey details
1992, 1995, 1998, 2001, 2003, 2006, 2007	Environmental Management and Research Consultants (EMRC)	Jarrahdale, Huntly, Karney	Long term fauna monitoring program (LTFMP)	The Alcoa LTFMP was designed in 1991. The program is designed to monitor fauna every three years at twenty plots located in rehabilitation and nearby forest at Jarrahdale, Huntly and Karnet (remote from mining). A variety of different survey methods were used including trapping (five successive trap nights in July, August and September), avifauna (quantitative and inventory surveys in summer and winter), reptile survey (trapping over five consecutive nights in Summer with toenail clippings to indicate recapture) opportunistic survey, nocturnal surveys and active searches.
2003, 2007, 2013	EMRC	McCoy	LTFMP	The monitoring program involved survey of terrestrial vertebrates (including mammals, birds and reptiles) and ground invertebrates. Mammals, birds, reptiles, and frogs were surveyed in both winter (July-August) and summer (December-January). Mammal and reptile trapping were undertaken. Birds were surveyed using quantitative methods (transects) and inventory methods (opportunistic recordings). In the 2013 survey additional methods were implemented including a single large trapping transect to sample highly mobile species, remote sensor cameras and all invertebrates collected in pitfall traps were identified to taxonomic order.
2012	Stokes	Keats	Vertebrate fauna survey of planned mining areas at Alcoa's Keats Mining Region 2011/12	Fauna were surveyed between November 2011 and February 2012 using a range of techniques, including trapping (Elliot), remote sensor cameras, tracking tunnels, observational surveys and spotlighting across a diversity of forest types. Five areas were trapped: two dieback free Jarrah forest areas and three stream zones. Pitfall traps were not used due to time constraints. Black Cockatoo habitat, feeding and occurrence was surveyed during January 2012 covering approximately 840 ha.
1999 2004, 2011, 2015	EMRC Stokes / EMRC	Orion	A fauna survey of planned mining areas at Alcoa's Orion Mining region. LTFMP	Fauna survey conducted between February and November 1999. The habitats monitored were surveyed in current mining areas, extensive dieback affected areas, small dieback free areas and on sites where mining operations are planned. The LTMFP was reviewed in 2003 which included a recommendation for a similar program to be established at Orion so that any differences in faunal successional processes taking place at Willowdale could be detected. Similar

Year	Author	Area	Study Name	Survey details
				techniques to those used at Jarrahdale, Huntly and McCoy. Mammals, birds, reptiles and frogs were surveyed during both summer (March) and winter (July), and ground dwelling invertebrates were sampled in summer only. Survey methods were similar to those used in the original LTFMP. A single large trapping transect designed to specifically target Chuditch was used in the later studies.
2000, 2007	EMRC	Huntly	A Vertebrate Fauna Survey of Rehabilitated Areas at Alcoa's Huntly Minesite	Overview of the vertebrate fauna surveys of Alcoa's rehabilitated bauxite mines at Huntly undertaken in 1994, 2000 and 2007. Mammals, birds and reptiles were surveyed in six rehabilitated pits ranging in age from 8 to 16 years.
2000	EMRC	Jarrahdale	A survey of the impact of burning on mammals and birds in Alcoa's rehabilitated Bauxite mines at Jarrahdale	To ascertain the impact of burning on birds and mammals, pre burning monitoring took place 1997, and post burn monitoring commenced in 1998 in both burnt and unburnt, rehabilitated and unmined forest sites.
2015, 2017	Burgar et al. 2017	Various	The importance of mature forest as bat roosting habitat within the production landscape Habitat features act as unidirectional and dynamic filters to bat use of production landscapes	Surveys undertaken in forest surrounding Huntly mine site, both unmined and different stages of vegetation succession. Study aimed at identifying roost habitat within restored forest versus unmined forest. Ultrasonic detectors (Anabat Titley Electronics) were set at 64 sites four times per year between October and March 2010/2011 and 2011/2012 for a total of 512 survey nights.
2013, 2014	Alcoa McGregor et al. 2014	Various	Chuditch survey raw data Myara. Does forest restoration in fragmented landscapes provide habitat for a wide-ranging carnivore?	Trapping transects undertaken in 'Myara west' and 'Myara east'. Fourteen Chuditch trapping sessions (13 at Huntly, one at Willowdale) across 9 trapping transects (8 at Huntly, one at Willowdale) undertaken between June 2009 and Dec 2010
2016, 2019	Doherty et al. 2016 Mastrantonis et al. Craig et al. 2021	Various	Successional changes in feeding activity by threatened cockatoos in revegetated mine sites. Climate change indirectly reduces breeding frequency of a mobile species through changes in food availability	Plots (232) were surveyed in revegetated forest and 480 plots were surveyed in unmined forest to determine whether there were successional patterns in cockatoo feeding activity in revegetation aged between 4 and 23 years. Using a dataset of annual breeding frequency spanning 19 years, in combination with hydrological, climatological, and remotely sensed data, the effects of environmental variation on the annual breeding frequency of Forest Red-tailed Black Cockatoo's (FRTBC) were modelled.

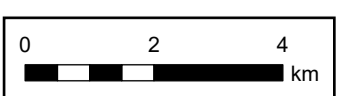
Year	Author	Area	Study Name	Survey details
				Nest selection of FRTBC was examined to identify factors influencing nest hollow selection at multiple spatial scales including interactions between functional resources.
2019-2020	Tony Kirkby	Myara North	Myara North black cockatoo surveys	Black cockatoo surveys undertaken by Black Cockatoo Specialist as engaged by Alcoa. Surveys undertaken along tracks throughout Myara North and reviewing the trees present 30 m either side of the track.
2011-2023	Alcoa; Tony Kirkby	Huntly and Willowdale mines	Pre-clearance black cockatoo hollow surveys	Black cockatoo surveys undertaken by Black Cockatoo Specialist as engaged by Alcoa. Surveys undertaken within all areas planned for clearing of potential black cockatoo breeding trees. Current extent of surveys are shown in Figure 6-1 and Figure 6-2.
2021	WRM	Myara North and Holyoake Regions	Aquatic Fauna Desktop Assessment Myara North and Holyoake Regions	Desktop assessment of aquatic fauna.
2021a	GHD	Myara North	Myara North – Terrestrial Fauna Survey and Black Cockatoo Assessment	Desktop assessment and two season detailed and targeted (Forest Red-tailed Black Cockatoo, Carnaby’s Cockatoo, Baudin’s Cockatoo, Chuditch, Quokka, and other priority species) vertebrate fauna survey.
2021b	GHD	Holyoake	Holyoake – Terrestrial Fauna Survey and Black Cockatoo Assessment	Desktop assessment and two season detailed and targeted (Forest Red-tailed Black Cockatoo, Carnaby’s Cockatoo, Baudin’s Cockatoo, Chuditch, Quokka, and other priority species) vertebrate fauna survey.
2021a	Phoenix	Huntly	Short-range endemic invertebrate fauna survey for the Huntly Mine Extension	Desktop assessment and two season short-range endemic (SRE) invertebrate fauna survey of Myara North, Holyoake and Huntly Mine rehabilitation sites. SRE habitat mapping was undertaken based on vegetation mapping prepared for the Proposal (Mattiske 2021) and taking into account habitat attributes relevant to SRE invertebrates. Each habitat was rated for its potential to support SREs (potential habitat rating; PHR) as High, Low or None.
1997 – 2019	WRM	Various	IRZ Streamzone monitoring	<p>Macroinvertebrates and fish were surveyed in the Camerons Intermediate Rainfall Zone (IRZ) area between 1995 and 2007 as part of streamzone monitoring for the Huntly Mine. Further monitoring for macroinvertebrates was conducted in the Camerons, Jayrup and O’Neill areas in 2009, 2011, 2014 and 2019.</p> <p>Long term aquatic biomonitoring during and post-mining aimed to track changes physical and biological attributes in response to mining, particularly in response to secondary salinisation (Croton & Dalton 2010).</p>

Year	Author	Area	Study Name	Survey details
2014; 2016; 2022	Alcoa	Willowdale and Huntly	Culvert Camera Trap Monitoring - Willowdale and Huntly	Monitoring of fauna and creek crossing culverts has been undertaken since 2014 across both the Huntly and Willowdale mines.
2021 – 2022	Alcoa	Orion	LTFMP	A revised LTFMP was conducted within the Orion region over four consecutive nights (five days), in winter of 2021 (June/July) and summer of 2022 (January/February). Two transects were established at each of the four sites, which included rehabilitation of five, ten and 15 year age as well as unmined forest. One stream zone site was also monitored, consisting of targeted monitoring of quokkas and short-range endemics and did not follow the standard transect design. An additional eight transects across four sites, and one stream zone site, were established prior to summer 2021/2022. Two landscape trapping transects were also established; one inside the current mine perimeter and close to operations, and one outside the current mine perimeter largely surrounded by unmined forest.

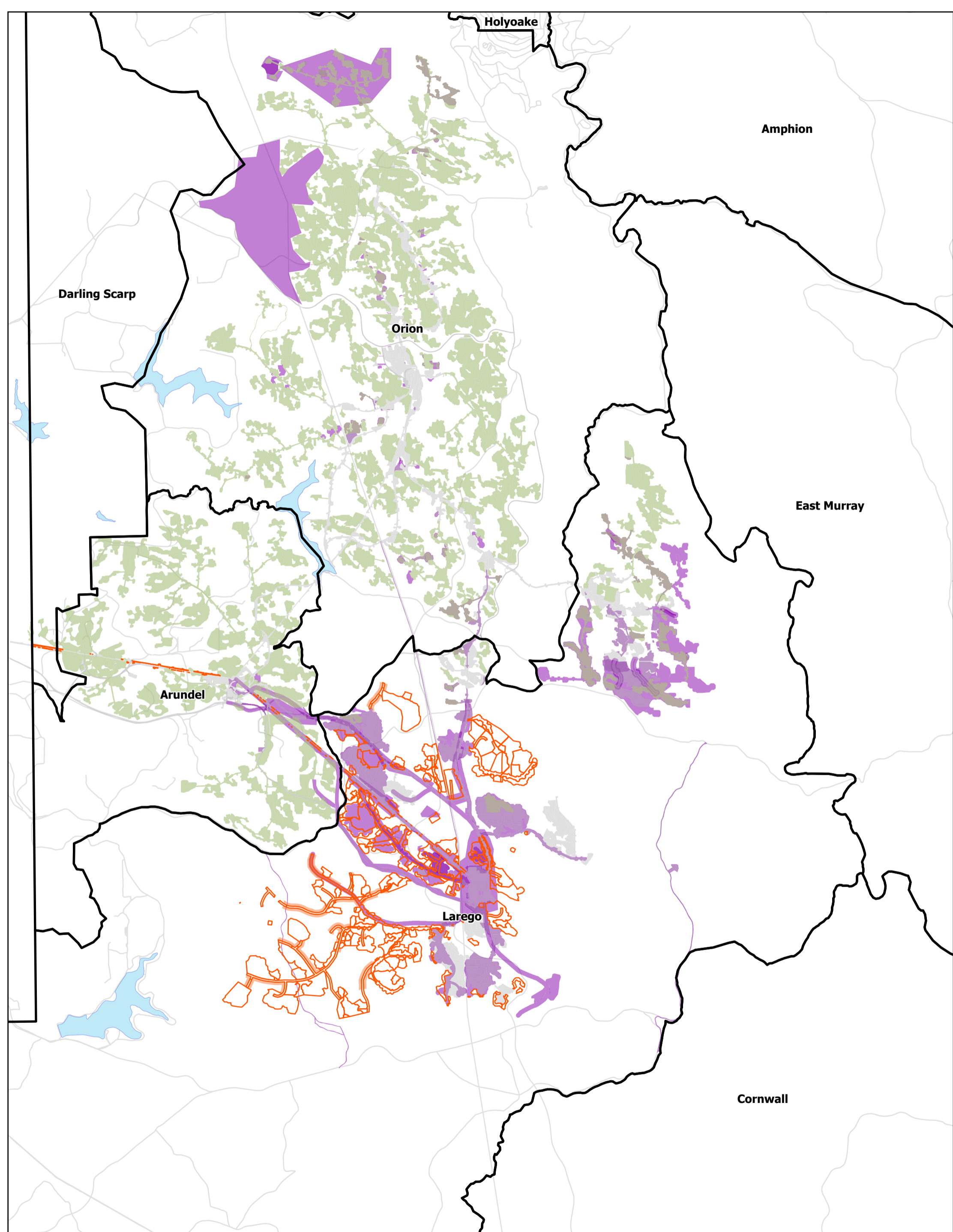


Legend

24 Month Clearing Schedule	Mining Regions
Conceptual Clearing Buffer	National Parks
Black Cockatoo Survey Area	Major Dams
Rehabilitation	
Cleared Areas	

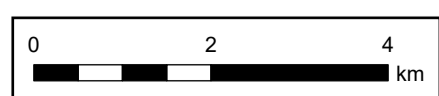


2023 – 2027 Mining and Management Plan	
Figure 6-1: Black Cockatoo survey areas - Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023



Legend

24 Month Clearing Schedule	Mining Regions
Conceptual Clearing Buffer	Rehabilitation
Black Cockatoo Survey Area	Cleared Areas
	Major Dams



2023 – 2027 Mining and Management Plan	
Figure 6-2: Black Cockatoo survey areas – Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

6.1.2 Fauna Habitats

6.1.2.1 Habitat Types

Seven broad fauna habitat types within the Huntly and Willowdale mine areas have been defined (Table 6-2 and Figure 6-3 and Figure 6-4).

Approximately 55% of the Huntly and Willowdale mine areas comprises Jarrah-Marri Forest, which is associated with the P, S, T, E and D dominant SVTs in uplands and slopes, and is widespread across the Northern Jarrah Forest (NJF) subregion. A further 23% of the Huntly and Willowdale mine areas comprise mine site rehabilitation, which is predominantly a restoration of the Jarrah-Marri Forest habitat type. Portions of the Jarrah-Marri Forest habitat type associated with the E and D dominant SVTs on the lower slopes are associated with potential GDVs.

Approximately 8% of the Huntly and 4% of the Willowdale mine areas comprises Blackbutt and Bullich Forest, associated with the C and W dominant SVTs in lower slopes and creek lines, and less widespread across the NJF subregion. These habitat types are also associated with potential GDVs, comprising seasonal aquatic fauna habitat along creek lines.

Approximately 4% of the Huntly and 1% of the Willowdale mine areas comprises Flooded Gum Woodland and Melaleuca Dampland, associated with the A dominant SVT in swamps and drainage floors, which is relatively restricted in distribution in the NJF subregion. These habitat types are also associated with potential GDVs.

Approximately 3% of the Huntly and 1% of the Willowdale mine areas comprises Granite Outcrops, associated with the G and R dominant SVTs, which is relatively restricted in distribution in the NJF subregion.

Approximately 5% of the Huntly and 3% of the Willowdale mine areas comprises cleared land.

In addition to the mapped terrestrial fauna habitats, the regions contain aquatic habitats associated with seasonally flowing streams, seasonally waterlogged swamps and downstream artificial perennial water bodies (water reservoirs). Based on available studies and the hydrological regimes, it is expected that the mine regions will support aquatic fauna communities characterised by a high degree of seasonality and high level of species endemism.

Permanence of water is an overall determinant of aquatic fauna composition within Jarrah forest ecosystems, such that headwater swamps and tributaries show distinctive communities compared to higher-order streams within the same sub-catchment (ARL 1989; Storey et al. 1990 as cited in WRM 2021). Communities in temporary waterbodies typically comprise a combination of species including those only found in temporary waters and those that periodically recolonise from adjacent permanent refuges (WRM 2021).

Many aquatic invertebrates in south-west WA are found only in temporary waters (Bunn et al. 1989 as cited in WRM 2020). They are specifically adapted to drying and refilling cycles and require a period of desiccation in order for further development to take place (Balla 1994, Williams & Hynes 1977 as cited in WRM 2021).

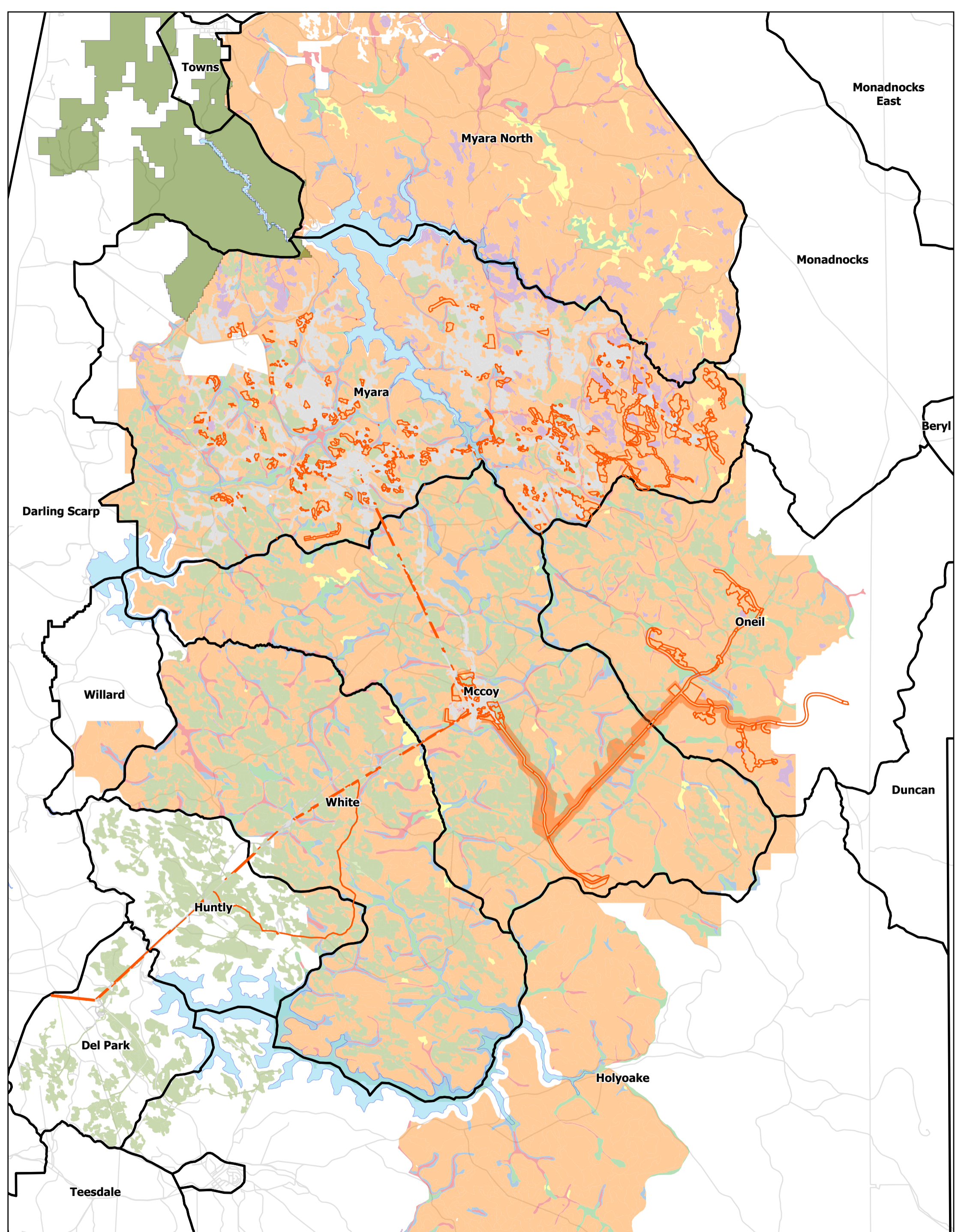
Table 6-2: Preliminary fauna habitats recorded within the mine regions

Description	Mapped extent area (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of mine area (%)	Area (ha)	Proportion of mine area (%)
<p>Blackbutt Forest</p> <p>Blackbutt open forest with occasional Bullich, and Marri over sparse <i>Banksia littoralis</i> over <i>Trymalium</i>, <i>Macrozamia</i>, <i>Xanthorrhoea preissii</i>, over <i>Lepidosperma tetraquetrum</i>, <i>Astartea scoparia</i> and areas of dense Swamp peppermint (<i>Taxandria linearifolia</i>). This habitat is limited to localised patches often associated with creeks and drainage lines.</p> <p>Habitat for conservation significant species:</p> <p>Western Brush Wallaby, Quenda, Quokka, Woylie, Chuditch and Western False Pipistrelle. Breeding and roosting habitat for all three Black Cockatoo species.</p>	3,959.0	2,790.6	2.8%	923.6	1.6%
<p>Bullich forest</p> <p>Valleys and drainage areas dominated by Bullich (<i>Eucalyptus megacarpa</i>) and with some Blackbutt (<i>E. patens</i>), occasional Marri (<i>Corymbia calophylla</i>), over Sheoak (<i>Allocasuarina fraseriana</i>), <i>Banksia littoralis</i> over Grass trees (<i>Xanthorrhoea preissii</i>), Bracken fern, patches of dense <i>Gahnia trifida</i> shrubland over <i>Lasiopetalum floribundum</i>, sedges and herbs. Substrate is dark clayloam soil. These areas are associated with seasonal creeks and drainage areas.</p> <p>Habitat for conservation significant species: Black Cockatoos, Chuditch, Quokka, Woylie, Quenda, Western Brush Wallaby, Masked Owl, Brush-tailed Phascogale, Western False Pipistrelle.</p>	4,642.7	3,317.2	3.4%	1,249.7	2.2%
<p>Flooded Gum woodland</p> <p>Flooded Gum (<i>E. rudis</i>) open woodland with occasional Blackbutt, over open to open to sparse <i>Banksia littoralis</i> over Prickly Moses (<i>Acacia pulchella</i>), myrtaceous species such as Swamp peppermint (<i>Taxandria linearifolia</i>), <i>Astartea scoparia</i>, <i>Trymalium odoratissimum</i>, low shrub/sedgeland. Substrate varies from dark grey to grey brown sandy clays. Associated with</p>	3,624.7	2,969.9	3.0%	446.3	0.8%

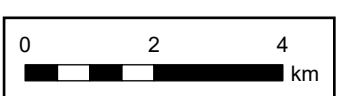
Description	Mapped extent area (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of mine area (%)	Area (ha)	Proportion of mine area (%)
<p>poorly drained broad valleys forming seasonal swamps and occasionally tall open forest along drainage lines.</p> <p>Habitat for conservation significant species: Chuditch and potential foraging habitat for Black Cockatoos. Favoured areas for Western Brush Wallaby. In areas of dense Myrtaceous thicket (low fire frequency) this provides refuge and movement corridors for Quokka, Woylie and Quenda.</p>					
<p>Granite outcrop</p> <p>Granite outcrops with associated lithic vegetation complexes and adjacent associated fringing open Jarrah and Marri areas with scattered Sheoak, Melaleuca, <i>Banksia ilicifolia</i> over occasional Grass trees over mixed open heath communities of Myrtaceous and Proteaceous low shrubs. Soils are pale grey to yellowish fine sand or sandy clay. Granite outcrops often associated with seasonal watercourse and seasonally damp areas. This habitat found as localised patches throughout the Survey Area. Disturbance factors include frequent fire, feral pigs, dieback, damage caused by rock removal, trail bike and 4WD on granite.</p> <p>Habitat for conservation significant species: Foraging and denning habitat for Chuditch. Habitat for Western Brush Wallaby, Southern Death Adder, and Dell's Ctenotus. Fringing open forest provides foraging and breeding habitat for Black Cockatoo species.</p>	1,615.9	1,513.5	1.5%	87.0	0.2%

Description	Mapped extent area (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of mine area (%)	Area (ha)	Proportion of mine area (%)
<p>Jarrah – Marri forest <i>E. marginata</i> and <i>C. calophylla</i> open forest over Grass trees (<i>Xanthorrhoea preissi</i>), <i>Lasiopetalum floribundum</i>, <i>Macrozamia</i> mid shrubland. Patches have dominance of understory <i>Allocasuarina fraseriana</i> and <i>Banksia grandis</i>. Often with complex mosaic of low shrubs such as Fabaceae, <i>Hibbertia</i>, <i>Leucopogon</i>, <i>Adenanthos</i>, and <i>Pteridium</i>. This is the most extensive habitat identified and comprises a number of vegetation types dominated by Jarrah on upper, mid and low slopes and broad valleys. Soils range from well drained gravely sand to sandy clay loam.</p> <p>Habitat for conservation significant species: Chuditch, Brush-tailed Phascogale, Western Brush Wallaby, Peregrine Falcon, Masked Owl, Western False Pipistrelle, Dell’s Skink, Southern Death Adder. Foraging and potential roosting habitat for all three locally occurring Black Cockatoo (<i>Calyptorhynchus</i>) species. Breeding habitat for all three Black Cockatoo species.</p>	68,268.3	52,974.1	53.6%	11,926.0	20.9%
<p>Melaleuca dampland Paperbark (<i>Melaleuca preissiana</i>) over sparse isolated <i>Banksia littoralis</i> over open <i>Hakea</i>, occasional Woody Pear (<i>Xylomelum</i>), Grass trees and over mixed shrub layer of Cyperaceae, Restionaceae, <i>Babingtonia</i>, <i>Jacksonia</i> and <i>Acacia</i>, over low shrubs, sedges and herbs. There are areas of sparse to occasional stunted Jarrah and Marri however these are limited to lowland transitional zones adjacent to slightly higher elevation and drainage open forest areas. Generally limited to areas of poor drainage and subject to winter inundation such as broad valleys and swamps. Substrate is grey gravely clay and clay loam. Disturbance factors include frequent fire and feral pigs.</p> <p>Habitat for conservation significant species: Western Brush Wallaby, Western False Pipistrelle. Foraging habitat for all three locally occurring Black Cockatoo (<i>Calyptorhynchus</i>) species although Jarrah and Marri are generally stunted and sub-optimal for breeding habitat. Where creek lines or dense vegetation is present Quokka and Quenda reside.</p>	976.9	931.8	0.9%	36.1	0.1%

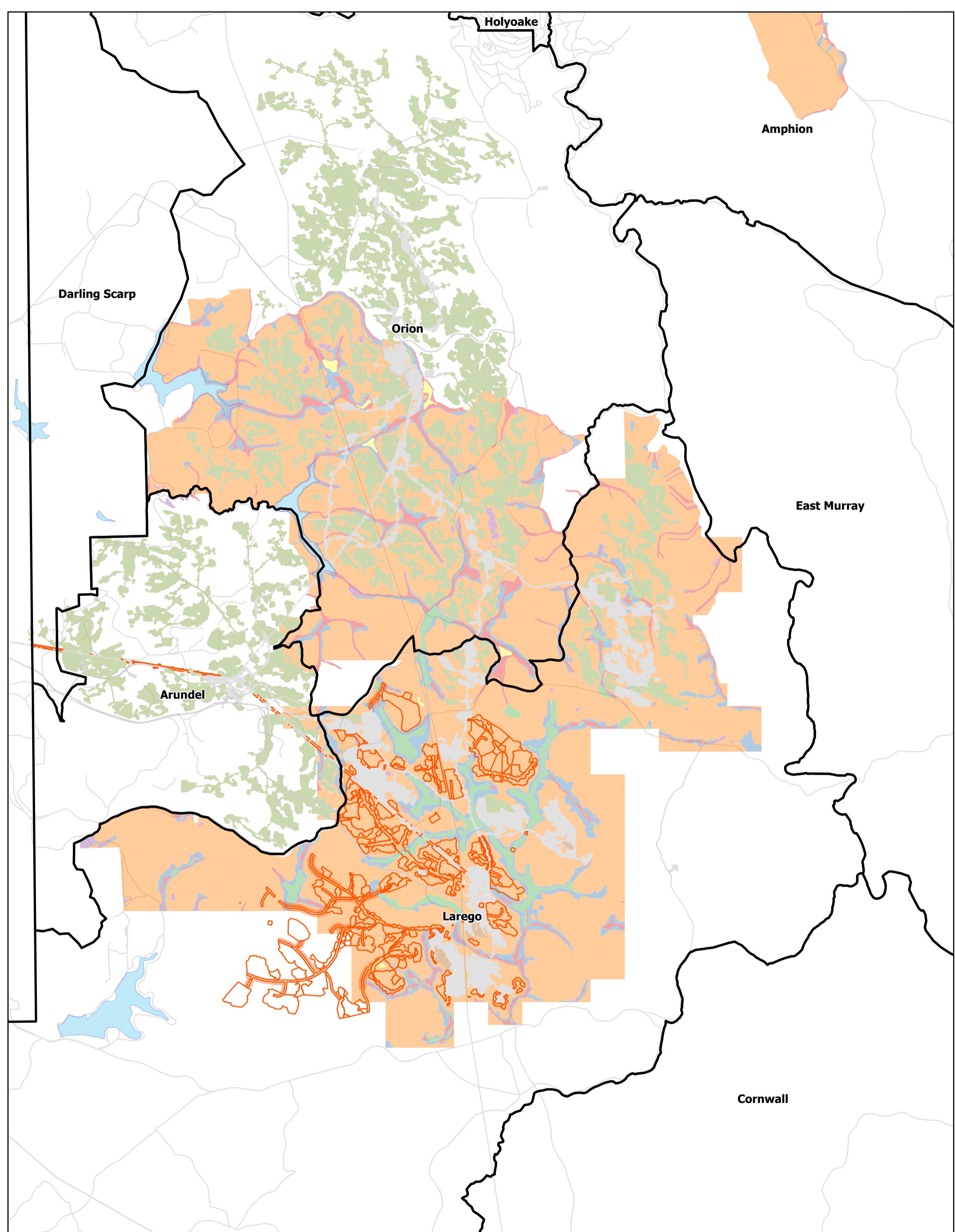
Description	Mapped extent area (ha)	Huntly mine area		Willowdale mine area	
		Area (ha)	Proportion of mine area (%)	Area (ha)	Proportion of mine area (%)
Mine rehabilitation These areas include either regrowth of native tree species or exotic eucalyptus trees. These areas generally have high value foraging habitat for Black Cockatoo species but lack trees of suitable age (trunk diameter) to have developed hollows of sufficient diameter and depth to be considered potentially suitable breeding trees for Black Cockatoos. These areas do however provide continuity of forest or woodland connectivity allowing fauna movement and foraging habitat for a range of species ground such as terrestrial reptiles, birds, small mammals.	22,526.6	13,767.3	13.9%	5,082.9	8.9%
Open Water (reservoir)	329.0	329.0	0.3%	-	0.0%
Cleared areas	7,262.3	4,784.7	4.8%	1,657.2	2.9%
Unsurveyed	589,791.4	15,400.7	15.6%	35,597.6	62.4%
Total Area	702,996.9	98,779.0	100.0%	57,006.5	100.0%



Legend		
24 Month Clearing Schedule	Rehabilitation	Flooded Gum Woodland
Conceptual Clearing Buffer	Cleared Areas	Granite Outcrop Association
Mining Regions	Blackbutt Forest	Jarrah Marri Forest
National Parks	Bullich Forest	Melaleuca Dampland
Major Dams		



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Figure 6-3: Indicative fauna habitats - Huntly	
Scale: 1:117,413	Date Printed: 30/10/2023



Legend

24 Month Clearing Schedule	Fauna Habitats	Jarrah Marri Forest
Conceptual Clearing Buffer	Blackbutt Forest	Melaleuca Dampland
Mining Regions	Bullich Forest	
Rehabilitation	Flooded Gum Woodland	
Cleared Areas	Granite Outcrop Association	
Major Dams		



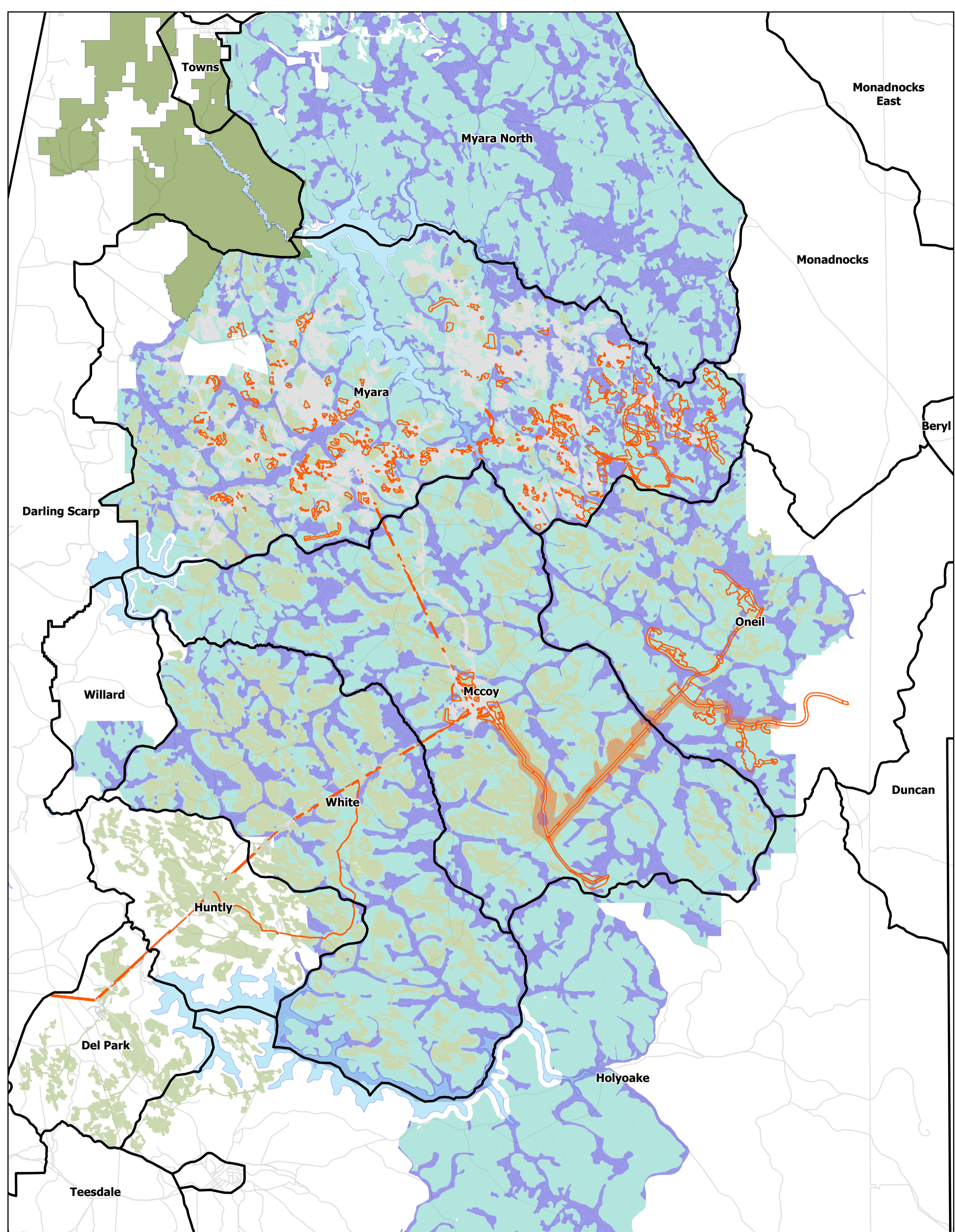
2023 – 2027 Mining and Management Plan	
Figure 6-4: Indicative fauna habitats - Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

6.1.2.2 Short Range Endemics

Vegetation units defined by Matiske, within the baseline study area, have been re-interpreted in relation to SRE invertebrates, based on factors considered important in defining fauna assemblages, including vegetation type and structure, substrate and position in the landscape. Each fauna habitat was then rated for its potential to support SREs (potential habitat rating; PHR) as follows:

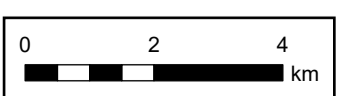
- High – defined/known areas of habitat that contain elements that often give rise to specialisation or dependency in invertebrate fauna, such as aspect (e.g. south-facing slopes, deeply incised gullies), geological features (e.g. granite), soil types that retain water (e.g. clay, loam).
- Low – areas of largely intact native vegetation that occur broadly across the landscape, are less incised and typically link more restricted habitats. This includes land that was cleared but has since been rehabilitated or is in the process of being rehabilitated.
- None – land that has been previously cleared for other uses that no longer contains native vegetation.

The indicative SRE habitat mapping is shown in Figure 6-5 and Figure 6-6 for Huntly and Willowdale mines, respectively.

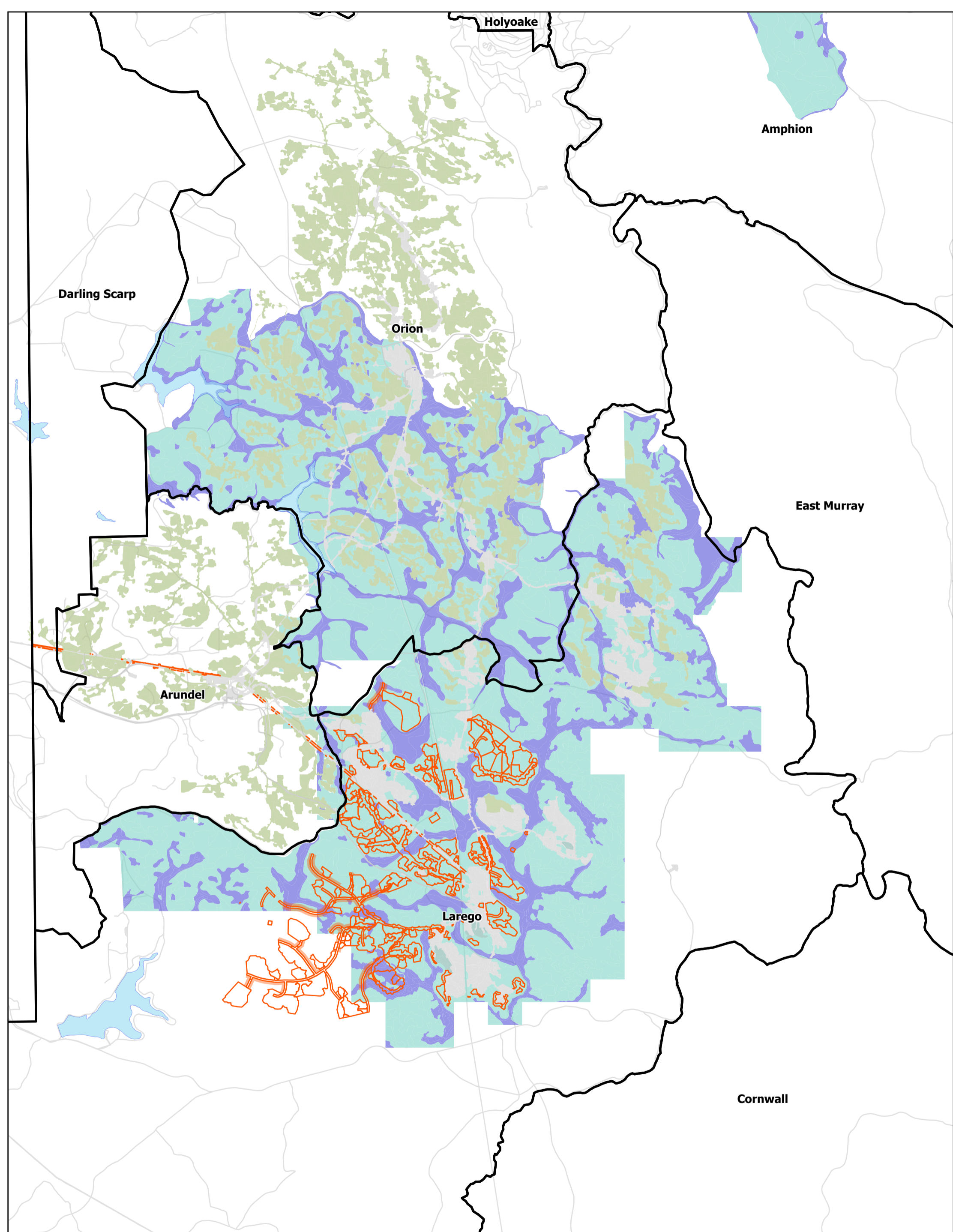


Legend

24 Month Clearing Schedule	Mining Regions
Conceptual Clearing Buffer	Rehabilitation
SRE Habitats Low	Cleared Areas
SRE Habitats High	National Parks
	Major Dams

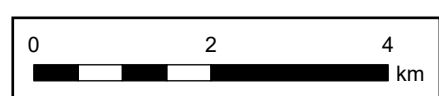


2023 – 2027 Mining and Management Plan	
Figure 6-5: Indicative SRE habitat - Huntly	
Scale: 1:117,413	Date Printed: 31/10/2023



Legend

24 Month Clearing Schedule	Mining Regions
Conceptual Clearing Buffer	Rehabilitation
SRE Habitats	Cleared Areas
Low	Major Dams
High	



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Figure 6-6: Indicative SRE habitat – Willowdale	
Scale: 1:85,380	Date Printed: 1/11/2023

6.1.3 Conservation Significant Fauna

The likelihood of occurrence of conservation significant fauna within the Huntly and Willowdale mine areas has been assessed, based on the species identified during desktop assessments and surveys, and search results from the EPBC Act PMST database, DBCA Threatened and Priority Fauna database, and Nature Map database (GHD 2022). The likelihood of occurrence assessment was based on species' biology, habitat requirements, the preliminary habitat types interpreted from vegetation mapping, and records of the species in the regions and locality.

In total 15 conservation significant species are known or likely to occur in the Huntly and Willowdale mine areas based on the Fauna LOO assessment Appendix 11). Nine are priority species, or other conservation significant species, listed by DBCA under the BC Act. Seven of the conservation significant species are listed as threatened under the EPBC Act or BC Act and comprise matters of national environmental significance (MNES). These include the following:

- Three Black Cockatoo species:
 - Baudin's Cockatoo (*Zanda baudinii*) – Endangered
 - Carnaby's Cockatoo (*Zanda latirostris*) – Endangered
 - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable
- Woylie (*Bettongia ogilbyi*) – Endangered
- Quokka (*Setonix brachyurus*) – Vulnerable
- Chuditch (*Dasyurus geoffroii*) – Vulnerable
- Carter's Freshwater Mussel (*Westralunio carteri*) - Vulnerable

Threatened species that were assessed as unlikely to occur in the Huntly and Willowdale mine areas include the Numbat (*Myrmecobius fasciatus*), Noisy Scrub Bird (*Atrichornis clamosus*) and Malleefowl (*Leipoa ocellata*). The Huntly and Willowdale mine areas may include suitable habitat for these species and, Numbat and Malleefowl have previously been recorded within the Huntly and Willowdale mine areas and the Noisy Scrub Bird previously recorded south of Dwellingup. The Noisy Scrub Bird was translocated into sites in the NJF from 1997-2003, however monitoring indicates that establishment of permanent populations was unsuccessful. The four species have not been in the regions nor recorded in the vicinity of the Huntly and Willowdale mine areas in recent decades and are considered locally extinct or very low densities likely to be below the level of survey detection.

No migratory bird species were considered likely to occur due to the lack of wetland habitats favoured by the species. The Flooded Gum Woodland and Melaleuca Dampland habitats are seasonally waterlogged and may have areas that are seasonally inundated, however they do not contain large areas of wading habitat with mudflat, grasses, sedges, rushes or reeds. The Huntly and Willowdale regions are unlikely to support populations of threatened birds that use such wetland habitats, such as the Australasian Bittern (*Botaurus poiciloptilus*) and Australian Painted Snipe (*Rostratula australis*).

The threatened aquatic invertebrate Carters Freshwater Mussel (*Westralunio carteri*) is known or likely to occur in the artificial perennial waterbodies (reservoirs) adjacent and downstream of the Huntly mine region. The species may disperse from water supply reservoirs into the Huntly mine area in the form of glochidia cysts attached to fish that swim upstream during periods of seasonal stream flow. Any juveniles that detach from their fish hosts and settle into sediments of seasonal streams or swamps are expected to die off during the subsequent sustained dry period (> 6 months) each year.

6.1.3.1 Black Cockatoo Habitat

Black cockatoo foraging habitat was mapped over the Huntly and Willowdale mine areas, based on the fauna habitat derived from the vegetation type mapping completed by Mattiske (2008-2022). The Huntly and Willowdale mine areas contain predominantly high-quality foraging habitat due to the prevalence of Jarrah Forest, which contains key foraging species including Marri, Jarrah and proteaceous species (Table 6-3). The mine areas comprise approximately 77% high quality foraging habitat for Forest Red-tailed Black Cockatoo (FRTBC) and approximately 78% high quality foraging habitat for Baudin's and Carnaby's Cockatoos. Other fauna habitats provide low to medium quality foraging habitat.

The Huntly and Willowdale mine areas are highly likely to support breeding by FRTBC and Baudin's Cockatoo (T. Kirkby, pers. Comm; GHD [2021a]).

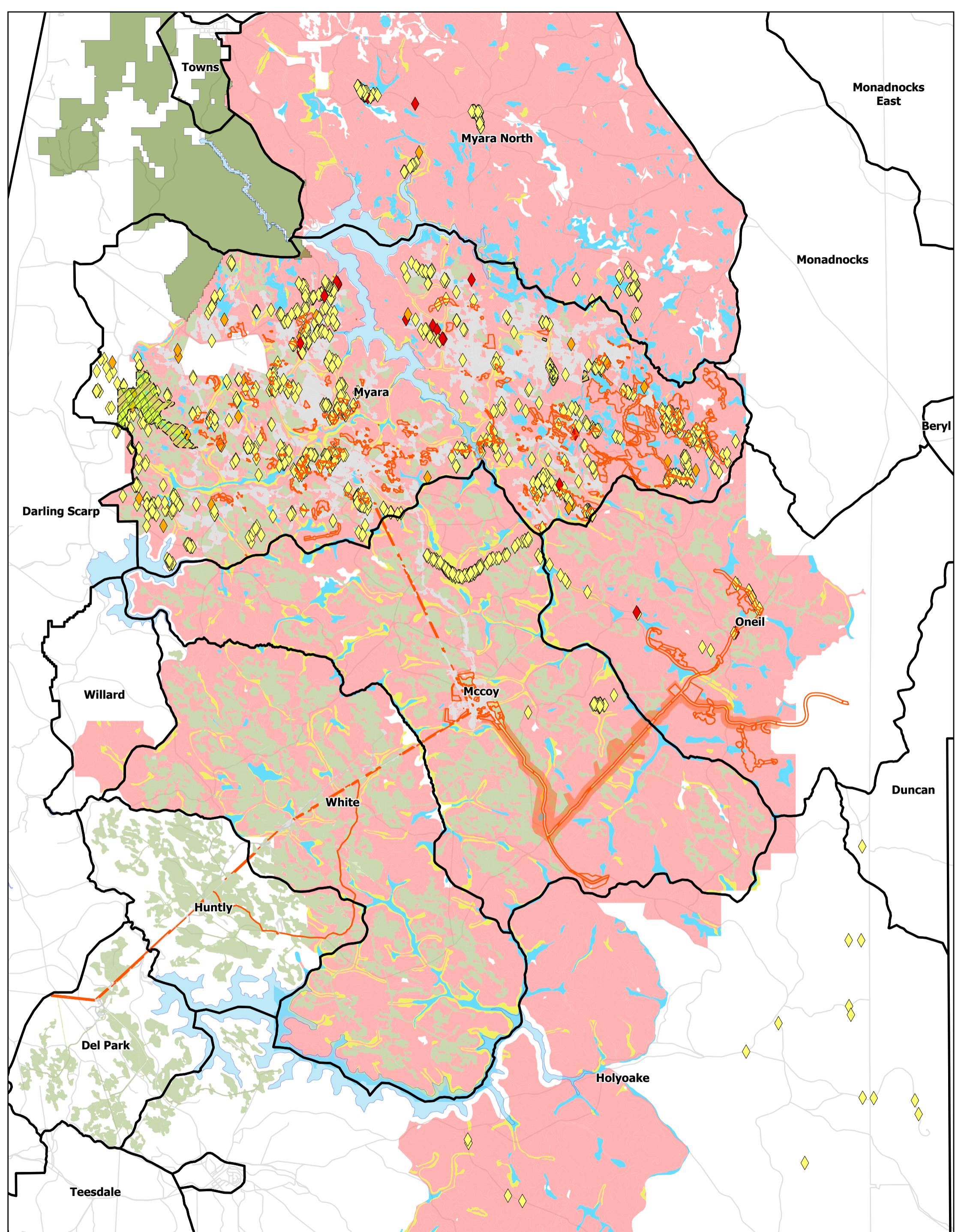
No confirmed roosting sites are located within the Huntly and Willowdale mine areas based on surveys data. However, it is highly likely that roosting occurs within these areas given the presence of high-quality foraging habitat, water sources, and large number of bird records.

Prior to the development of clearing plans, black cockatoo surveys are undertaken for all proposed disturbance areas to identify Black Cockatoo trees. All nest trees with a suitable hollow (size, entry angle, position), regardless of evidence of use, are protected irrespective of where they are located. Significant trees, which include marri with DBH>1500mm and Jarrah with DBH>2000mm, are also protected everywhere in the landscape. Ten metre radius buffers are applied to all these tree types. Habitat trees, which include marri trees with DBH>500mm are avoided for haul road clearing.

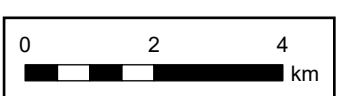
Black Cockatoo trees recorded to date and indicative foraging habitat values are shown in Figure 6-7 to Figure 6-10.

Table 6-3: Black Cockatoo foraging habitat in the Huntly and Willowdale mine areas

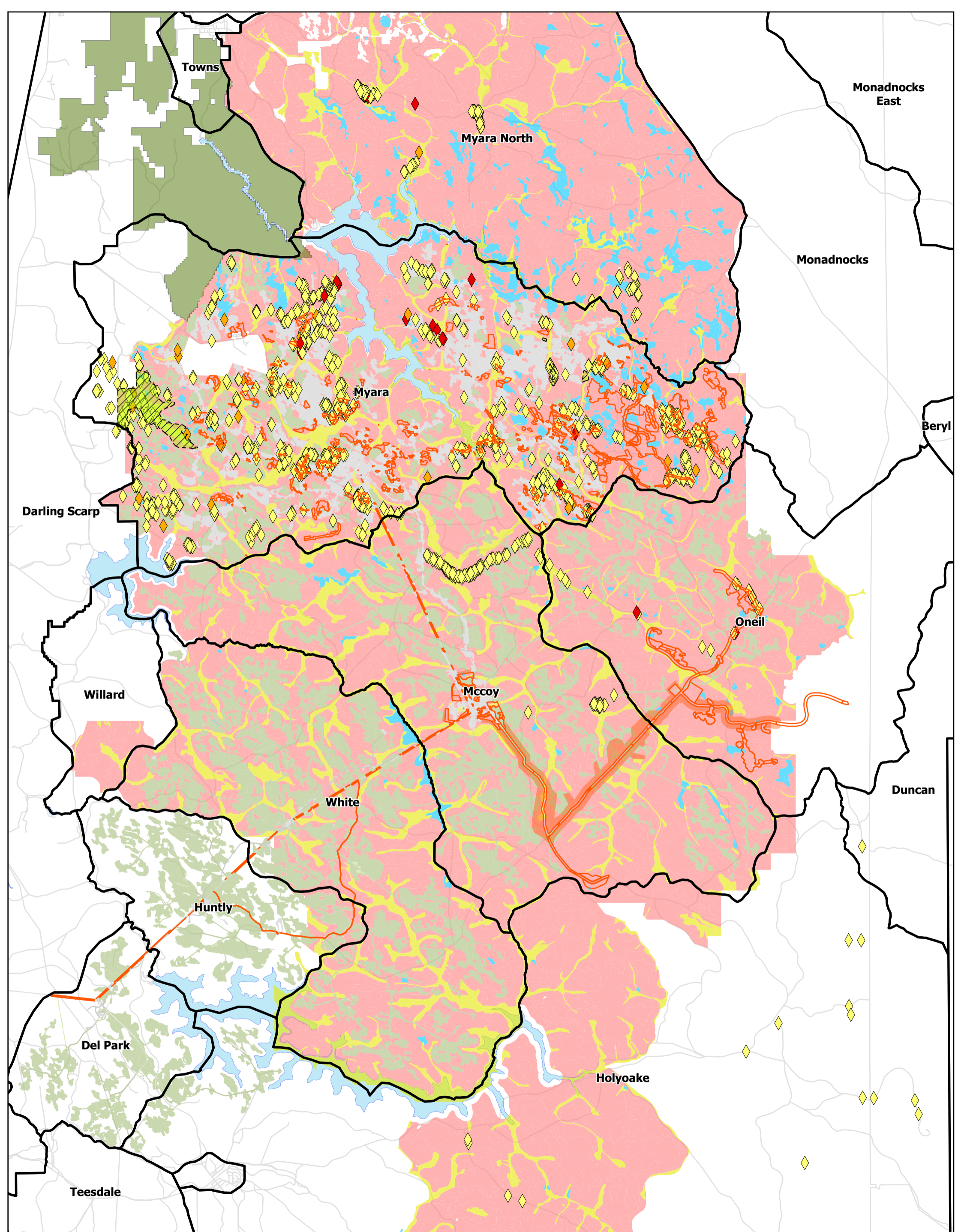
Fauna habitat type	Huntly				Willowdale			
	Area (ha)	Foraging habitat quality			Area (ha)	Foraging habitat quality		
		Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo		Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo
Blackbutt forest	2,791	High	Medium	Medium	924	High	Medium	Medium
Bullich forest	3,317	Medium	Medium	Medium	1,250	Medium	Medium	Medium
Flooded Gum woodland	2,970	Low	Medium	Medium	446	Low	Medium	Medium
Granite outcrop	1,513	Low	Low	Low	87	Low	Low	Low
Jarrah-Marri forest	52,974	High	High	High	11,926	High	High	High
Melaleuca dampland	932	None	Low	Low	42	None	Low	Low
Mine rehabilitation	13,767	Medium	Medium	Medium	5,083	Medium	Medium	Medium
Cleared and other land	4,785	None	None	None	1,657	None	None	None
Unsurveyed	15,401	n/a	n/a	n/a	35,598	n/a	n/a	n/a
Foraging habitat quality summary								
High		55,765	52,974	52,974		12,850	11,926	11,926
Medium		17,085	22,845	22,845		6,333	7,703	7,703
Low		4,483	2,445	2,445		533	129	129
None		5,717	4,785	4,785		1,699	1,657	1,657
Unsurveyed		15,401	n/a	n/a		35,598	n/a	n/a
Total		98,450	48,107	48,107		57,012	57,292	57,292



Legend		
24 Month Clearing Schedule	Forest Red-tailed Black Cockatoo High	Black Cockatoo Nests Habitat tree
Conceptual Clearing Buffer	Forest Red-tailed Black Cockatoo Medium	Nest tree
Mining Regions	Forest Red-tailed Black Cockatoo Low	Significant tree
National Parks	Black Cockatoo Protection Zones	
Major Dams		
Rehabilitation		
Cleared Areas		

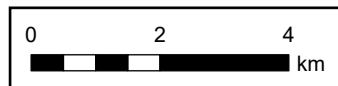


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Figure 6-7: Black Cockatoo records and Forest Red-Tailed Black Cockatoo indicative habitat - Huntly	
Scale: 1:117,413	Date Printed: 31/10/2023



Legend

24 Month Clearing Schedule	Baudin's & Carnaby's Cockatoo (Foraging Habitat Quality) High	Black Cockatoo Nests Habitat tree
Conceptual Clearing Buffer	Baudin's & Carnaby's Cockatoo (Foraging Habitat Quality) Medium	Nest tree
Mining Regions	Baudin's & Carnaby's Cockatoo (Foraging Habitat Quality) Low	Significant tree
National Parks	Black Cockatoo Protection Zones	
Major Dams		
Rehabilitation		
Cleared Areas		

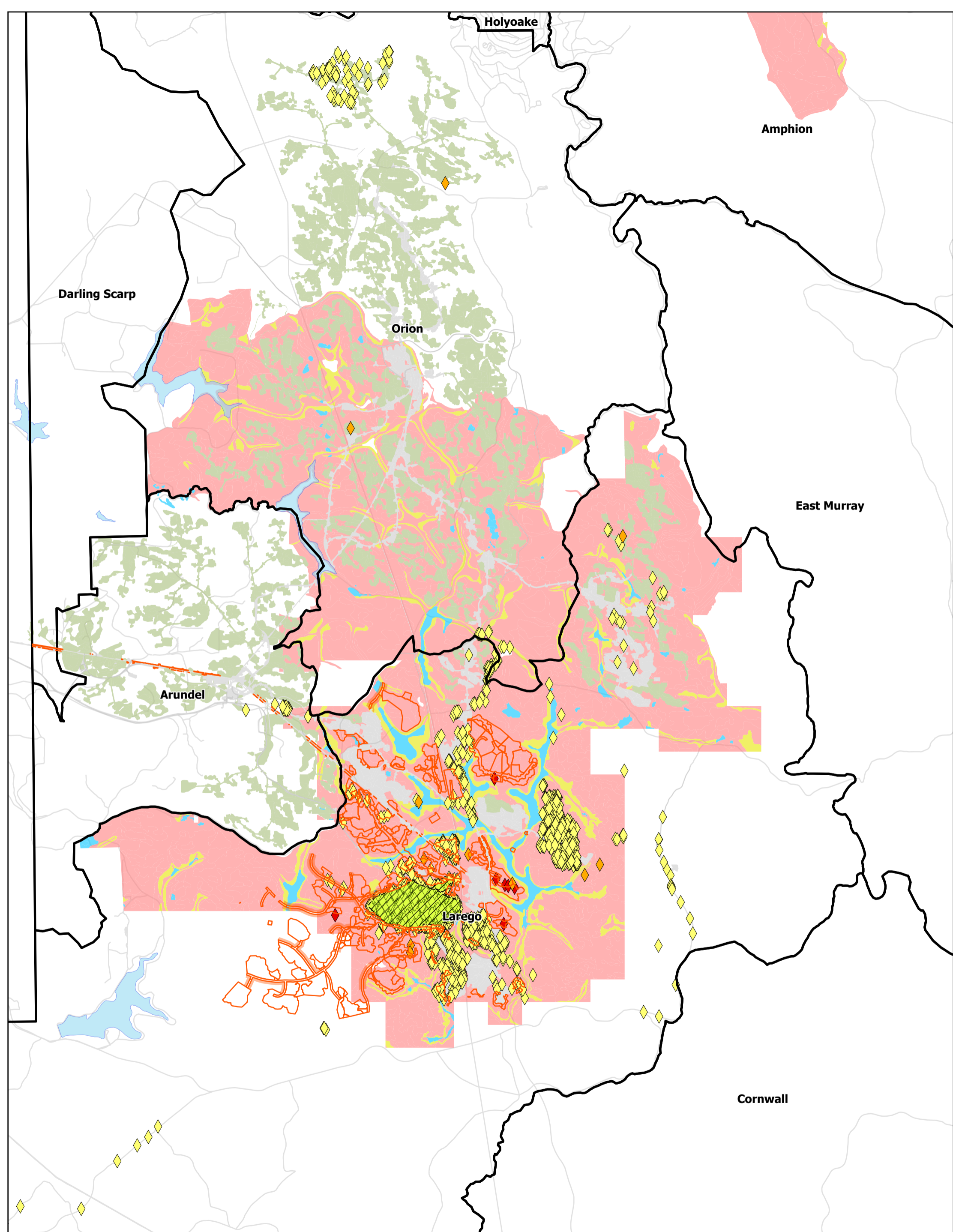


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Figure 6-8: Black Cockatoo records and Baudin's & Carnaby's Black Cockatoo indicative habitat - Huntly

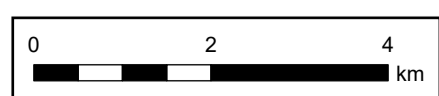
Scale: 1:117,413

Date Printed: 31/10/2023



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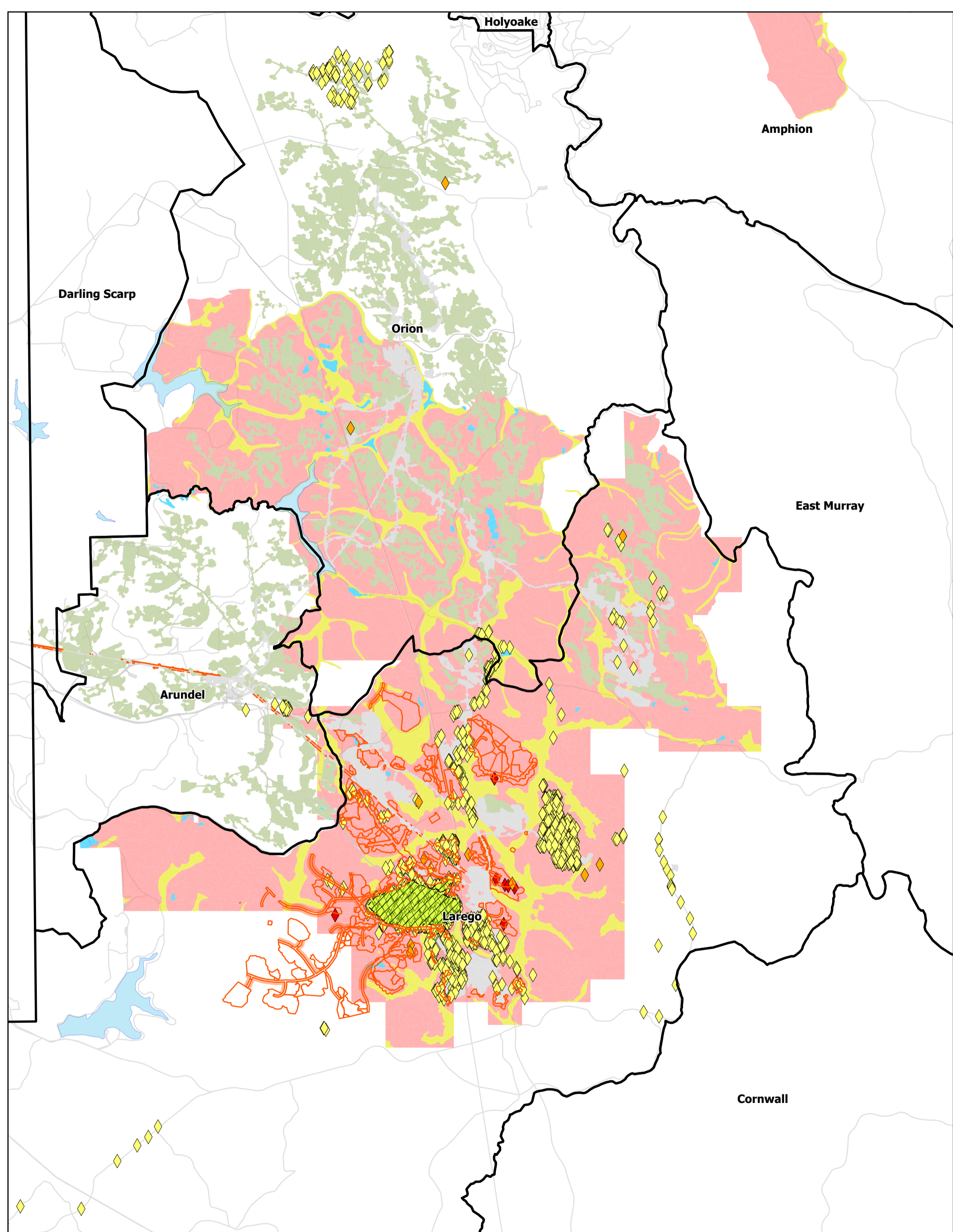
24 Month Clearing Schedule	Forest Red-tailed Black Cockatoo	Black Cockatoo Nests
Conceptual Clearing Buffer	High	Habitat tree
Mining Regions	Medium	Nest tree
Major Dams	Low	Significant tree
Rehabilitation	Black Cockatoo Protection Zones	
Cleared Areas		



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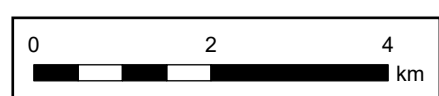
Figure 6-9: Black Cockatoo records and Forest Red-Tailed Black Cockatoo indicative habitat – Willowdale

Scale: 1:85,380	Date Printed: 3/11/2023
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Legend

24 Month Clearing Schedule	Baudin's & Carnaby's Cockatoo (Foraging Habitat Quality)	Black Cockatoo Nests
Conceptual Clearing Buffer	High	Habitat tree
Mining Regions	Medium	Nest tree
Major Dams	Low	Significant tree
Rehabilitation	Black Cockatoo Protection Zones	
Cleared Areas		



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Figure 6-10: Black Cockatoo records and Baudin's & Carnaby's Black Cockatoo indicative habitat - Willowdale

Scale: 1:85,380	Date Printed: 3/11/2023
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6.2 Potential Environmental Impacts

The mine activities may result in the following potential direct and indirect impacts to terrestrial fauna:

- Direct impacts to terrestrial fauna as a result of clearing.
- Direct impacts to terrestrial fauna as a result of injury/mortality from fauna entrapment or vehicle/equipment collisions.
- Indirect impacts to fauna as a result of:
 - Introduction and/or spread of weeds.
 - Introduction and/or spread of dieback.
 - Attraction of feral animals.
 - Light emissions from infrastructure.
 - Noise emissions from construction and operational equipment
 - Spills and/or leaks from storage and handling of hazardous materials and waste.

6.2.1 Direct impacts as a result of clearing - Huntly

The proposed 24 Month Clearing Schedule will directly impact fauna habitat as provided in Table 6-4 below. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 6-3.

Table 6-4: Proposed clearing by fauna habitat – Huntly

Fauna Habitat	Mapped extent (ha)	24 Month Clearing Schedule Area (ha)	% of clearing	% of Mapped extent
Blackbutt Forest	3,959.0	12.6	0.7%	0.3%
Bullich forest	4,642.7	20.5	1.2%	0.4%
Flooded Gum woodland	3,624.7	5.4	0.3%	0.1%
Granite outcrop	1,615.9	8.5	0.5%	0.5%
Jarrah – Marri forest	68,268.3	1,480.5	87.7%	2.2%
Melaleuca damp land	976.9	4.0	0.2%	0.4%
Mine rehabilitation	22,526.6	96.8	5.7%	0.4%
Open Water (reservoir)	329.0	-	0.0%	0.0%
Cleared areas	7,262.3	9.1	0.5%	0.1%
Sub-total	113,205.5	1,637.5	97.0%	1.4%
Unsurveyed	589,791.4	50.2	3.0%	0.0%
Total	702,996.9	1,687.6	100.0%	0.2%

6.2.2 Direct loss of conservation significant fauna habitat - Huntly

The proposed 24 month clearing will directly impact fauna habitat suitable for a number of conservation significant species.

Jarrah-Marri forest habitat is used by the majority of conservation significant fauna species, which is associated with lateritic soils with potential economic bauxite that may be subject to mining. The Jarrah-Marri forest habitat type is widely distributed across the NJF with the 24 month clearing areas impacting 2% of the mapped extent. However, similar to vegetation types, this fauna habitat is considered to be widely distributed and represented within the NJF.

Portions of Melaleuca dampland and Flooded Gum woodland may provide valuable habitat for Quokka, Woylie, Rakali and Quenda, which prefer dense riparian and swamp habitat. The riparian and swamp habitats will be subject to limited clearing, predominantly for haul road or conveyor crossings. Haul roads have potential to cause fragmentation of riparian and swamp habitats by disrupting fauna movements along riparian and swamp corridors.

Carters Freshwater Mussel is unlikely to be present in seasonally flowing streams or seasonal river pools. However, targeted surveys will be completed for haul road crossing over streams for Carters Freshwater Mussel as they can exist in permanent aquatic systems.

All Black Cockatoo nest trees with a suitable hollow (size, entry angle, position), regardless of evidence of use, will be avoided. Significant trees, which include marri with DBH>1500mm and Jarrah with DBH>2000mm, are also to be avoided. Ten metre radius buffers are applied to all these tree types. Habitat trees, which include marri trees with DBH>500mm are avoided for haul road clearing. Black Cockatoo nest trees are located within the 24 Month Clearing Schedule, as the locations are confirmed prior to clearing and then avoidance measures are implemented. A summary of 24 Month Clearing Schedule impacts to potential foraging habitat for Black Cockatoos is provided in Table 6-5. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 6-7 and Figure 6-8.

Table 6-5: Indicative estimates of direct impacts to Black Cockatoo foraging habitat – Huntly

Fauna habitat type	Foraging habitat area (ha)			Foraging habitat proportion of mapped extent		
	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo
High	1,493.1	1,480.5	1,480.5	2.1%	2.2%	2.2%
Medium	117.3	135.3	135.3	0.4%	0.2%	0.2%
Low	13.9	12.5	12.5	0.3%	0.8%	0.5%
None	13.1	9.1	9.1	0.2%	0.1%	0.1%
Unsurveyed	50.2	50.2	50.2	-	-	-
Total	1,687.7	1,687.7	1,687.7	1.5%	1.5%	1.5%

6.2.3 Direct impacts as a result of clearing - Willowdale

The proposed 24 Month Clearing Schedule will directly impact fauna habitat as provided in Table 6-6 below. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 6-4.

Table 6-6: Proposed clearing by fauna habitat – Willowdale

Fauna Habitat	Mapped extent (ha)	24 Month Clearing Schedule Area (ha)	% of clearing	% of Mapped extent
Blackbutt Forest	3,959.0	0.7	0.1%	0.0%
Bullich forest	4,642.7	6.7	0.9%	0.1%
Flooded Gum woodland	3,624.7	2.6	0.3%	0.1%
Granite outcrop	1,615.9	0.7	0.1%	0.0%
Jarrah – Marri forest	68,268.3	701.8	90.0%	1.0%
Melaleuca dampland	976.9	1.1	0.1%	0.1%
Mine rehabilitation	22,526.6	-	0.0%	0.0%
Open Water (reservoir)	329.0	-	0.0%	0.0%
Cleared areas	7,262.3	0.0	0.0%	0.0%
Sub-total	113,205.5	713.7	91.5%	0.6%
Unsurveyed	589,791.4	66.6	8.5%	0.0%
Total Area	702,996.9	780.2	100.0%	0.1%

6.2.4 Direct loss of conservation significant fauna - Willowdale

The proposed 24 month clearing will directly impact fauna habitat suitable for a number of conservation significant species.

Jarrah-Marri forest habitat is used by the majority of conservation significant fauna species, which is associated with lateritic soils with potential economic bauxite that may be subject to mining. The Jarrah-Marri forest habitat type is widely distributed across the NJF with the 24 month clearing areas impacting 1% of the current mapped extent. However, similar to vegetation types, this fauna habitat is considered to be widely distributed and represented within the NJF.

Portions of Melaleuca dampland and Flooded Gum woodland may provide valuable habitat for Quokka, Woylie, Rakali and Quenda, which prefer dense riparian and swamp habitat. The riparian and swamp habitats will be cleared predominantly for haul road or conveyor crossings, which will cause limited clearing. Haul roads have potential to cause fragmentation of riparian and swamp habitats by disrupting fauna movements along riparian and swamp corridors.

Carters Freshwater Mussel is unlikely to be present in seasonally flowing streams or seasonal river pools. However, Carters Freshwater Mussel could exist in permanent aquatic systems, therefore targeted surveys will be completed for haul road crossing over streams.

All Black Cockatoo nest trees with a suitable hollow (size, entry angle, position), regardless of evidence of use, will be avoided. Significant trees, which include marri with DBH>1500mm and Jarrah with DBH>2000mm, are also to be avoided. Ten metre radius buffers are applied to all these tree types. Habitat trees, which include marri trees with DBH>500mm are avoided for haul road clearing. Black Cockatoo nest trees are located within the 24 Month Clearing Schedule, as the locations are confirmed prior to clearing and then avoidance measures are implemented. A summary of impacts to potential foraging habitat for Black Cockatoos is provided in Table 6-7. The potential impacts from the 24 Month Clearing Schedule are shown in Figure 6-9 and Figure 6-10.

Table 6-7: Indicative estimates of direct impacts to Black Cockatoo foraging habitat - Willowdale

Fauna habitat type	Foraging habitat area (ha)			Foraging habitat proportion of mapped extent		
	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo
High	702.5	701.8	701.8	1.0%	1.0%	1.0%
Medium	6.7	9.9	9.9	0.0%	0.0%	0.0%
Low	3.3	1.9	1.9	0.1%	0.1%	0.1%
None	1.1	0.0	0.0	0.0%	0.0%	0.0%
Unsurveyed	66.6	66.6	66.6	-	-	-
Total	780.2	780.2	780.2	0.7%	0.7%	0.7%

6.2.5 Direct impacts of injury/mortality from fauna entrapment or vehicle/equipment collisions

Fauna are at risk of injury or mortality due to interaction with heavy and light vehicles undertaking vegetation clearing, transportation or mining activities. Fauna may also potentially become entrapped within mining infrastructure such as water storages or excavations.

Interaction between vehicles/machinery and fauna is most likely to occur during vegetation clearing as resident fauna could potentially be struck by vehicles undertaking the activity. Due to the progressive nature of mining, there is suitable similar native vegetation for fauna to take refuge or find suitable alternate habitat, provided they are allowed the opportunity to displace.

Fauna interaction with vehicles may also occur along transport routes, however fauna are more likely to inhabit areas away from mining activity and transport routes due to the associated noise, vibration and dust impacts.

6.2.6 Indirect impacts

6.2.6.1 Introduction and/or spread of weeds

The mine regions contains vegetation communities vulnerable to weed invasion, particularly valley and swamp habitats that are restricted in distribution, retain soil moisture and provide important habitat for conservation significant fauna (Chuditch and Quokka). Granite outcrops are typically (though not always) higher in the landscape but may still be located adjacent, downhill or downstream of weed

invasion that may then spread into the outcrops. Granite outcrops can also retain moisture through seepage faces at the base of outcrops and provide important habitat for Chuditch, priority fauna and reptiles.

Interactions with swamps, valleys and granite outcrops is minimised and the greatest potential for weeds to spread into these restricted distribution habitats will be via stormwater runoff and creek flow. The spread of weeds into swamps and creeks may impact the vegetation composition through competition with native species, however the impact to fauna is uncertain. Weeds are not listed as a threatening process to any of the threatened fauna that are known or likely to occur. The associated mitigation measures are detailed in Section 6.3.

6.2.6.2 Introduction and/or spread of dieback

Dieback spread into uninfested areas can result in a transition from Jarrah dominant forest with a diverse understorey to open woodlands with Marri dominant canopy and sedge dominant understorey. The associated mitigation measures are detailed in Section 6.3.

The effects of Dieback on fauna can include a loss of Jarrah and proteaceous understorey foraging resources for Black Cockatoos, including the loss of breeding trees (noting that Jarrah is less likely to form hollows than Marri). Dieback (and other forest diseases) is listed as a threatening process for Carnaby's Cockatoo.

Dieback is listed as threatening process for Quokka due to changes to floristic composition and vegetation structure favoured by Quokka. Other herbivorous fauna may also be affected by the loss of flora diversity and vegetation structure caused by Dieback.

6.2.6.3 Attraction of feral animals

The Feral Pig, Feral Cat, European Fox and European Rabbit are considered key threatening processes, and are threats to fauna species listed under the EPBC Act. These species are key threats to the EPBC Act listed species recorded or likely to occur in the Huntly and Willowdale mines: three Black Cockatoo species, Chuditch, and Quokka. The associated mitigation measures are detailed in Section 6.3.

Habitat disturbance from the Feral Pig (*Sus scrofa*) was notable in fauna habitat types that support conservation significant fauna species during the Myara North and Holyoake terrestrial surveys (GHD 2021a; 2021b), and throughout other regions noted during LTFMP and other environmental activities.

Feral Cat is a known threat to the Quokka and Woylie, Numbat and Malleefowl (DEE 2013). Feral cats have been recorded across both Huntly and Willowdale during culvert monitoring and the LTFMP.

The European Fox is a known threat to the Malleefowl, Numbat, Quokka, Woylie and Chuditch (DEE 2013). While no records confirming their presence within the Huntly or Willowdale sites have been collected, foxes are presumed to occur as indicated by their known range.

The European Rabbit is a known threat to the Chuditch (DEE 2016). The European Rabbit has been recorded across both Huntly and Willowdale during the LTFMP.

6.2.6.4 Spills and/or leaks from storage and handling of hazardous materials and waste

The majority of spills and leaks, particularly those from major incidents and involving large volumes, are expected to be identified quickly and the contaminated soils excavated and disposed off-site at a licensed waste facility. The associated mitigation measures are detailed in Section 6.3.

Small spills of diesel and oil that escape detection and remediation will predominantly remain as in-situ soil contamination rather than migrating into streams. All mine pits and haul roads will be rehabilitated post mining, and any un-identified minor soil contamination arising from small spills and leaks will be overlaid with overburden, topsoil and establishing native. Pockets of soil contamination remaining in the rehabilitation are expected to biodegrade over time.

The majority of spills and leaks, particularly those from major incidents and involving large volumes, are expected to be identified quickly and the contaminated soils excavated and disposed off-site at a licensed waste facility.

6.2.6.5 Noise and light emissions

Construction and mining operations generate noise and light emissions which can disturb or displace fauna, causing them to avoid using habitat in impacted areas. Construction is limited to day time operations where practicable. Mining, haulage and mine facilities operate 24 hours a day. The associated mitigation measures are detailed in Section 6.3.

Construction areas operating at night will be illuminated by mobile towers. Mine facilities will be illuminated by permanent lighting whereas mine pits will be illuminated by mobile towers to ensure safe mining operations. Haul trucks conducting night time haulage will use headlights.

Night time noise and light emissions may disturb nocturnal fauna including Chuditch, Quokka, Western False Pipistrelle and Masked Owl.

The effect of noise and light emissions on fauna will be localised and temporary for the duration of construction or mine pit operations in a given area, following which sensitive fauna are expected to recolonise the area. Mine facilities and primary haul roads will operate over a longer timeframe, which may result in a longer period of disturbance to highly sensitive fauna.

6.2.7 Cumulative Impacts

6.2.7.1 Past and present activities

The NJF subregion has been subject to environmental impacts from a range of past and present activities, with the key activities in order of area of disturbance as follows:

- Agriculture.
- Timber harvesting.
- Prescribed burning.
- Bauxite and gold mining.
- Plantations.
- Water supply reservoirs.

Agriculture and timber harvesting have caused widespread impacts including:

- Loss of biodiversity and habitat from permanent clearing.
- Long term loss of mature trees and associated hollows from timber harvesting.
- Spread of *Phytophthora* Dieback in forested areas from timber harvesting.
- Agricultural impacts to soils including erosion, salinity, compaction and acidification.
- Secondary salinity impacts to the Murray and Avon rivers from permanent clearing.
- Conversion of natural landscape to rural character and conversion of old growth forest to juvenile to immature forest age.

Mining has caused impacts as follows:

- Short to medium term ecological and amenity impacts during operations and until rehabilitation establishes.
- Long term loss of fauna habitats.
- Rehabilitation restoring varying biodiversity, ecological integrity and landscape quality.

Prescribed burning is undertaken to reduce the severity and extent of wildfires, which can have significant ecological, water quality and amenity impacts.

Water supply reservoirs have caused localised loss of incised river valley landforms and vegetation and widespread disruption to aquatic fauna migrations and dispersal, however they have created perennial waterbodies that provide refuges for aquatic fauna.

6.2.7.2 Reasonably foreseeable future activities

Reasonably foreseeable future activities within the NJF subregion include approved and proposed mining. The majority of Jarrah forest cleared for mining is expected to be rehabilitated.

The WA Government has announced an end to native forest logging in 2024, at which point FPC will continue its independent logging activities within areas that have been approved for mining.

Prescribed burning is expected to continue within the subregion in accordance with the WA Government's strategy to reduce fuel loads and minimise the likelihood and severity of large scale wildfires.

Other future activities within the subregion may include future urban or rural residential development and infrastructure development and agriculture, which are expected to be relatively minor and subject to regulation under Part V of the EP Act.

6.2.7.3 Fauna Cumulative Impacts

Cumulative impacts on the fauna within the NJF subregion may be due to the following:

- Mining and rehabilitation.
- Fragmentation.
- Timber harvesting.
- Climate change and wildfire.
- Disease and weed invasions.

Table 5-21 presents an overview of cumulative impacts of the MMP and other developments and processes to flora and vegetation in the NJF subregion. The scale of impacts to vegetation can be considered to be similar to fauna habitat.

A breakdown of Alcoa's existing and future clearing impacts is included in Table 6-8. The Huntly Ten Year Mine Plan consists of the Revised Proposal clearing within Myara North and Holyoake. The Willowdale ten Year Mine Plan predominately consists of ore shells, which may under-estimate clearing requirements. The conceptual clearing buffer and areas historically endorsed under FCAs, which are not considered likely to be cleared are shown, however are excluded from future mine area totals.

Future mine areas could impact up to 4% of the NJF subregion. However, this fauna habitat, which supports a range of conservation significant species is considered to be widespread throughout the NJF. Other fauna habitats are less widespread and potential impacts are less than 4% of the current mapped extent.

Table 6-8: Overview of Alcoa cumulative impacts to fauna habitat

Conservation Significant Vegetation	Mapped Extent	Buffer		24 Month Clearing Schedule (ha)		FCA Endorsed Clearing (ha)		Five Year Mine Plan (ha)		Ten Year Mine Plan (ha)		Total future mined area (ha)	Proportion of VT mapped (%)
		HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL	HUN	WDL		
Clearing amount	-	726.3	103.4	1,687.7	780.2	791.7	280.8	1,390.5	628.1	8,075.4	841.2	12,007.7	-
Blackbutt forest	3,959.0	4.6	1.1	1.1	12.6	0.7	5.9	2.3	2.2	0.2	36.4	0.0	47.0
Bullich forest	4,642.7	20.5	8.1	8.1	20.5	6.7	6.6	10.0	5.6	6.6	31.1	8.2	68.1
Flooded Gum woodland	3,624.7	12.1	3.6	3.6	5.4	2.6	1.7	4.5	3.1	1.0	20.2	-	30.5
Granite outcrop	1,615.9	2.1	-	-	8.5	0.7	22.5	0.1	0.8	-	60.5	-	83.8
Jarrah – Marri forest	68,268.3	480.3	57.4	57.4	1,480.5	701.8	720.2	218.9	930.1	380.8	7,780.7	408.3	10,439.1
Melaleuca dampland	976.9	3.8	0.9	0.9	4.0	1.1	0.8	-	1.4	0.9	31.9	-	34.9
Total	83,087.6	523.5	71.1	71.1	1,531.5	713.6	757.7	235.7	943.2	389.4	7,960.8	416.5	10,703.3

6.3 Mitigation

Alcoa's environmental management incorporates the mitigation hierarchy consistent with industry guidance, which is in order of priority:

- Impact avoidance
- Impact minimisation
- Rehabilitation.

A risk-based approach has been taken to align with Alcoa's environmental management system and management plans. Associated mitigation actions are provided in Table 6-9 as a risk register and risk assessment methodology is provided in Appendix 3 .

Key mitigations include:

- New mine regions (for example, portions of O'Neil which have not been previously disturbed) will have basic/detailed surveys undertaken.
- Black Cockatoo targeted surveys are undertaken as part of pre-clearance surveys.
- Black Cockatoo nest and significant trees are avoided with an associated 10m buffer.
- All stream crossings (within Quokka habitat) are designed and constructed to minimise ecological and hydrological impact.
- Development of Mining Avoidance Zones for the following:
 - Black Cockatoo nest trees, significant trees and associated 10m buffer as per 'Survey and Management of Black Cockatoo Habitats' (Alcoa internal procedure - Doc no. AUACDS-2053-3273).
- Development of Mining Exclusion Zones, where practicable, for the following:
 - Carter's Freshwater Mussel populations.
 - Swamp and stream zone fauna habitats and associated buffers.
- Pre-clearance displacement, monitoring and trapping is implemented to minimise impacts to conservation significant fauna, in particular Chuditch and Quokka.

As noted throughout this document, FPC are responsible for harvesting timber, which is associated with the most significant proportion of clearing.

Alcoa remains focussed on opportunities to continue to improve understanding of fauna impacts and obtain further data in that regard. One of these opportunities is gaining more baseline survey data, to further develop mitigation measures and monitoring, to further minimise impacts. Alcoa intends to achieve this opportunity by implementing an improvement plan (Figure 6-11) which includes the following:

- Implement the Fauna Management Plan (FMP; Appendix 12) which details management objectives and targets, with associated management measures. Alcoa is committed to implementing the FMP as per improvement plan timeframes by 31 December 2024

(Commitment 17). Any revisions to the FMP will be done in consultation with DBCA to ensure expected mitigations and methodologies are included (Commitment 19).

- Undertake baseline and pre-clearance survey requirements outlined in Table 1-9 of the FMP.

This includes undertaking:

- Basic/detailed surveys for conceptual clearing areas in new mine regions with reports submitted as part of the MMP.
 - Targeted Black Cockatoo surveys as per current guidance with reports submitted as part of FCAs.
 - Targeted fauna surveys for Threatened species in Conceptual Clearing areas where potential habitat exists. Reports will be submitted as part of FCAs
 - undertake targeted surveys and associated risk avoidance & management for all future clearing under the MMP where reasonably practicable, as per the FMP (Commitment 18).
 - Pre-clearing displacement, monitoring and trapping to minimise likelihood of fauna injury or mortality from clearing activities. The level of displacement activities is dependent on prior FPC harvesting activities.
- Include environmental impact assessment as part of this MMP, based on information available.
 - Update of the FMP, once additional surveys and monitoring data becomes available, as part of the FMP adaptive management process.

Implementation of the FMP has already commenced, however implementation will be staggered as per the Improvement Plan (Figure 6-11), following approval as part of this submission. This includes undertaking Havel vegetation mapping and the associated fauna habitat mapping, and Targeted fauna surveys prior to clearing. Available Fauna reports will be provided in FCAs submitted from Q2 2024.

Figure 6-11: Fauna Improvement Plan

Legend			Indicative Schedule											
In Progress	Consultation	Complete	Implementation	2023			2024				2025			
				Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		Expected Completion												
Fauna	Fauna													
	Fauna Management Plan	Complete												
	Fauna Monitoring Program	Q4 2024												
	Feral Monitoring Program	Q4 2024												
	Fauna Underpass Monitoring Program	Q4 2024												
	Myara Central													
	Baseline survey – existing mine regions (Fauna Habitat Mapping based on Havel Vegetation Mapping)	Q1 2024												
	Targeted Survey - Black Cockatoo	Q1 2024												
	Targeted Survey - Carter's Freshwater Mussel	Q1 2024												
	Targeted Survey - Chuditch, Quokka, Woylie	Q1 2024												
	Willowdale													
	Baseline survey – existing mine regions (Fauna Habitat Mapping based on Havel Vegetation Mapping)	Q1 2024												
	Targeted Survey - Black Cockatoo	Q1 2024												
	Targeted Survey - Carter's Freshwater Mussel	Q1 2024												
	Targeted Survey - Chuditch, Quokka, Woylie	Q1 2024												
	O'Neil													
	Baseline survey – existing mine regions (Fauna Habitat Mapping based on Havel Vegetation Mapping)	Complete												
	Baseline survey – new mine regions (As per EPA Guidelines - basic/detailed survey)	Q2 2024												
	Targeted Survey - Black Cockatoo	Q2 2024												
	Targeted Survey - Carter's Freshwater Mussel	Q2 2024												
Targeted Survey - Chuditch, Quokka, Woylie	Q2 2024													

Table 6-9: Avoidance and minimisation of potential impacts to terrestrial fauna

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Direct loss to fauna habitat	Decrease in fauna population sizes and extent	<ul style="list-style-type: none"> Provision of Mining Avoidance and Exclusion Zones as per the Fauna Management Plan Black Cockatoo Protection Zones may be established, whereby no mining activities will occur. Protection Zones may include high quality foraging habitat, high density of nest and/or habitat trees or permanent water sources 	<ul style="list-style-type: none"> Conduct baseline and pre-clearance fauna surveys (vertebrate, aquatic and SRE invertebrate) as per Fauna Management Plan. Detailed infrastructure and mine plans minimise clearing where possible and are designed to minimise impacts to breeding habitat. Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. Clearing procedures/process (clearing boundary for approved clearing areas). Clearing lines in work pack and GIS (tablet within dozer, procedures to ensure clearing in approved areas). Increase the area (ha) in which rehabilitation activities are being undertaken each year over the next 4 years on a rolling basis, achieving a minimum 	<ul style="list-style-type: none"> Rehabilitation to meet Completion Criteria. Rehabilitation to re-instate potential fauna habitat. Installation of constructed fauna habitat as per 'Build Fauna Habitat' (Doc no. AUSCDS02053-223). 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			of 3,159 ha of rehabilitation (cumulative) over this period (2024-2027) (Commitment 11) <ul style="list-style-type: none"> Regulatory approval process (MMP/FCA) stipulates approved clearing areas. Native fauna interactions reported in register. 		
Direct loss to suitable breeding habitat for threatened fauna	Loss of breeding habitat for threatened fauna	<ul style="list-style-type: none"> No mining pits are located within stream zones (Mining Exclusion Zones) Avoid all nest trees, significant trees and associated 10m buffer as per 'Survey and Management of Black Cockatoo Habitats' (Doc no. AUACDS-2053-3273) (Mining Avoidance Zones) Provision of Mining Avoidance Zones as per the Fauna Management Plan Black Cockatoo Protection Zones may be established, whereby no mining activities will occur. Protection Zones may include high quality foraging habitat, high density of nest and/or 	<ul style="list-style-type: none"> Infrastructure crossings over stream zones are minimised. Conduct pre-clearance surveys for Black Cockatoo and implement avoidance as per 'Survey and Management of Black Cockatoo Habitats' (Doc no. AUACDS-2053-3273). Conduct pre-clearance survey for to identify breeding habitat for other conservation significant fauna. Detailed infrastructure and mine plans minimise clearing where possible and are designed to minimise impacts to breeding habitat. 	<ul style="list-style-type: none"> Rehabilitation to meet Completion Criteria. Installation of constructed fauna habitat as per 'Build Fauna Habitat' (Doc no. AUSCDS02053-223) to supplement breeding habitat for Chuditch. 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		<p>habitat trees or permanent water sources</p>	<ul style="list-style-type: none"> Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. 		
<p>Mortality and injury to conservation significant fauna individuals as a result of clearing activities</p>	<p>Loss of conservation significant fauna individual</p>	<ul style="list-style-type: none"> Avoid construction during night-time hours as far as practicable, to avoid peak nocturnal animal activity. Provision of Mining Avoidance and Exclusion Zones as per Fauna Management Plan, which will be demarcated in construction spatial data to guide mine planning personnel. Mining Avoidance Zones for: <ul style="list-style-type: none"> high value habitat for black cockatoos habitat. Black Cockatoo nest trees and significant trees with 10m buffer. 	<ul style="list-style-type: none"> Conduct baseline fauna surveys (vertebrate, aquatic and SRE invertebrate) as per Fauna Management Plan. Conduct pre-clearance surveys in suitable habitat as determined by baseline fauna surveys in accordance with relevant technical guidance and/or conservation/listing advice as per Fauna Management Plan. Conduct pre-clearance surveys within all proposed waterway crossings (100 m downstream and 50 m upstream) as per Fauna Management Plan. Forests Products Commission undertakes harvesting activities prior to Alcoa clearing. Haul road construction to only occur during the day. 	<ul style="list-style-type: none"> Injured Animal Procedure includes agreements with organisations to undertake care for injured animals. Injured conservation significant fauna to be cared in accordance with DBCA guidance and advice provided via the Wildcare Helpline. 	<p>Medium</p>

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> Where disturbance to a recorded Carter's Freshwater Mussel population/s cannot be avoided, consult with DBCA to determine if permanent translocation of population/s, in accordance with a Translocation Management Plan approved under the <i>Biodiversity Conservation Act 2016</i> can be undertaken. Pre-clearing displacement, monitoring and trapping for Chuditch and Quokka to be undertaken as per Fauna Management Plan. Conduct clearing activities in consistent direction towards native vegetation to avoid fauna becoming trapped against multiple clearing fronts or 'dead ends'. Inductions for construction personnel in native fauna presence, risks and management/reporting requirements. 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> • Clearing procedures/process (clearing boundary for approved clearing areas). • Clearing lines in work pack and GIS (tablet within dozer, procedures to ensure clearing in approved areas). • Regulatory approval process (MMP/FCA) stipulates approved clearing areas. • Native fauna interactions reported in register. • Training for all personnel around requirements for licences to handle/remove flora/fauna. 		
Mortality and injury to listed threatened fauna species as a result of vehicle movements (light vehicle and heavy vehicle fauna strikes)	Mortality and injury to listed threatened fauna	<ul style="list-style-type: none"> • High value habitat for conservation significant fauna are identified and Mining Avoidance Zones implemented as applicable. 	<ul style="list-style-type: none"> • Construct fauna underpasses where conservation significant fauna populations may become isolated by haul roads. • Establish speed limits appropriate for location and commensurate with fauna strike risk, with Speed limit audits/checks. 	<ul style="list-style-type: none"> • 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> • Inductions for vehicle users in native fauna presence, risks and avoidance, including fatigue management. • Roadside vegetation is controlled to minimise fauna interactions. • Fauna sightings reported in register, providing information on fauna hotspots. • Training for all personnel around requirements for licences to handle/remove flora/fauna. • Injured animal and handling training undertaken for key personnel. • Injured Animal Procedure includes agreements with organisations to undertake care for injured animals. • Injured conservation significant fauna to be cared in accordance with DBCA guidance and advice provided via the Wildcare Helpline. 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Increase in feral predator populations as a result of exploration, construction and mining activities	<p>Direct loss of, or injury to, individual fauna</p> <p>Competition of food resources</p> <p>Destruction of habitat/s</p>	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Maintain current contributions to Western Shield program and other feral control programs. • All exploration phase food wastes bagged and disposed off site. • No domestic animals are to be brought onsite by mining personnel or contractors. • All construction and operational food wastes stored in containers with secured lids and disposed off-site at a licensed waste facility. • Exploration, construction and operations personnel trained in feral animal presence, risk and management/reporting requirements. • Feral animal sightings recorded to improve understanding and improve monitoring programmes. • Potential water sources that may attract feral animals are minimised or interactions limited. 	<ul style="list-style-type: none"> • 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
<p>Fragmentation of habitat (multi) [disruption of gene flow, movement though disruption of transport] (however able to transverse the forest)</p> <p>Decline in health and/or change in habitat composition</p>	<p>Disruption to gene flow</p> <p>Reduced habitat size</p> <p>Reduced connectivity between habitat and populations</p>	<ul style="list-style-type: none"> No mining pits are located within stream zones (Mining Exclusion Zones) High value habitat for conservation significant fauna are identified and Mining Avoidance Zones implemented as applicable. 	<ul style="list-style-type: none"> Construct fauna underpasses or reduce isolation and to maintain connectivity between areas of significant habitat. Infrastructure crossings over stream zones are minimised. Undertake study to determine effectiveness of fauna underpasses for each species of conservation significant fauna. Undertake targeted feral animal control and monitoring at fauna underpasses to verify or guide management effectiveness. Undertake trapping program in vegetated islands less than 90 ha in size to prevent isolation of female Chuditch in areas that will not sustain the individual. All captured fauna moved into nearby suitable habitat within likely home range. 	<ul style="list-style-type: none"> Rehabilitation to meet Completion Criteria. Rehabilitation Plan to minimise the timeframe of areas open. 	<p>Medium</p>
<p>Loss of individual from entrapment</p>	<p>Loss of fauna individual</p>	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Drill holes are capped when not in use and rehabilitated 	<ul style="list-style-type: none"> Injured Animal Procedure includes agreements with 	<p>Low</p>

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			(including plugging) when no longer required. <ul style="list-style-type: none"> Open holes, sumps and trenches are to be minimised. If required, egress options (ramps or egress netting) will be installed or inspections undertaken. Lined sumps will have fencing or egress options installed. Training for all personnel around requirements for licences to handle/remove flora/fauna. 	organisations to undertake care for injured animals. <ul style="list-style-type: none"> Injured conservation significant fauna to be cared in accordance with DBCA guidance and advice provided via the Wildcare Helpline. Drill holes are rehabilitated when no longer required. 	
Increased light spill, noise or vibration resulting in disruption to breeding cycles of conservation significant fauna or displacement	Disruption to breeding cycles of conservation significant fauna. Behavioural changes in individuals to avoid areas previously used for foraging and/or breeding.	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Avoid construction during night-time hours as far as practicable, to avoid peak nocturnal animal activity. Restricted use of forest tracks at night to avoid peak nocturnal animal activity. In-pit lighting towers to be directed away from uncleared areas. (Tow and Set up Lighting Plant procedure includes details on where/how to set up 	<ul style="list-style-type: none"> 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			lighting with minimal forest disturbance.) • Undertake studies to determine the medium and long-term impacts of mining operations on the breeding cycles of conservation significant fauna.		

6.4 Assessment of impacts

Alcoa has proposed substantial avoidance, mitigation and rehabilitation to reduce the residual impacts to a low as reasonably practicable.

The 24 Month Clearing Schedule will reduce the quality and extent of habitat for conservation significant fauna species, however the risk is considered to be medium given mitigation measures proposed and the proportion of impact to current mapped extent. Fauna habitats are considered widespread and well represented through the sub-region. Black Cockatoo nest and significant trees will be avoided, with habitat trees avoided for haul roads. Alcoa's rehabilitation practises and clearing of predominately FPC harvested areas minimises impacts. The FMP (Appendix 12) details the key mitigation measures.

The 24 Month Clearing Schedule impacts represent only 0.1% of current clearing to the NFJ subregion in the context of more widespread cumulative impacts from historic timber harvesting, historic mine rehabilitation, climate change, fire and dieback. Consideration of the five and ten year plan in these cumulative impacts represent an increase of 0.7% of clearing, which is considered to have a medium risk.

7 Inland Waters

7.1 Receiving environment

7.1.1 Baseline studies

Alcoa has been operating within ML1SA since the 1960's, which has resulted in a significant volume of monitoring data and reports. A summary of the key water studies that have been used in the environmental impact assessment are presented in Table 7-1 and study reports are presented in Appendix 13.

Surface and groundwater baseline data will be presented in relevant FCAs.

Table 7-1: Water baseline studies

Year	Author	Study Name	Study details
2022	GHD	Drinking Water Risk Assessment Serpentine, Serpentine Pipehead, South Dandalup, and Wungong Brook Catchments	Surface hydrology model development over the Myara North and Holyoake mine regions, which covered the Serpentine, Serpentine Pipehead and South Dandalup Public Drinking Water Source Areas. A Drinking Water Risk Assessment was completed to determine impacts to reservoirs from mining activities.
2019	Dixon, Grigg, Alam	Modelling long-term flow and salinity response to bauxite mining in the Upper Serpentine catchment	Investigation into the potential effects of bauxite mining on stream flows and stream salinity into the Serpentine Reservoir, using the semi-distributed conceptual catchment hydrology model, LUCICAT, to consider possible long-term mine plans and a projected changing climate over a 40-year planning horizon.
2017	Grigg	Hydrological response to bauxite mining and rehabilitation in the Jarrah forest in south west Australia	A published review of the hydrological response to bauxite mining in the Jarrah forest, which is considered to differ from other land uses due to the excavation of the regolith. The review consisted of monitoring three catchments for streamflow, rainfall, groundwater and leaf area index over a 36 year period.
2013	Croton, Dalton, Green and Dalton	Hydrological response of the O'Neil to McCoy mining area	A study was undertaken to assess the hydrological responses associated with mining the O'Neil-to-McCoy mine area. It consisted of a review of water data in combination with estimate stream inflow and water storage volume for the Serpentine Reservoir, to estimate the effect of mining on the reservoir salinity.
2007	Croton & Reed	Hydrology and bauxite mining on the Darling Plateau	A published review of the interaction between bauxite mining, restoration and Darling Plateau hydrology based on Alcoa's mining operation in Perth water supply catchments. It

Year	Author	Study Name	Study details
			focused on three hydrological issues – turbidity, stream yields and stream salinity.

7.1.2 Public Drinking Water Source Area

Alcoa's mining lease is located within drinking water catchments which are classified as a Priority 1 Public Drinking Water Source Area (PDWSA) and assigned under "*values directly protected under State and /or Commonwealth legislation*".

The Water Corporation (WC) has a responsibility for controlling access within PDWSAs and Reservoir Protection Zones (RPZs). RPZs are defined in the *Metropolitan Water Supply, Sewerage, and Drainage By-laws 1981*, and generally extend to 2 kilometres from the top water level of any reservoir, back into the defined PDWSA. RPZs are located within both mine sites, surrounding the Serpentine Dam, North Dandalup Dam, Samson Dam and Stirling Dam.

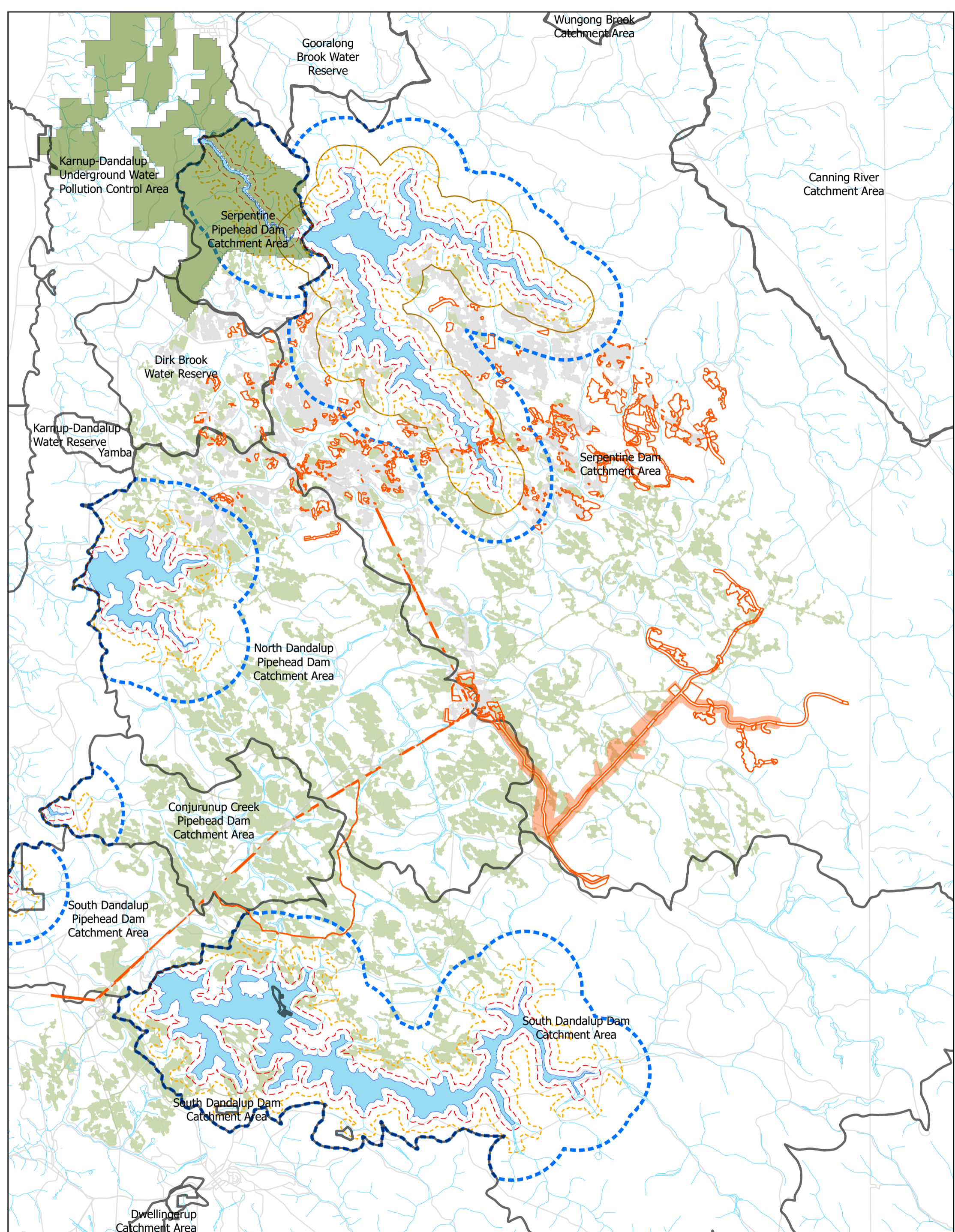
At Huntly, the mining areas intercept Serpentine and North Dandalup PDWSAs. The two water supply dams (Serpentine and North Dandalup) release limited flows (<10% of inflow) to maintain downstream beneficial uses. Some minor infrastructure is located within the South Dandalup PDWSA.

The Willowdale mine area intercepts the catchments of Harvey Dam, Stirling Dam, Logue Brook Dam and Sampson Brook Dam. Two of these dams, Stirling and Sampson Brook, are used for drinking water and their catchments comprise PDWSAs.

The locations of these dams and PDWSAs are shown in Figure 7-1 and Figure 7-2 for Huntly and Willowdale, respectively.

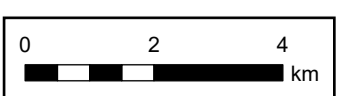
Desalination inputs from the Integrated Water Supply Scheme (IWSS) to Serpentine Dam for eventual discharge to Pipehead Dam are substantial and are projected to make up an increasing proportion of the source water in the future. Catchment access is restricted, with permissible activities listed in Source Water Protection plans for each PDWSA. The PDWSAs are predominantly managed as Priority 1 with small areas of private land managed as Priority 2. The source water is treated with chlorine, and then transferred to the IWSS for distribution to downstream customers.

The Water Working Arrangements between Alcoa, DWER and WC, provide the framework under which Alcoa manages its mining operations within the drinking water catchments with respect to catchment protection.



Legend

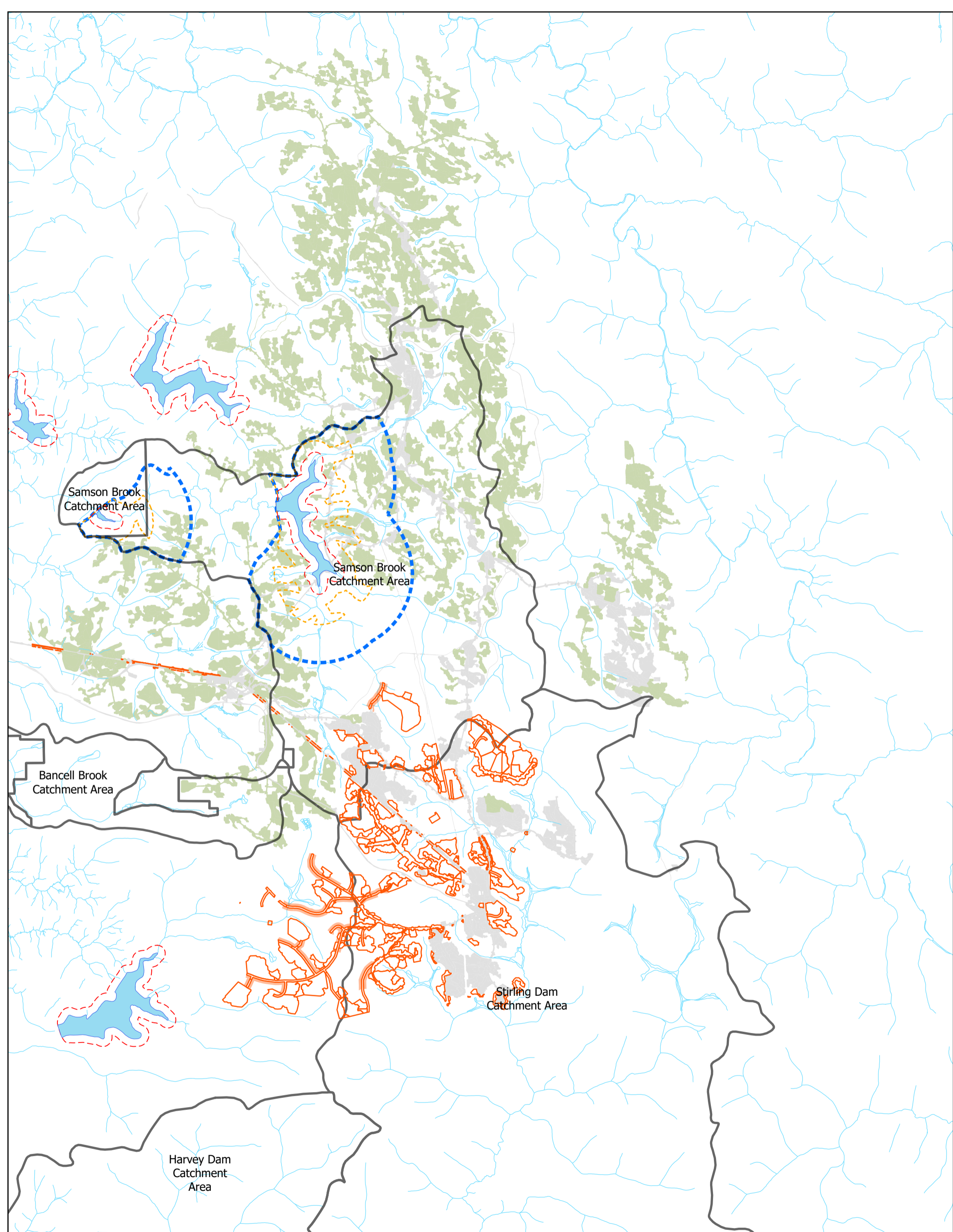
24 Month Clearing Schedule	1km Radius from Reservoir TWL	Rehabilitation
Conceptual Clearing Buffer	Reservoir Protection Zone (RPZ)	Cleared Areas
Reservoir Top of Water Line (TWL)	Catchments	National Parks
OCA1	Streams	
OCA2		



2023 – 2027 Mining and Management Plan

Figure 7-1: Huntly Public Drinking Water Source Areas

Scale: 1:117,413 Date Printed: 31/10/2023



Legend

Conceptual Clearing Buffer	Catchments	Streams
24 Month Clearing Schedule	OCA1	Rehabilitation
Reservoir Top of Water Line (TWL)	OCA2	Cleared Areas
	Reservoir Protection Zone (RPZ)	



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**Figure 7-2: Public Drinking Water Source Areas
- Willowdale**

Scale: 1:85,380	Date Printed: 1/11/2023
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7.1.3 Hydrology

7.1.3.1 Regional hydrology

The Huntly and Willowdale mine areas are located within the basins of the Serpentine, Murray and Harvey rivers. The Serpentine, Murray and Harvey River Basins have their headwaters in the Darling Plateau, an undulating lateritic regolith over Archaean granite with dolerite intrusions that retains extensive forested land of the Northern Jarrah Forest. The Darling Plateau generally lies at elevations of approximately 250 to 350 metres Australian Height Datum (AHD), interspersed by isolated granite hills or ‘monadnocks’ that can exceed 400 mAHD. Rainfall is greatest in the western edge of the plateau near the Darling Scarp, decreasing to the north and east. The Serpentine and Murray run in a characteristic north-west direction influenced by underlying granite and dolerite structures (Hickman et al 1992).

The Serpentine, Murray and Harvey rivers flow west off the Darling Plateau, via incised valleys through the Darling Scarp, and onto the Swan Coastal Plain (SCP). The SCP comprises deep sediments deposited from the ocean or washed down from the Darling Scarp, with a series of sandy dunes to the west and the relatively flat Pinjarra Plain to the east. The SCP lies at elevations from sea level on the coast up to 50 mAHD near the Darling Scarp with higher elevations in larger dune landforms. The SCP has been extensively developed for urban land uses over the sandy dunes, and for agricultural land use on the heavier soils of the Pinjarra Plain.

The Serpentine, Murray and Harvey rivers meander through the SCP towards the coast. The Serpentine River adopts a southerly direction due to the influence of north-south coastal dunes, before discharging into the Peel Inlet. The extensive agricultural development of the Pinjarra Plain has resulted in high nutrient loads and eutrophication of the Peel-Harvey Estuary (Hale and Butcher 2007). Along with river diversions, agricultural land use poses a key threat to the environmental values of the Peel-Yalgourup Ramsar site (Hale and Butcher 2007).

7.1.3.2 Local Hydrology – Huntly

The majority of the Serpentine River within and upstream of the Huntly mine region is regulated by Serpentine Dam. Serpentine Dam was constructed in 1961 and supplies the Serpentine Pipehead Dam, which was constructed in 1957. Releases to the Serpentine River downstream of the Pipehead Dam are managed according to the Serpentine allocation statement (DWER 2017a), which allows for the release of 0.8 GL/year for ‘low-inflow’ years (inflow to dam less than 30 GL) and 0.86 GL/year for ‘standard’ years (inflow to dam greater than 30 GL). Accordingly, for average inflows of approximately 14 GL/year, as was recorded over 2008-2015 (DWER 2017a), Serpentine Dam would divert more than 94%, with less than 6% released downstream. For average inflows of approximately 33 GL/year, as was recorded over 1975-2008 (DWER 2017a), the dam would divert more than 97%, with less than 3% released downstream.

Within the Huntly mine area, the Serpentine Dam is supplied by seasonal streams, with major tributaries being the Serpentine River and Big Brook. The seasonal streams are interspersed by headwater swamps that occupy colluvial and alluvial sediments in valley floors. The swamps comprise seasonally waterlogged wetlands with distinct vegetation types.

The Huntly mine area lies partially in the catchment of the North Dandalup River, which is regulated by North Dandalup Dam. North Dandalup Dam was constructed in 1994 and supplies the IWSS.

Releases from the dam to North Dandalup River downstream are managed according to the North Dandalup allocation statement (DWER 2017b), which allows for the release of 0.46 GL/year for 'low-inflow' years (inflow to dam less than 30 GL) and 0.51 GL/year for 'standard' years (inflow to dam greater than 30 GL). Accordingly, for average inflows of approximately 8 GL/year, as was recorded over 2008-2015 (DWER 2017b), North Dandalup Dam would divert more than 95%, with less than 5% released downstream. For inflows exceeding 30 GL/year, the dam would divert more than 98%, with less than 2% released downstream.

Within the Huntly mine area, the North Dandalup Dam is supplied by the North Dandalup River. There is a stream gauging station at North Road (614036), approximately 1 km upstream of the reservoir. Annual flows in the North Dandalup River and North Dandalup Dam have declined from an average of 37.6 GL/year over 1960-1974, to an average of 17.1 GL/year over 1975-2007, to an average of 8.4 GL/year over 2008-2015 (DWER 2017b), attributable to a reduction in average annual rainfall of approximately 20% over the same period.

The North Dandalup River is interspersed by a series of headwater swamps that occupy colluvial and alluvial sediments in valley floors.

7.1.3.3 Surface Water Quality

Historic water quality monitoring over the Huntly mine area is available from the 1970s to present, subject to periods of discontinuity, with parameters comprising salinity, pH, and some turbidity data.

Monitoring of surface water locations within sub-catchments intersecting the Huntly mine area have recorded mildly acidic to mildly alkaline (pH ranging from 3.6 to 8.0) and fresh (<1000 µS/cm since 2000) water quality. All records since 2010 (except MBF11) are below the Australian Drinking Water Guidelines (NHMRC, NRMCC 2018) aesthetic limit for TDS of 600 mg/L (EC equivalent of 937.5 µS/cm). The recorded exceedance at MBF11 occurred 12 July 2022 (1342 µS/cm). Other historical peaks greater than 900 µS/cm were recorded on 17 June 2018 and 12 July 2019. MBF11 is located within the O'Neil region within a sub catchment mined between 2011 and 2013 and rehabilitated between 2013 and 2021.

7.1.3.4 Local hydrology – Willowdale

The Willowdale mine area lies in the catchments of the Murray and Harvey rivers. The Murray River catchment intersects the north-eastern portion of the Willowdale mine area within the Middle Murray and Lower Murray, unregulated sub-catchments of the Murray River. The Murray River is perennial, however very low flows (< 10 ML/month) were recorded in autumn in 2011 and 2020 following record low rainfalls in 2010 and 2019.

Middle Murray and Lower Murray flow through shallow valleys of Yarragil landform transitioning to moderately incised valleys of Murray landform as they approach the Murray River. The Murray River flows through deeply incised valleys of the Murray landform and transitions to the steep, rocky Helena landform as it dissects the Darling Scarp.

The Harvey River catchment intersects with the majority of the Willowdale mine regions and is regulated by five dams, two of which (Stirling and Sampson Brook) supply the IWSS.

The Stirling Dam catchment has an area of 254 km². Elevation in the catchment is 80 m Australian Height Datum (AHD) at the reservoir to 320 m AHD at the head of the catchment. Water inflow to the

reservoir is mostly from surface runoff over the winter months. However, there is subsurface flow year round due to the gravelly nature of the geology in the Darling Range.

Samson Brook Dam was completed in 1941. It is 31 metres high and impounds a reservoir of 8 GL volume and 104 ha surface area at a top water level of 245 m AHD. The estimated average annual streamflow into the reservoir is 16.6 GL from a catchment area of 64 km².

7.1.3.4.1 Surface Water Quality

Historic water quality monitoring over the Willowdale mine area is available from the 1970s to 2010, subject to periods of discontinuity, with parameters comprising salinity, pH and some turbidity data.

Monitoring of surface water locations within sub-catchments intersecting the Willowdale mine area have identified mildly acidic to neutral (pH ranging from 5.4 to 6.7) and fresh (<7000 µS/cm) water quality. All records since 1980 are below the Australian Drinking Water Guidelines (NHMRC, NRMCC 2018) aesthetic limit for TDS of 600 mg/L (EC equivalent of 937.5 µS/cm).

7.1.4 Hydrogeology

7.1.4.1 Regional hydrogeology

The Huntly and Willowdale mines lie within the Darling Plateau, an undulating lateritic regolith over Archaean granite with dolerite intrusions. The regional hydrogeology comprises aquifers predominantly within weathered and fresh Archaean basement rocks, as well as superficial aquifers within more recent sediments incised in the basement, coincident with existing and paleo drainage lines. Table 7-2 presents the main aquifer units that characterise the regional hydrogeology across the Darling Plateau, from surface level down to the basement.

Table 7-2: Main aquifer units within Darling Plateau geology

Aquifer unit	Description
Shallow weathered zone	Shallow gravely and sandy sediments, lateritic caprock and friable upper saprolite. The lateritic caprock and friable saprolite can contain economic bauxite and be subject to mining. Seasonal aquifer with significant storage, infiltration and flow capability.
Deep weathered zone	Lower saprolite layer. Aquifer of some storage potential, but limited bulk permeability, comprising clays. Clayey nature of this zone can be interspersed by macropore features developed along deep root systems which were subsequently filled with more clastic material.
Transition zone	Transition zone between fresh basement and saprolite, referred to as saprock, which typically has enhanced permeability
Fractured bedrock	Permeability and yields are dependent on fracture development and connectivity of fractures

Groundwater has been an active part of lateritisation across the Darling Plateau, particularly in the development of the duricrust or caprock which lies above the weathered saprolite clays. The formation of caprock has been driven by groundwater flow and capillary action which lead to the precipitation of iron minerals leached from the weathered bedrock. Caprock can also form in valley floors due to the accumulation of iron brought by groundwater flow and its precipitation due to evapotranspiration or exposure to the surface.

The caprock layer is discontinuous and of varying thickness, being found on slopes but generally being absent in valley floors, as well as where the basement rock outcrops. Of hydrological significance, root channels penetrate vertically via fissures and discontinuities in the caprock and deep into the saprolite clays are a consistent feature in the lateritic profiles. These channels create preferential flow paths which are understood to enable significant vertical fluxes from the shallow weathered zone into the deeper aquifers of weathered saprolite and saprock.

In addition to the aquifers presented in Table 7-2, aquifers are present in alluvial and colluvial sediments accumulated in drainage lines, where these are sufficiently developed and have eroded the basement. The permeability of the alluvial / colluvial sediments is variably distributed and related to lithology, depth and degree of weathering.

Broadly, groundwater levels within all aquifers appear to follow topography, such that groundwater level is highest in areas of highest topography and lowest in areas of lowest topography. Where groundwater levels intersect the base of streams, groundwater discharges provide baseflow following winter rains (topped up aquifer storage and groundwater levels).

Flow within the shallow aquifer (subsurface flow) immediately near and within stream zones can express as streamflow. Jarrah forest streamflow generation is not induced by catchment wide overland surface flow but is primarily a consequence of rainfall infiltration and groundwater discharge. In lower slopes there is the potential for shallow subsurface flow to express as streamflow.

7.1.4.2 Local Hydrogeology – Huntly

The key data set used to describe baseline groundwater conditions is the Alcoa bore data set which provides groundwater level and groundwater quality data from 1989 until present. The locations of the Alcoa bores relevant to the Huntly mine area (within surface water sub-catchments intersecting the mined areas) are shown in Figure 7-23. The distribution of these bores is concentrated in the south-east, west and north-east of the Myara and O’Neil regions and surrounds.

7.1.4.2.1 Groundwater levels

Alcoa has engaged specialist consultants to assist in the development of evaluation methodology for seasonally variable groundwater level conditions, relative to baseline conditions for vegetation clearing and rehabilitation.

The current approach uses a purpose-built three-dimensional continuous groundwater surface, plus other inputs to generate an understanding of the groundwater profile in relation to the mine plan. The inputs include:

- Groundwater levels from site wide monitoring bores, collected between December 2020 and November 2022, derive an estimated seasonal high groundwater surface.
- Accepting the superficial aquifer is unconfined.
- The inferred groundwater surface between monitoring bores was informed by topographical geometry i.e., greater depth to groundwater in higher elevation topography and shallower depth to groundwater in lower slope elevation, as described within the hydrogeological and surface water system conceptualisation (GHD 2021).
- Using standard-practice modelling software.

- Review by specialist hydrogeological practitioners.

The resultant continuous groundwater surface and interpretation has provided a base level tool for the assessing the risk of groundwater intercepting the base of the mine void.

Within the sub catchments that intersect the Huntly mine, 168 bores have been installed for the purpose of collecting data to better understand groundwater levels and seasonal trends.

The key observations are detailed in Table 7-3.

Table 7-3: Groundwater level key observations

Sub catchment	Data Availability	Information
Dirk/Karnet/Punrack	<ul style="list-style-type: none"> • From 2008 until present 	<ul style="list-style-type: none"> • Bores within unmined areas show stable groundwater levels since 2008. • Bores within mined areas show a slight increase in groundwater levels from June 2017.
North Dandalup Dam	<ul style="list-style-type: none"> • From 2013 until present (one bore within historical rehabilitation has data from 2001) 	<ul style="list-style-type: none"> • Bores within mined areas show a slight increase in groundwater levels from June 2017. • One bore (MF450315R) located within historical rehabilitation, to the south of the Huntly mine area, demonstrates a reduction in groundwater levels between 2004 and 2013 when stabilisation occurs.
North Dandalup Below Dam	<ul style="list-style-type: none"> • From 2013 with single bore present 	<ul style="list-style-type: none"> • Stable groundwater levels
Serpentine Dam	<ul style="list-style-type: none"> • From 1989 until present 	<ul style="list-style-type: none"> • General trend of decreasing groundwater levels in unmined areas • Bores within mined areas showing a general trend of increasing groundwater levels
Serpentine Pipehead	<ul style="list-style-type: none"> • From 2021 until present 	-

7.1.4.2.2 Groundwater Quality

There are 112 bores with salinity data recorded within the Serpentine Dam sub-catchment and one bore with salinity data recorded within the North Dandalup Dam sub-catchment. Key observations from bores within each sub-catchment are provided in Table 7-4.

Table 7-4: Groundwater quality key observations

Sub catchment	Data Availability	Information
Serpentine Dam	<ul style="list-style-type: none"> • From 1989 until present 	<ul style="list-style-type: none"> • Salinity is moderately variable for each bore and between bores, but consistently less than 1000 $\mu\text{S}/\text{cm}$ (equivalent to around 600 mg/L TDS) • Seven bores have highly variable salinities with changes between 2500 and 7000 $\mu\text{S}/\text{cm}$. Six of these bores are outside of the Huntly mine area, to the north.

Sub catchment	Data Availability	Information
North Dandalup Dam	<ul style="list-style-type: none"> From 2001, from one data point 	<ul style="list-style-type: none"> Low salinity from one recording (217.6 $\mu\text{S/cm}$)

7.1.4.3 Local Hydrogeology – Willowdale

The bore dataset is the main dataset used to understand the baseline groundwater conditions such as groundwater levels and quality.

Alcoa has engaged specialist consultants to assist in the development of evaluation methodology for seasonally variable groundwater level conditions, relative to baseline conditions for vegetation clearing and rehabilitation.

The current approach uses a purpose-built three-dimensional continuous groundwater surface, plus other inputs, to generate an understanding of the groundwater profile in relation to the mine plan. The inputs include:

- Groundwater levels from site wide monitoring bores, collected between December 2020 and November 2022, derive an estimated seasonal high groundwater surface.
- Accepting the superficial aquifer is unconfined.
- The inferred groundwater surface between monitoring bores was informed by topographical geometry i.e. greater depth to groundwater in higher elevation topography and shallower depth to groundwater in lower slope elevation, as described within the hydrogeological and surface water system conceptualisation (GHD 2021).
- Using standard-practice modelling software.
- Review by specialist hydrogeological practitioners.

The resultant continuous groundwater surface and interpretation has provided a base level tool for the assessing the risk of groundwater intercepting the base of the mine void.

Data analysis has been conducted of groundwater monitoring bores and data obtained from a further 639 bores in areas around the site over the last two years. This analysis confirms that groundwater levels mimic topography within the mine regions.

Groundwater levels are highest (further from surface) in areas of highest elevation and lowest (closest to surface) in areas of low elevation.

7.1.5 Water Supply

Alcoa's WA mining operations use approximately 1 GL of water per year, primarily for use in dust suppression on haul roads and conveyors.

7.1.5.1 Huntly Mine

The Huntly mine is licenced by the DWER to abstract water from four surface water sources (Table 7-5):

- Banksiadale Dam supplies water to the Huntly Central offices, McCoy facilities, White Road facilities and the Myara facilities, via a header tank on Radio Hill.
- Boronia Waterhole supplies water to the Del Park facilities and conveyor belt transfer station.
- Pig Swamp and Marrinup Nursery (Lot 908 on Marrinup Brook) supplies have been disconnected from the main water supply network; however, they are both being maintained for emergency water supply purposes or potential future use.

Table 7-5: Huntly surface water licences

Water source	Surface water licence	Annual water entitlement (kL)
Banksiadale Dam	SWL63409	500,000
Pig Swamp Waterhole	SWL153635	30,000
Boronia Waterhole on Marrinup Brook	SWL83356	70,000
Lot 908 on Marrinup Brook	SWL68893	45,000

The Huntly mine also has a Bulk Water Agreement with the WC to purchase water from the South Dandalup Dam. This abstraction may increase up to 2.6GL per year to supply construction and operational water for the O’Neil mine region, pending approvals. Consultation has commenced on this potential increase.

The Alcoa-managed McCoy and Myara Reservoirs are used to store water abstracted from Banksiadale Dam, site stormwater runoff and treated wastewater. Treated wastewater from the McCoy wastewater treatment facility must achieve the water quality standards identified in the Huntly Part V licence (L6210/1991/10) prior to release. This water is then released directly to the environment or transferred to the McCoy reservoir and subsequently the Myara reservoir for re-use on site.

The Myara reservoir is currently considered affected by minor detections of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Detections were below the PFAS National Environmental Management Plan (NEMP) V2 95% Species Protection limit. Water from the Myara reservoir is treated via the temporary PFAS treatment plant and must be confirmed non-detect for 28 PFAS species to ultra-trace levels prior to use on the site. Reservoir water is used for haul road dust suppression, crusher dust suppression, vehicle wash down, and workshop hose down.

7.1.5.2 Willowdale Mine

The Willowdale mine is licenced by the DWER to abstract water from the Samson Dam (Table 7-6) and has a Bulk Water Agreement with the WC for the purchase of this water. Samson Dam supplies water to the Orion facilities, Arundel facilities and Larego facilities.

Table 7-6: Willowdale surface water licence

Water source	Surface water licence	Annual water entitlement (kL)
Samson Dam	SWL61024	450,000

The Alcoa-managed Larego Reservoir is used to store water abstracted from Samson Dam, as well as site stormwater runoff and treated wastewater. Treated wastewater from the Larego wastewater treatment facility must achieve the water quality standards identified in the Willowdale Part V licence (L6465/1989/10) prior to release. This water is then released to the Larego reservoir for re-use on-site. Reservoir water is used for haul road dust suppression, crusher dust suppression and wash down, conveyor belt wash and workshop hose down.

7.2 Potential Environmental Impacts

An Environmental Risk Assessment has been undertaken and the following activities have the potential to impact inland waters:

- Clearing of native vegetation.
- Water use for construction and mining activities.
- Waste disposal.
- Storage and handling of contaminants.
- Closure and decommissioning.
- Mining activities within PDWSAs and RPZs.
- Application of chemicals (fertilizers and pesticides) within PDWSAs.
- Alteration of hydrological regimes.

The activities listed above may result in the following potential impacts to inland waters:

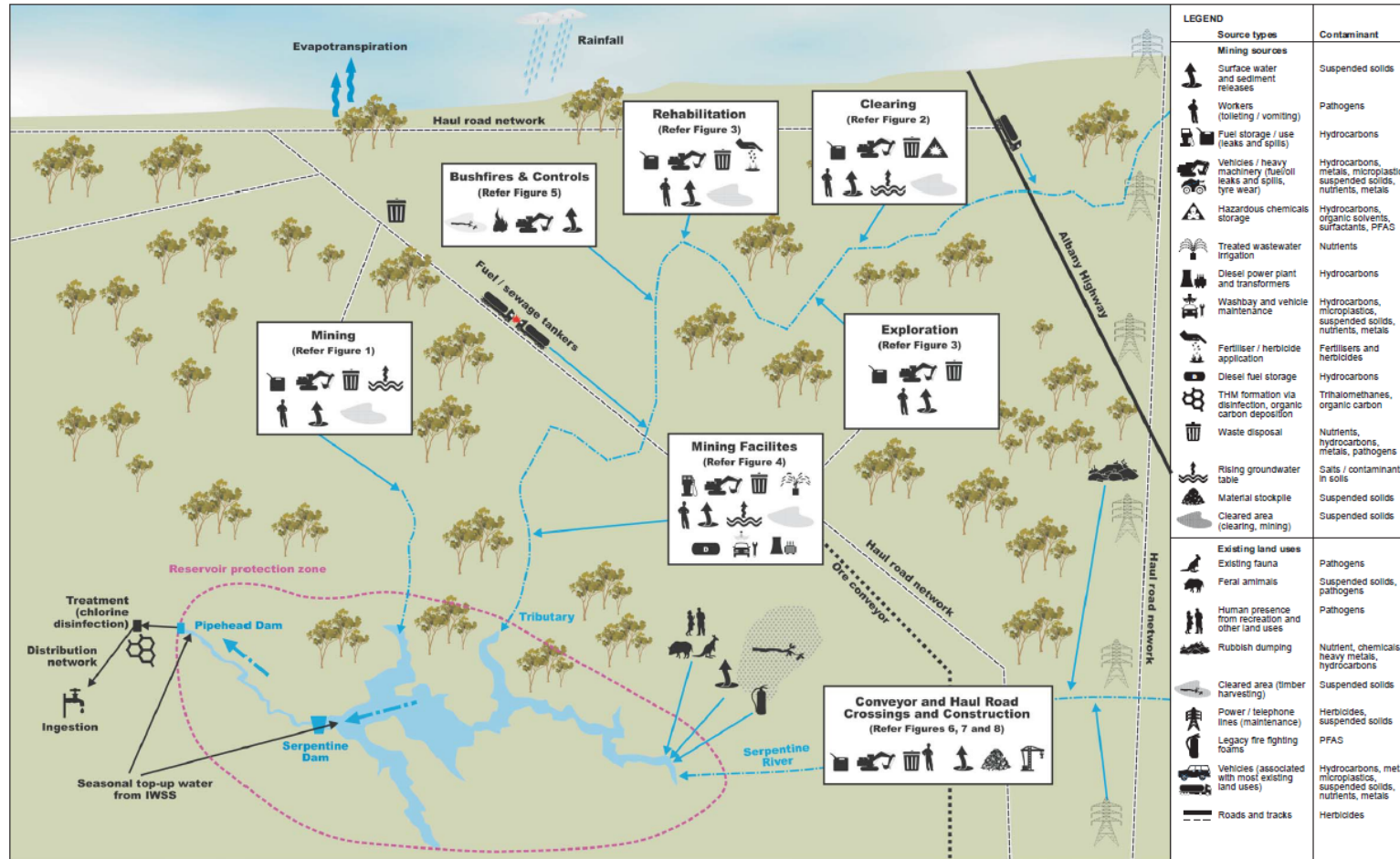
- Increased sediment due to erosion from mine disturbance.
- Increased sediment due to erosion of post-mining landforms.
- Increased stream salinity as a result of mining-induced saline groundwater discharge.
- Changes to hydrological regimes.
- Contamination from spills and/or leaks from storage and handling of hazardous materials and waste.
- Contamination from pathogens.

The potential impacts could influence public drinking water supply quality through the following:

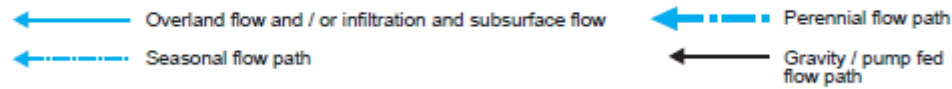
- Generation and discharge of pathogenic microorganisms from increased human activity.
- Increases in turbidity from erosion during mining and rehabilitation activities.
- Increases in stream salinity from mining-induced saline groundwater discharge.
- Contamination from spills, leaks, and/or emissions from the storage, handling and use of hazardous materials and waste.

A conceptual water model of potential impacts is shown in Figure 7-3.

Figure 7-3: Water conceptual model



CONTAMINANT PATHWAYS



7.2.1 Direct impacts from mine disturbance - Huntly

Mine disturbance to surface water catchments due to the 24 Month Clearing Schedule is expected to predominantly occur in the Serpentine Dam catchment with some also occurring in the North Dandalup catchment (Table 7-7).

The increase in clearing to the Serpentine Dam catchment is expected to be 2%, with 4% of the catchment currently cleared and 6% of the catchment rehabilitated. Total mine impacts to the Serpentine Dam catchment are 12%.

The increase in clearing to the North Dandalup catchment is expected to be only 1%, with 4% of the catchment currently cleared, or could be cleared under granted approvals, and 26% of the catchment is rehabilitated. Total mine impacts to the North Dandalup catchment are 30%.

The Dirk Brook Water Reserve has the highest portion of disturbance (10%) excluding rehabilitation.

Table 7-7: Indicative estimates of mining disturbance to surface water catchments – Huntly

Catchment	Catchment area (ha)	Open areas		Rehabilitated areas		24 Month Clearing Schedule		Total mined area (ha)	Proportion of catchment cleared (%)
		Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)		
PDWSAs									
Conjurunup Creek Pipehead Dam Catchment Area	3,922	56.0	1.4%	1,606	41.0%	1	7.9	0.2%	1,670
Dirk Brook Water Reserve	3,116	303.3	9.7%	436	14.0%		53.3	1.7%	793
North Dandalup	15,165	534.3	3.5%	3,936	26.0%	87	141.7	0.9%	4,612
Serpentine Dam	66,490	2,952.6	4.4%	3,847	5.8%	621	1,462.6	2.2%	8,262
Serpentine Pipehead Dam	2,885	71.1	2.5%	97	3.4%			0.0%	169
South Dandalup Dam	31,675	8.5	0.0%	2,174	6.9%	15	9.4	0.0%	2,192
South Dandalup Pipehead Dam Catchment Area	3,854	40.8	1.1%	577	15.0%	2	10.5	0.3%	628
Subtotal	127,107	3,967	3.1%	12,673	10.0%	726	1,686	1.3%	18,325
Unregulated catchments	-	32	-	705	-	2	-	739	-

7.2.2 Direct impacts from mine disturbance - Willowdale

Mine disturbance to surface water catchments due to the 24 Month Clearing Schedule is expected to predominantly occur in the Stirling and Samson Brook catchments (Table 7-8).

The increase in clearing to the Stirling Dam catchment is expected to be 2%, with 3% of the catchment currently cleared and total mine impacts of 5%.

The increase in clearing to the Samson Brook catchment is expected to be only 1%, with 8% of the catchment currently cleared and 18% of the catchment is rehabilitated. Total mine impacts to the Samson Brook catchment are 27%.

Table 7-8: Indicative estimates of mining disturbance to surface water catchments – Willowdale

Catchment	Catchment area (ha)	Open areas		Rehabilitated areas		24 Month Clearing Schedule		Total mined area (ha) Proportion of catchment (%)	Proportion of catchment cleared (%) Area (ha)
		Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Area (ha)		
PDWSA catchments									
Bancell Brook Catchment Area	1,838	2	0.1%	108	5.9%	-	-	0.0%	-
Samson Brook	7,755	583	7.5%	1,410	18.2%	10.6	102.8	1.3%	2,096
Stirling Dam	25,366	608	2.4%	22	0.1%	20.1	602.9	2.4%	1,233
Subtotal	34,958	1,193	3.4%	1,541	4.4%	30.7	706	2.0%	3,329
Unregulated catchments	-	494	-	3,498	-	75	-	4,066	-

7.2.3 Increased sediment from mining activities

While not classified as hazardous in itself, increase in turbidity flow to reservoirs has been identified as a water quality risk. Turbidity has the ability to reduce the efficacy of treatment to inactivate or remove pathogens.

Increase in sediment flow is a key concern for WC, as it poses a risk to residential water quality. Turbidity is measured by nephelometric turbidity units (NTU) and the Australian Drinking Water Guidelines (ADWG) notes that where the turbidity of a source exceeds 1 NTU, adequate disinfection may be difficult to maintain, but may still be achievable. High turbidity (20 NTU) waters containing organic particles generated from wastewater could be effectively disinfected for chlorine-resistant viruses, but require longer chlorine contact times to factor in the chlorine demand from wastewater particulates.

Alcoa has refined the 24 Month Clearing Schedule to minimise risk of mining related sediment flow to the PDWSA RPZs resulting in the following actions:

- No new mining activities will occur within OCA2. Minor infrastructure clearing (17 ha) will occur within OCA2, which is associated with the Big Brook Crossing upgrade and haul road re-alignments. The Big Brook Crossing clearing is related to the existing drainage sump network and discussed further in Section 7.2.9.
- Not undertake any clearing for mining within 1km of the top water level of any water reservoir in Myara Central and Myara South (Commitment 2). Clearing for infrastructure, monitoring and rehabilitation activities will still occur within this area.
- Not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024 (Commitment 3). It should be noted that infrastructure, monitoring and rehabilitation activities will still occur within this area. Minimal disturbance within 1 km of the Serpentine Dam reservoir Top Water Level (TWL), with only an additional 1 ha of new disturbance included in the 24 Month Clearing Schedule.
- Not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (Commitment 4). It should be noted that rehabilitation activities will still occur within this area.
- Not undertake any new pit clearing in any areas with an average pit slope greater than 16% within any Reservoir Protection Zone (RPZ, 2km from reservoir top water level) (Commitment 5).
- Prioritise rehabilitation within the Serpentine Dam RPZ.
- Prioritise clearing outside of the RPZ through re-entry to O'Neil mine region.

The impacts and indicative estimates of mining disturbance within the RPZ associated with the 24 Month Clearing Schedule are shown in Table 7-9. Minor amounts of clearing (5 ha) are expected in the South Dandalup RPZ, which are associated with an upgrade of existing infrastructure (water

pipelines to Banksiadale). The majority of RPZ impacts occur in the Serpentine Dam RPZ, with 138 ha included in the 24 Month Clearing Schedule, reflecting 1% of the total RPZ. It is noted that 13% of the RPZ is classified as open areas with a further 2% consisting of FCA endorsed areas. Figure 7-4 shows all potential clearing within the RPZs associated with Huntly. No impacts to Willowdale RPZs are expected.

DWER and WC have highlighted areas with a Topographical Wetness Index of greater than 9 (TWI>9) to be a high risk area due to interactions with groundwater. The impacts to TWI>9 are detailed in Table 7-10 and shown in Figure 7-5 and Figure 7-6 for Huntly and Willowdale, respectively. On average, approximately 20% of each catchment consists of areas with are TWI>9. Of this, an average of 0.5% is currently open and 2% has already been rehabilitated. The 24 Month Clearing Schedule impacts less than 0.5% to each catchments TWI>9 areas.

Areas with slope greater than 16% are considered to be higher risk as detailed in Table 7-11 and shown in Figure 7-7 and Figure 7-8 for Huntly and Willowdale, respectively. The majority of catchments have 2% to 13% of the total area with slopes greater than 16%. The exceptions are Serpentine Pipehead (34%) and South Dandalup Pipehead (32%), of which no further clearing will occur within Serpentine Pipehead and a minor (2 ha) amount of clearing will occur in South Dandalup Pipehead (for conveyor protection in bushfire events). The areas of 24 Month Clearing Schedule which are greater than 16% slope consist of less than 0.5% of any catchment. The greatest portion of the 24 Month Clearing Schedule areas with a slope greater than 16% occur within the Serpentine Dam Catchment, with 20% of the Huntly 24 Month Clearing Schedule areas greater than 16% slope located in this catchment. Within Serpentine catchment 11% of the area has a slope greater than 16%, of which 0.6% is open areas and 0.3% is rehabilitated. The 24 Month Clearing Schedule will impact another 0.5% of the catchment areas greater than 16% with the total future cleared areas potentially impacting 2% of the catchment.

The 24 Month Clearing Schedule areas with an average slope greater than 16% are detailed in Table 7-12 and shown in Figure 7-7 and Figure 7-8 for Huntly and Willowdale, respectively. Average slope is considered a more appropriate operational category, as it accounts for minor areas with slope greater than 16%. The majority of the 24 Month Clearing Schedule areas with an average slope greater than 16% (20%; 343 ha) are located within the Serpentine catchment. It noted that 14% of the areas with an average slope greater than 16% are less than 22%.

The 24 Month Clearing Schedule contributions to the proportion of sub-catchment clearing are detailed in Table 7-13 and shown in Figure 7-9 and Figure 7-10 for Huntly and Willowdale, respectively. It should be noted that sub-catchment clearing proportions include rehabilitated areas. Rehabilitated areas are considered to have a lower likelihood of drainage failures, therefore sub-catchment clearing after open areas should be considered. 26 out of the 51 sub-catchments have sub-catchment clearing below 30%. An additional 15 sub-catchment has sub-catchment clearing below 40%. Of the remaining sub-catchment with clearing proportions above 40%, six of these sub-catchment have the proportion of rehabilitation above 13%, with the 24 Month Clearing Schedule clearing consisting of 111 ha (an average contribution of 1% of sub-catchment clearing). In particular, the Conjurunup 04 sub-catchment has 65% sub-catchment clearing, however 63% of the sub-catchment has been cleared (only 2% of the sub-catchment is currently open).

Table 7-9: Indicative estimates of mining disturbance within the RPZs

RPZ	Location	Area (ha)	Open Areas		Rehabilitated areas		24 Month Clearing Schedule		FCA Endorsed Areas		Five year mine plan		Total mined area (ha)	Proportion of area total mined (%)
			Area (ha)	Proportion of Area (%)	Area (ha)	Proportion of Area (%)	Area (ha)	Proportion of Area (%)	Area (ha)	Proportion of Area (%)	Area (ha)	Proportion of Area (%)		
Serpentine Dam	Within OCA2	4,955	116	2.3%	74	1.5%	17	0.3%	10	0.2%	-	-	217	4.4%
	Within 1km of TWL	6,878	502	7.3%	309	4.5%	18	0.3%	22	0.3%	-	-	852	12.4%
	Within RPZ	11,291	1,415	12.5%	583	5.2%	138	1.2%	214	1.9%	60	0.5%	2,410	21.3%
Serpentine Pipehead Dam	Within OCA2	927	-	-	0	0.0%	-	-	-	-	-	-	0	0.0%
	Within RPZ	2,160	7	0.3%	76	3.5%	-	-	-	-	-	-	83	3.8%
North Dandalup	Within OCA2	1,859	12	0.6%	160	8.6%	-	-	-	-	-	-	172	9.2%
	Within RPZ	3,935	131	3.3%	652	16.6%	0	0.0%	18	0.5%	6	0.2%	808	20.5%
South Dandalup Dam	Within OCA2	6,359	0	0.0%	485	7.6%	-	-	-	-	-	-	485	7.6%
	Within RPZ	11,334	8	0.1%	1,311	11.6%	5	0.0%	0	0.0%	-	-	1,324	11.7%
Conjurunup	Within OCA2	154	-	-	-	-	-	-	-	-	-	-	-	0.0%
	Within RPZ	487	-	-	57	11.7%	-	-	-	-	-	-	57	11.7%
Samson Brook	Within OCA2	756	40	5.2%	93	12.3%	-	-	-	-	-	-	133	17.5%
	Within RPZ	1,960	97	4.9%	421	21.5%	-	-	-	-	-	-	518	26.4%
Samson Brook Pipehead	Within OCA2	145	-	-	0	0.2%	-	-	-	-	-	-	0	0.2%
	Within RPZ	438	1	0.3%	70	16.0%	-	-	-	-	-	-	71	16.3%
Stirling Dam	Within OCA2	1,766	-	-	-	-	-	-	-	-	-	-	-	0.0%
	Within RPZ	3,869	-	-	-	-	-	-	-	-	-	-	-	0.0%

Table 7-10: Clearing impacts to area with TWI>9

Catchment	Catchment area (ha)	Catchment area TWI>9		Open Area TWI>9		Rehabilitation Area TWI>9		FCA Endorsed Area TWI>9		24 Month Clearing Schedule Area TWI>9			5 Year Clearing Schedule Area TWI>9			Total Future Mined TWI>9	
		Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of Five Year Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)
Conjurunup Creek Pipehead Dam Catchment Area	3,922	929	23.7%	12.0	0.3%	262.7	6.7%	2.6	0.1%	2.6	0.2%	0.1%	-	0.0%	0.0%	279.9	7.1%
Dirk Brook Water Reserve	3,116	759	24.4%	38.4	1.2%	18.7	0.6%	18.0	0.6%	10.0	0.6%	0.3%	8.0	0.6%	0.3%	93.0	3.0%
North Dandalup	15,165	3,859	25.4%	73.2	0.5%	486.5	3.2%	63.9	0.4%	23.2	1.4%	0.2%	19.0	1.4%	0.1%	665.8	4.4%
Serpentine Dam	66,490	13,368	20.1%	314.2	0.5%	361.4	0.5%	571.1	0.9%	256.7	15.2%	0.4%	156.5	11.3%	0.2%	1,659.8	2.5%
Serpentine Pipehead Dam	2,885	397	13.8%	6.9	0.2%	2.8	0.1%	-	-	-	-	-	-	-	-	-	-
South Dandalup Dam	31,675	8,804	27.8%	3.6	0.0%	267.1	0.8%	6.0	0.0%	2.3	0.1%	0.0%	-	-	-	-	-
South Dandalup Pipehead Dam Catchment Area	3,854	654	17.0%	10.3	0.3%	64.8	1.7%	1.0	0.0%	1.0	0.1%	0.0%	-	-	-	-	-
Unregulated catchments	-	-	-	10.0	-	128.8	-	0.5	-	0.5	0.0%	-	-	-	-	-	-
Huntly Subtotal	127,107	28,769	22.6%	468.7	0.4%	1,592.8	1.3%	663	0.5%	296	17.6%	0.2%	183	13.2%	0.1%	3,204.2	2.5%
Bancell Brook Catchment Area	1,838	445	24.2%	0.4	0.0%	43.0	2.3%	-	0.0%	-	0.0%	0.0%	-	0.0%	-	-	-
Samson Brook	7,755	1,703	22.0%	84.3	1.1%	155.6	2.0%	17.9	0.2%	10.8	1.4%	0.1%	2.8	1.7%	0.0%	271.4	3.5%

Catchment	Catchment area (ha)	Catchment area TWI>9		Open Area TWI>9		Rehabilitation Area TWI>9		FCA Endorsed Area TWI>9		24 Month Clearing Schedule Area TWI>9			5 Year Clearing Schedule Area TWI>9			Total Future Mined TWI>9	
		Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of Five Year Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)
Stirling Dam	25,366	3,587	14.1%	92.5	0.4%	0.8	0.0%	113.7	0.4%	80.9	10.4%	0.3%	23.4	12.9%	0.1%	311.3	1.2%
Unregulated catchments	-	-	-	73.6	-	225.9	-	89.1	-	23.0	2.9%		54.8	3.7%		466.4	-
Willowdale Subtotal	34,958	5,735	16.4%	250.8	0.7%	425.2	1.2%	221	0.6%	115	14.7%	0.3%	81	18.3%	0.2%	1,092.4	3.1%
Total	162,065.21	34,504.43	21.3%	719.4	0.4%	2,018.0	1.2%	883.80	0.5%	411.01	16.7%	0.3%	264.40	20.4%	0.2%	4,296.6	2.7%

Table 7-11: Clearing impacts to slopes greater than 16%

Catchment	Catchment area (ha)	Catchment area >16%		Open Areas >16%		Rehabilitation Areas >16%		FCA Endorsed Area >16%		24 Month Clearing Schedule Area >16% slope			5 Year Clearing Schedule Area >16%			Total Future Mined	
		Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of Five Year Clearing Area (%)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)
Conjurunup Creek Pipehead Dam Catchment Area	3,922	254.3	6.5%	1.1	0.0%	92.0	2.3%	0.0	0.0%	0.1	0.0%	0.0%	-	-	-	93.2	2.4%
Dirk Brook Water Reserve	3,116	152.5	4.9%	3.1	0.1%	11.4	0.4%	0.2	0.0%	0.3	0.0%	0.0%	0.3	0.0%	0.0%	15.4	0.5%
North Dandalup	15,165	786.2	5.2%	23.4	0.2%	132.9	0.9%	5.1	0.0%	6.2	0.4%	0.0%	3.7	0.3%	0.0%	171.3	1.1%
Serpentine Dam	66,490	7,398.0	11.1%	426.3	0.6%	212.9	0.3%	69.0	0.1%	342.1	20.3%	0.5%	259.2	18.6%	0.4%	1,309.5	2.0%
Serpentine Pipehead Dam	2,885	972.5	33.7%	6.3	0.2%	18.7	0.6%	-	-	-	-	-	-	-	-	25.0	0.9%
South Dandalup Dam	31,675	1,256.7	4.0%	0.2	0.0%	123.5	0.4%	0.0	0.0%	0.5	0.0%	0.0%	-	-	-	124.3	0.4%
South Dandalup Pipehead Dam Catchment Area	3,854	1,214.9	31.5%	6.1	0.2%	84.3	2.2%	0.0	0.0%	2.0	0.1%	0.1%	-	-	-	92.4	2.4%
Unregulated catchments	-	-	-	2.9	-	65.6	-	-	-	-	-	-	-	-	-	68.5	-
Huntly Subtotal	127,107	12,035	9.5%	470	0.4%	741.2	0.6%	74.2	0.1%	351.3	20.8%	0.3%	263.2	18.9%	0.2%	1,899.6	1.5%
Bancell Brook Catchment Area	1,838	44.0	2.4%	0.1	0.0%	4.7	0.3%	-	-	-	-	-	-	-	-	4.7	0.3%
Samson Brook	7,755	1,006.8	13.0%	23.7	0.3%	91.1	1.2%	1.9	0.0%	13.6	0.8%	0.2%	19.1	3.0%	0.2%	149.3	1.9%
Stirling Dam	25,366	1,933.9	7.6%	16.0	0.1%	0.0	0.0%	3.3	0.0%	21.5	1.3%	0.1%	45.1	7.2%	0.2%	85.9	0.3%
Unregulated catchments	-	-	-	81.3	-	280.2	-	1.3	-	0.9	0.1%	-	2.9	0.5%	-	366.6	-
Willowdale Subtotal	34,958	2,985	8.5%	121.1	0.3%	376.0	1.1%	6.5	0.0%	36.0	2.1%	0.1%	67	10.7%	0.2%	606.6	1.7%
Total	162,065	15,020	9.3%	590.7	0.4%	1,117.2	0.7%	80.7	0.0%	387.3	15.7%	0.2%	330.27	16.4%	0.2%	2,506.1	1.5%

Table 7-12: Clearing areas with average sloper greater than 16%

Catchment	Catchment area (ha)	24 Month Clearing Schedule Area >16% average slope		24 Month Clearing Schedule Area >16% and <18% average slope		24 Month Clearing Schedule Area >18% and <22% average slope		24 Month Clearing Schedule Area >22% average slope	
		Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)
North Dandalup	15,165	6.1	0.4%	0.1	0.0%	-	0.0%	-	0.0%
Serpentine Dam	66,490	343.0	20.3%	172.1	10.2%	137.8	8.2%	41.2	2.4%

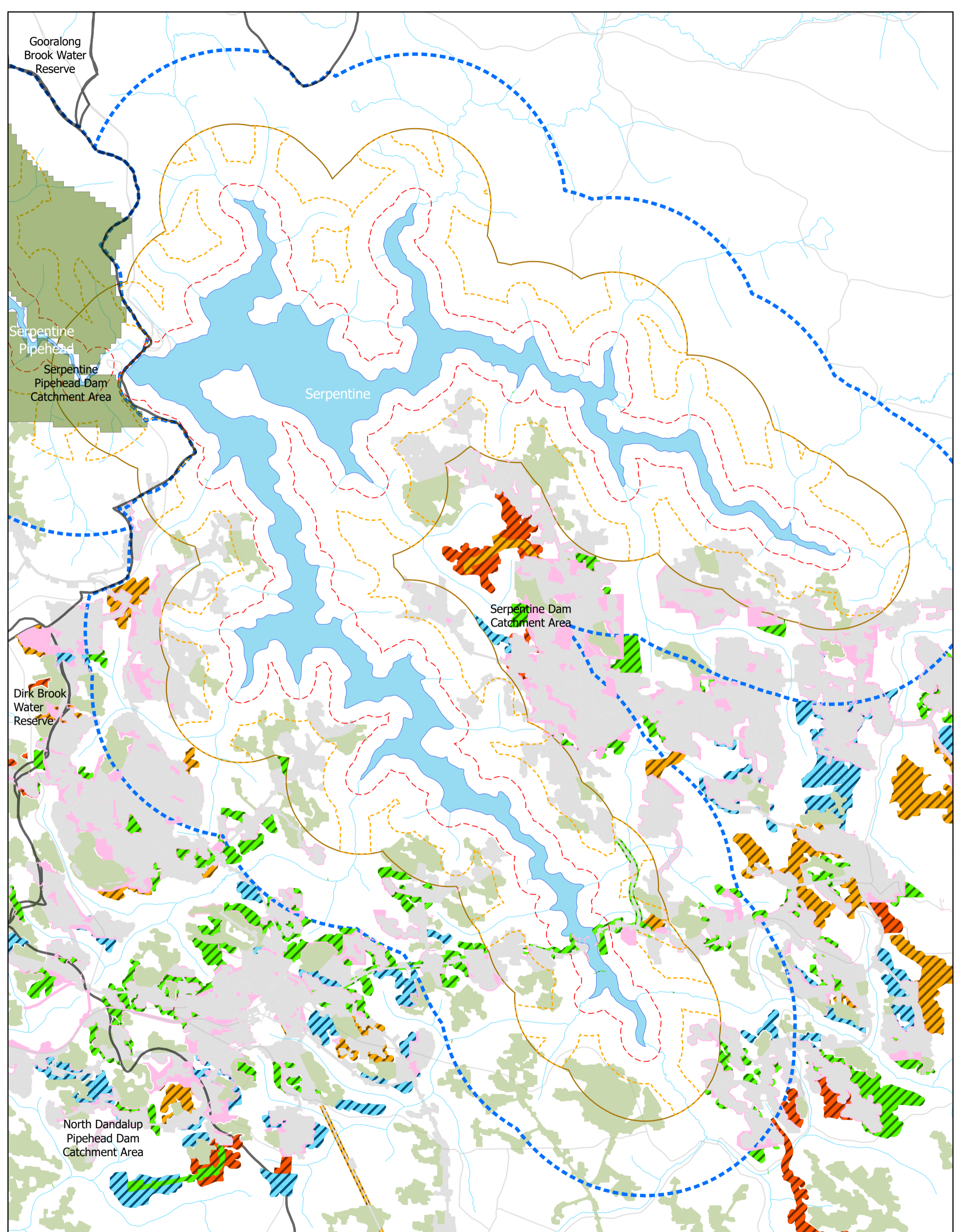
Catchment	Catchment area (ha)	24 Month Clearing Schedule Area >16% average slope		24 Month Clearing Schedule Area >16% and <18% average slope		24 Month Clearing Schedule Area >18% and <22% average slope		24 Month Clearing Schedule Area >22% average slope	
		Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)	Area (ha)	Proportion of 24 Month Clearing Area (%)
South Dandalup Dam	31,675	0.5	0.0%	-	0.0%	0.2	0.0%	-	0.0%
South Dandalup Pipehead Dam Catchment Area	3,854	2.2	0.1%	0.2	0.0%	0.1	0.0%	-	0.0%
Samson Brook	7,755	14.5	1.9%	13.1	1.7%	7.4	0.9%	0.0	0.0%
Stirling Dam	25,366	23.3	3.0%	2.7	0.4%	0.0	0.0%	-	0.0%

Table 7-13: Clearing impacts to sub-catchments

Sub-Catchment	Sub-Catchment area (ha)	Open areas		Rehabilitated areas		FCA Endorsed areas		24 Month Clearing Schedule Areas		Proportion of sub-catchment clearing following 24 Month Clearing Schedule Areas			Remaining Five Year Clearing Schedule Areas		Maximum proportion of sub-catchment clearing following total future mined areas (%)
		Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	After open areas (%)	After open areas and rehabilitation (%)	After open areas, rehabilitation and FCA Endorsed clearing (%)	Area (ha)	Proportion of sub-catchment (%)	
BIG BROOK 01	214.5	32.8	15%	6.9	3%	4.56	2%	6.5	3%	18%	22%	24%	-	-	24%
BIG BROOK 02	250.7	61.8	25%	19.5	8%	4.91	2%	0.8	0%	25%	33%	35%	-	-	35%
BIG BROOK 03	821.0	347.6	42%	68.1	8%	49.67	6%	10.7	1%	44%	52%	58%	3.1	0%	58%
BIG BROOK 05	504.0	168.4	33%	3.6	1%	16.16	3%	-	-	33%	34%	37%	0.9	0%	38%
BIG BROOK 07	749.9	205.3	27%	37.5	5%	34.35	5%	31.7	4%	32%	37%	41%	9.6	1%	42%
BIG BROOK 09	1,829.0	333.5	18%	321.5	18%	44.59	2%	15.5	1%	19%	37%	39%	61.9	3%	42%
BIG BROOK 13	574.4	112.7	20%	49.3	9%	19.10	3%	-	-	20%	28%	32%	3.0	1%	32%
BIG BROOK 14	1,160.0	70.3	6%	373.9	32%	0.01	0%	6.2	1%	7%	39%	39%	-	-	39%
BIG BROOK 15	1,661.7	68.3	4%	540.3	33%	2.69	0%	0.6	0%	4%	37%	37%	-	-	37%
BIG BROOK 16	1,355.5	-	-	199.2	15%	-	-	1.2	0%	0%	15%	15%	-	-	15%
BIG BROOK 18	1,708.9	-	-	223.7	13%	-	-	64.5	4%	4%	17%	17%	-	-	17%
BOOMER BROOK UPPER	606.5	9.6	2%	73.5	12%	-	-	3.9	1%	2%	14%	14%	-	-	14%
CONJURUNUP 04	364.9	7.4	2%	229.8	63%	0.00	0%	0.4	0%	2%	65%	65%	-	-	65%
CONJURUNUP 05	1,096.6	28.9	3%	511.1	47%	0.16	0%	4.9	0%	3%	50%	50%	-	-	50%
CONJURUNUP 06	773.2	15.2	2%	414.2	54%	0.00	0%	2.3	0%	2%	56%	56%	-	-	56%
CRONIN BROOK 07	2,030.5	146.7	7%	604.8	30%	32.39	2%	12.1	1%	8%	38%	39%	49.1	2%	42%
FOSTER BROOK	1,601.8	258.5	16%	398.3	25%	62.09	4%	14.3	1%	17%	42%	46%	46.6	3%	49%
KIMBERLING HILL	2,835.7	-	-	-	-	-	-	41.0	1%	1%	1%	1%	69.6	2%	4%
LANG BROOK	1,412.9	331.4	23%	188.3	13%	71.91	5%	6.2	0%	24%	37%	42%	11.7	1%	43%
LUCY BROOK	274.3	12.2	4%	9.6	3%	0.42	0%	1.3	0%	5%	8%	9%	-	-	9%
MIA MIA CREEK	336.1	10.0	3%	101.8	30%	0.00	0%	0.3	0%	3%	33%	33%	-	-	33%

Sub-Catchment	Sub-Catchment area (ha)	Open areas		Rehabilitated areas		FCA Endorsed areas		24 Month Clearing Schedule Areas		Proportion of sub-catchment clearing following 24 Month Clearing Schedule Areas			Remaining Five Year Clearing Schedule Areas		Maximum proportion of sub-catchment clearing following total future mined areas (%)
		Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	After open areas (%)	After open areas and rehabilitation (%)	After open areas, rehabilitation and FCA Endorsed clearing (%)	Area (ha)	Proportion of sub-catchment (%)	
MOUNT SOLUS	1,416.7	187.6	13%	211.6	15%	34.33	2%	112.9	8%	21%	36%	39%	30.5	2%	41%
NORTH DANDALUP RIVER 11	923.9	2.0	0%	192.6	21%	0.00	0%	1.4	0%	0%	21%	21%	-	-	21%
NORTH DANDALUP RIVER 14	852.9	11.6	1%	302.6	35%	0.02	0%	2.1	0%	2%	37%	37%	-	-	37%
NORTH DANDALUP RIVER 15	3,968.7	109.2	3%	1,285.8	32%	18.49	0%	11.9	0%	3%	35%	36%	-	-	36%
NULLBIG BROOK 08	270.5	73.7	27%	27.6	10%	3.42	1%	-	-	27%	37%	39%	3.3	1%	40%
NULLBIG BROOK 17	1,991.5	-	-	198.1	10%	-	-	25.5	1%	1%	11%	11%	-	-	11%
O'NEILL BROOK 02	1,893.9	0.0	0%	333.1	18%	-	-	61.1	3%	3%	21%	21%	-	-	21%
O'NEILL BROOK 03	867.6	-	-	25.9	3%	-	-	81.4	9%	9%	12%	12%	-	-	12%
SERPENTINE RIVER 36	729.9	159.4	22%	56.6	8%	37.65	5%	14.6	2%	24%	32%	37%	5.4	1%	37%
SERPENTINE RIVER 40	999.5	336.9	34%	65.7	7%	65.82	7%	0.7	0%	34%	40%	47%	30.5	3%	50%
SERPENTINE RIVER 45	615.6	182.7	30%	9.2	1%	36.15	6%	39.1	6%	36%	38%	43%	31.3	5%	48%
SERPENTINE RIVER 49	356.3	22.8	6%	-	-	27.71	8%	40.6	11%	18%	18%	26%	11.6	3%	29%
SERPENTINE RIVER 50	348.3	30.6	9%	-	-	8.89	3%	25.0	7%	16%	16%	18%	-	-	18%
SERPENTINE RIVER 51	277.4	2.0	1%	-	-	9.39	3%	4.9	2%	3%	3%	6%	-	-	6%
SERPENTINE RIVER 55	1,208.2	21.0	2%	-	-	33.72	3%	38.1	3%	5%	5%	8%	71.2	6%	14%
SERPENTINE RIVER 56	1,003.1	6.0	1%	111.6	11%	1.84	0%	16.5	2%	2%	13%	14%	42.7	4%	18%
SERPENTINE RIVER 57	775.4	0.0	0%	105.8	14%	-	-	32.5	4%	4%	18%	18%	45.8	6%	24%
SERPENTINE RIVER 58	2,342.7	-	-	113.9	5%	-	-	-	-	0%	5%	5%	80.8	3%	8%
SERPENTINE RIVER 61	3,715.9	-	-	-	-	-	-	-	-	0%	0%	0%	28.1	1%	1%
SERPENTINE RIVER 62	4,248.0	-	-	-	-	-	-	2.1	0%	0%	0%	0%	124.2	3%	3%
SOUTH DANDALUP RIVER 05	387.4	25.3	7%	151.3	39%	0.00	0%	1.1	0%	7%	46%	46%	-	-	46%
TURNER HILL	862.3	10.0	1%	145.3	17%	-	0%	4.7	1%	2%	19%	19%	-	-	19%
DRIVERS HILL	1,436.3	185.8	13%	-	-	49.78	3%	23.3	2%	15%	15%	18%	26.9	2%	20%
HARVEY RIVER 33	968.1	-	-	-	-	3.17	0%	-	-	0%	0%	0%	0.9	0%	0%
HARVEY RIVER 34	1,033.3	71.0	7%	-	-	26.36	3%	70.3	7%	14%	14%	16%	38.3	4%	20%
HARVEY RIVER 37	1,322.1	210.1	16%	15.5	1%	65.71	5%	110.6	8%	24%	25%	30%	58.1	4%	35%
HARVEY RIVER 38	1,178.1	125.0	11%	7.0	1%	31.38	3%	23.5	2%	13%	13%	16%	-	0%	16%

Sub-Catchment	Sub-Catchment area (ha)	Open areas		Rehabilitated areas		FCA Endorsed areas		24 Month Clearing Schedule Areas		Proportion of sub-catchment clearing following 24 Month Clearing Schedule Areas			Remaining Five Year Clearing Schedule Areas		Maximum proportion of sub-catchment clearing following total future mined areas (%)
		Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	Area (ha)	Proportion of sub-catchment (%)	After open areas (%)	After open areas and rehabilitation (%)	After open areas, rehabilitation and FCA Endorsed clearing (%)	Area (ha)	Proportion of sub-catchment (%)	
LAKE KABBAMUP 05	763.2	68.2	9%	3.8	0%	15.96	2%	2.4	0%	9%	10%	12%	51.6	7%	19%
LAKE KABBAMUP 07	856.3	84.0	10%	57.2	7%	6.39	1%	7.4	1%	11%	17%	18%	2.7	0%	18%
MOUNT WILLIAM	1,158.4	99.6	9%	255.9	22%	17.46	2%	46.7	4%	13%	35%	36%	-	-	36%

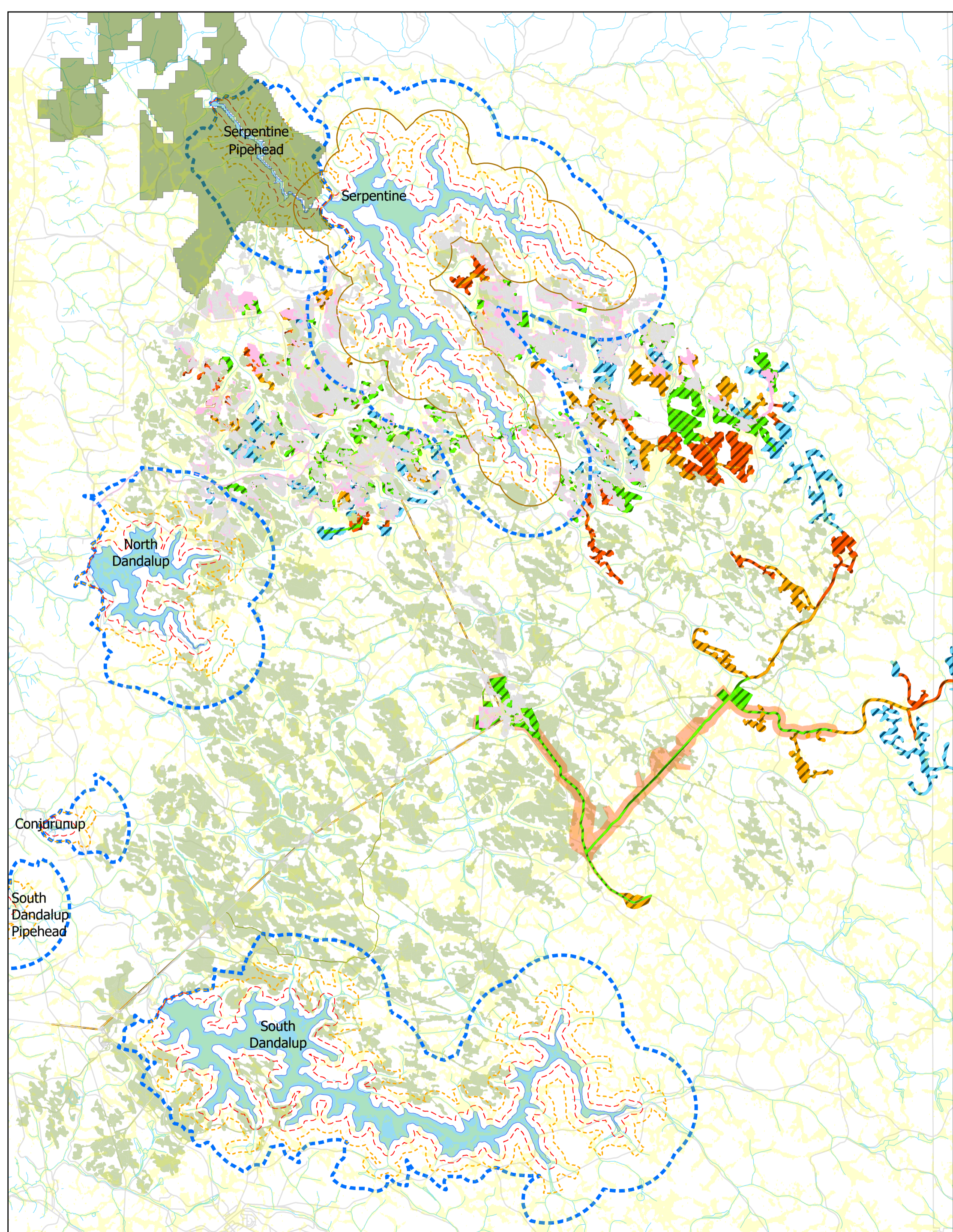


Legend

<p>Proposed Clearing Schedule</p> <ul style="list-style-type: none"> 2024 2025 2026 2027 	<ul style="list-style-type: none"> FCA Endorsed Reservoir Top of Water Line (TWL) OCA1 OCA2 1km Radius from Reservoir TWL Reservoir Protection Zone (RPZ) 	<ul style="list-style-type: none"> Catchments Streams Rehabilitation Cleared Areas National Parks
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2023 – 2027 Mining and Management Plan	
Figure 7-4: RPZ indicative estimates of mining disturbance - Huntly	
Scale: 1:43,481	Date Printed: 31/10/2023



Legend

Proposed Clearing Schedule	FCA Endorsed	Reservoir Top of Water Line (TWL)
2024	TWI	Streams
2025	OCA1	National Parks
2026	OCA2	Rehabilitation
2027	1km Radius from Reservoir TWL	Cleared Areas
Conceptual Clearing Buffer	Reservoir Protection Zone (RPZ)	

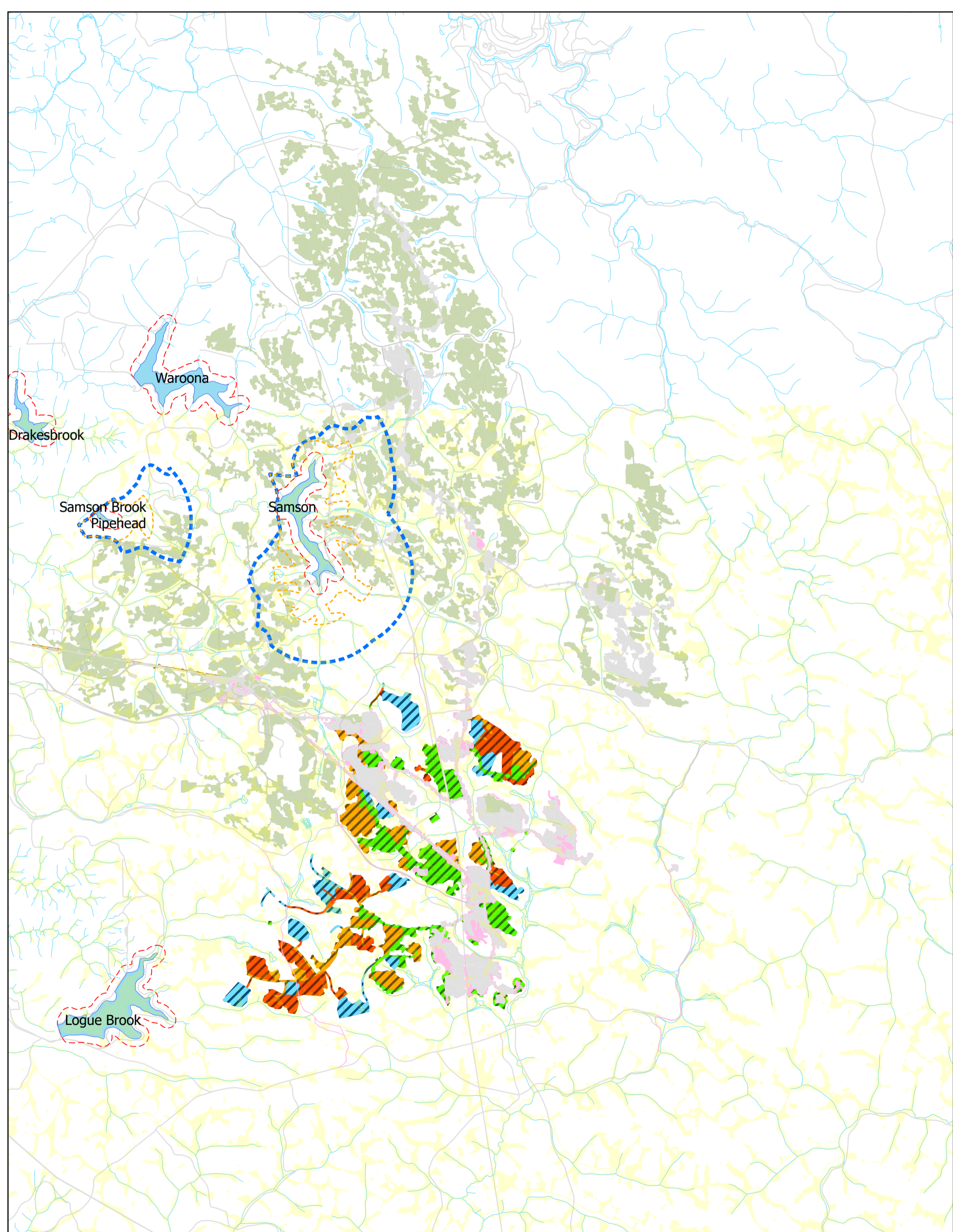


2023 – 2027 Mining and Management Plan

Figure 7-5: Clearing impacts to TWI greater than 9 - Huntly

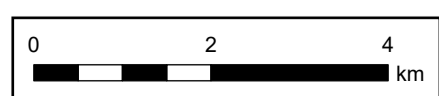
Scale: 1:109,015

Date Printed: 2/11/2023



Legend

Proposed Clearing Schedule	FCA Endorsed	Reservoir Top of Water Line (TWL)
2024	TWI	Streams
2025	OCA1	National Parks
2026	OCA2	Rehabilitation
2027	1km Radius from Reservoir TWL	Cleared Areas
Conceptual Clearing Buffer	Reservoir Protection Zone (RPZ)	

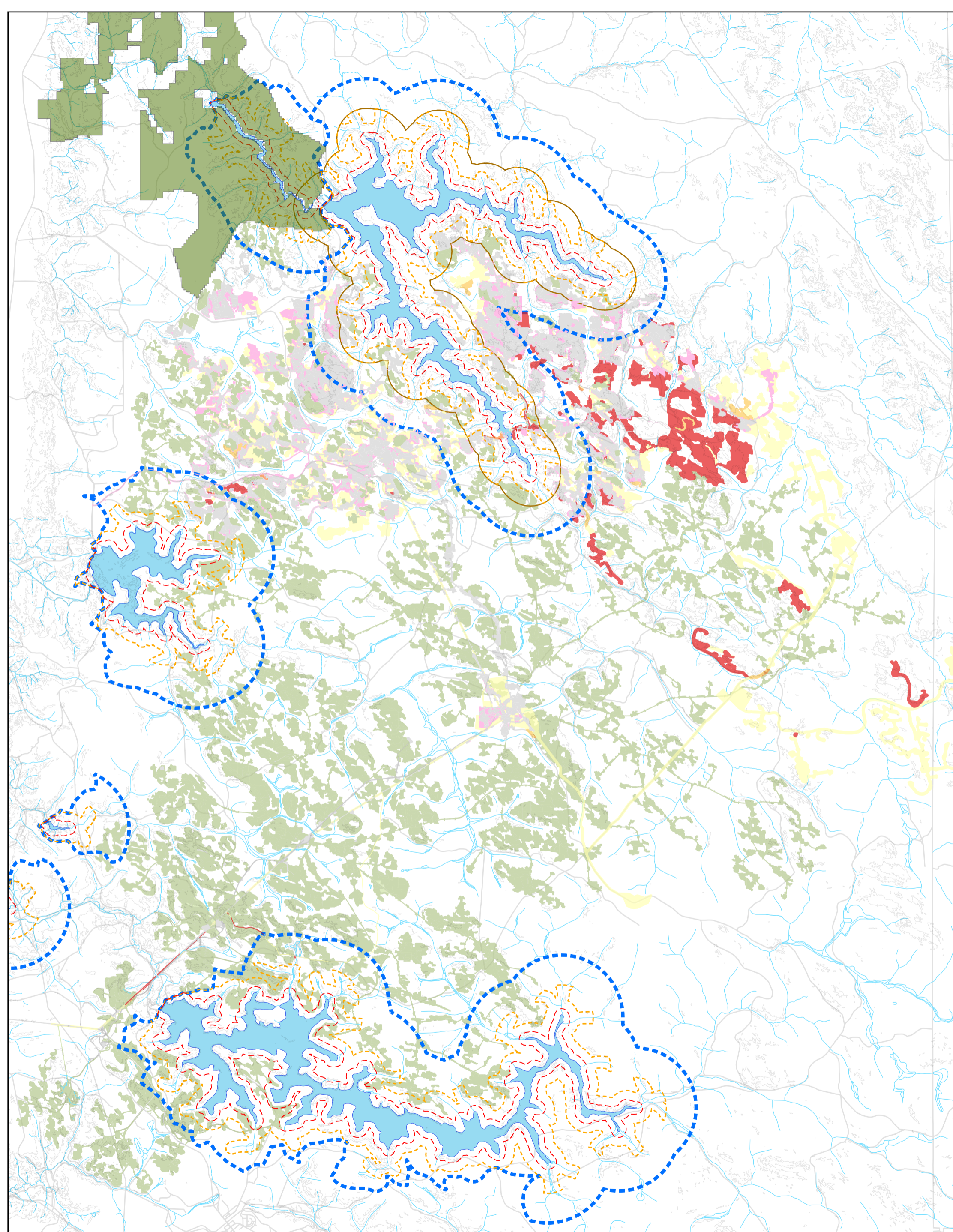


2023 – 2027 Mining and Management Plan

Figure 7-6: Clearing impacts to TWI greater than 9 - Willowdale

Scale: 1:85,380

Date Printed: 2/11/2023



Legend

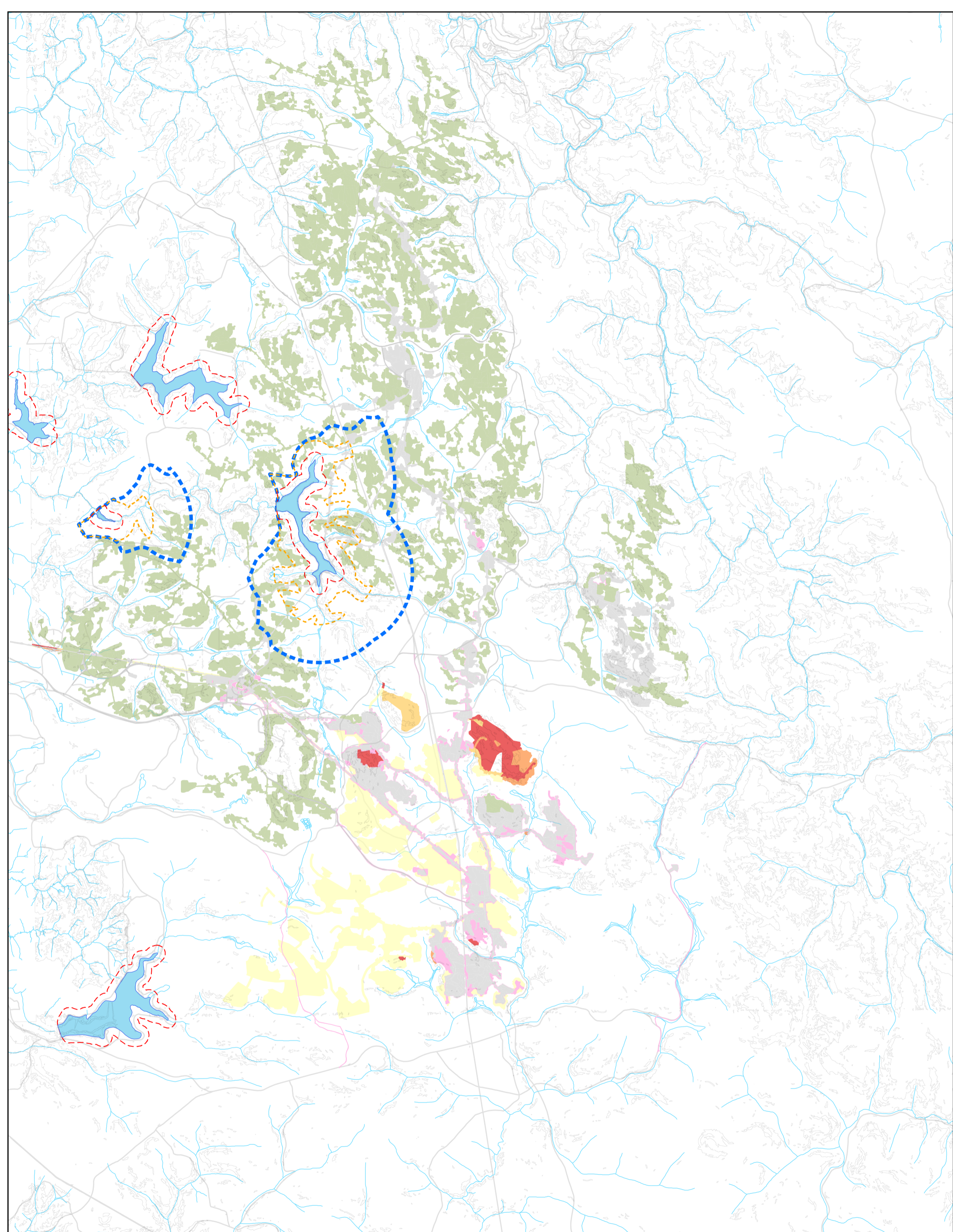
Proposed Clearing Schedule	DOLA Derived Slope	Streams
0 - 16 %	FCA Endorsed	Reservoir Protection Zone (RPZ)
16.1 - 18%	Reservoir Top of Water Line (TWL)	Rehabilitation
18.1 - 22%	1km Radius from Reservoir TWL	Cleared Areas
22.1 - 100%	OCA1	National Parks
	OCA2	



2023 – 2027 Mining and Management Plan

Figure 7-7: Clearing impacts to slopes greater than 16% - Huntly

Scale: 1:109,015	Date Printed: 2/11/2023
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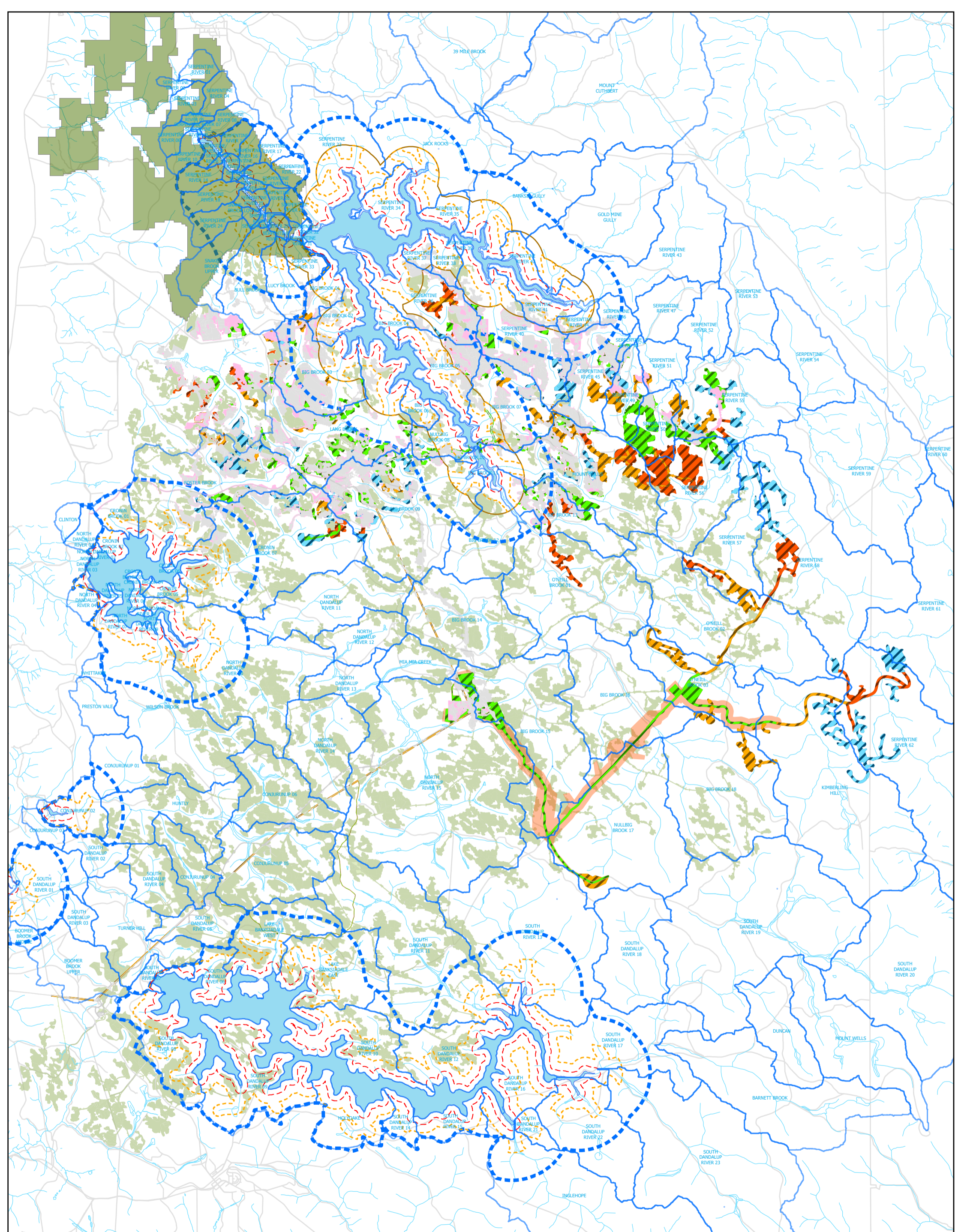


Legend

<p>Proposed Clearing Schedule</p> <ul style="list-style-type: none"> 0 - 16 % 16.1 - 18% 18.1 - 22% 22.1 - 100% 	<ul style="list-style-type: none"> DOLA Derived Slope FCA Endorsed Reservoir Top of Water Line (TWL) OCA1 OCA2 	<ul style="list-style-type: none"> Streams Reservoir Protection Zone (RPZ) Rehabilitation Cleared Areas National Parks
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2023 – 2027 Mining and Management Plan	
Figure 7-8: Clearing impacts to slopes greater than 16% - Willowdale	
Scale: 1:85,380	Date Printed: 2/11/2023



Legend

- | | | |
|----------------------------|-----------------------------------|---------------------------------|
| Proposed Clearing Schedule | FCA Endorsed | Streams |
| 2024 | Subcatchments | Reservoir Protection Zone (RPZ) |
| 2025 | Reservoir Top of Water Line (TWL) | Rehabilitation |
| 2026 | 1km Radius from Reservoir TWL | Cleared Areas |
| 2027 | OCA1 | National Parks |
| Conceptual Clearing Buffer | OCA2 | |

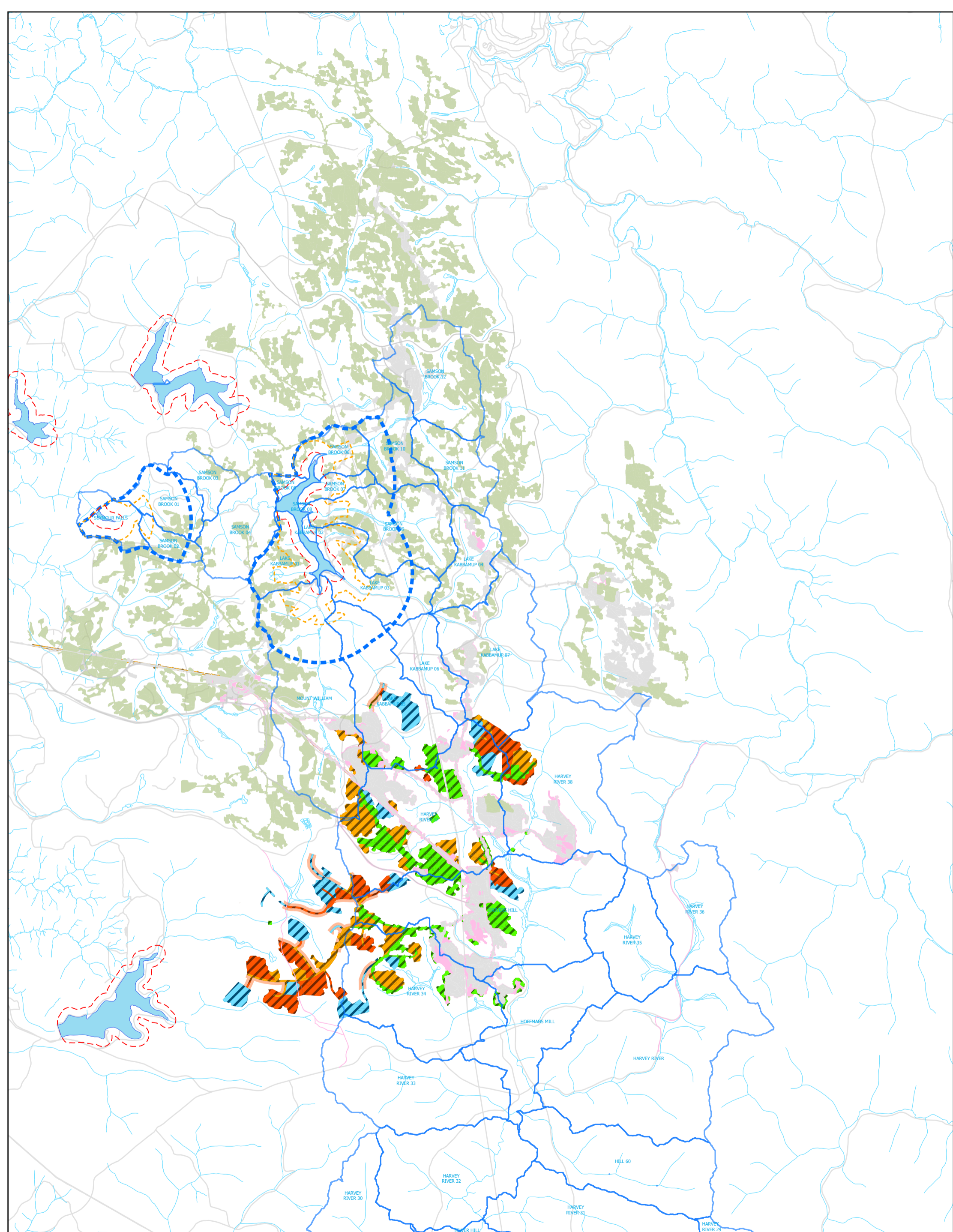


2023 – 2027 Mining and Management Plan

Figure 7-9: Clearing impacts to sub-catchments - Huntly

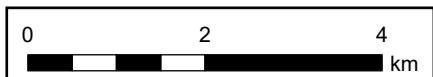
Scale: 1:117,352

Date Printed: 31/10/2023



Legend

2024	FCA Endorsed	Streams
2025	Subcatchments	Reservoir Protection Zone (RPZ)
2026	Reservoir Top of Water Line (TWL)	Cleared Areas
2027	OCA1	Rehabilitation
24 Month Conceptual Clearing Buffer	OCA2	National Parks



2023 – 2027 Mining and Management Plan

Figure 7-10: Clearing impacts to subcatchments - Willowdale

Scale: 1:85,380

Date Printed: 2/11/2023

7.2.3.1 Drinking Water Risk Assessment

A quantitative hydrological assessment of the drinking water reservoir was undertaken for the future Huntly mine by GHD (2022) and an associated Drinking Water Risk Assessment (DWRA). The assessment focussed on the Myara North and Holyoake mine regions, which are not included in the 24 month or Five Year Mine Plans presented in this document.

However, Myara North is located within the Serpentine Catchment and Alcoa proposes to revise the surface hydrology model, and associated DWRA, to reflect Huntly mining operations in 2023 and Willowdale mining operations in 2024. In the interim, the potential impacts to Serpentine Dam, from Myara North future mine region, is presented below for comparative purposes.

The potential turbidity hazards for the Serpentine, South Dandalup and Pipehead PDWSAs have been modelled by GHD (2022) in the form of inorganic clay and silt particles, simulating turbidity inputs associated with natural waterways and mining sumps. The predicted effects of large inflow events and associated drainage failures on the suspended solids in the reservoirs and withdrawals were evaluated.

The hydrodynamic modelling simulated the relative differences of large winter and summer inflow events on reservoir and withdrawal turbidity levels represented by 10% and 1% Average Exceedance Probability (AEP) events, equivalent to a return period of approximately 10 years and 100 years, respectively. The 10% and 1% AEP inflow events were assumed to occur in combination with either moderate (30%) and high (75%) failure rates in mine sediment controls. Turbidity was modelled as suspended sediment for scenarios of baseline (no-mining), existing mining and additional mining associated with Myara North.

The predicted effects of major sediment releases and assumed sediment control failures on the reservoirs and offtake water quality were as follows:

- Increased concentrations of coarser suspended sediments (silt fractions) were of short duration due to the relatively rapid settling within reservoirs before reaching the offtake. Increased concentrations that occurred at the offtake were predominantly fine suspended sediments (clay fractions).
- For Serpentine Dam with moderate failure in mine sediment controls, there was limited change in suspended sediment between the non-mining and mining scenarios for either winter or summer 10 % AEP events. Suspended sediment increases of up to ~0.5 mg/L and ~0.2-0.3 mg/L were simulated for moderate failure in mine sediment controls for the summer and winter 1% AEP inflow events, respectively. The relatively higher increases for summer are due to the presence of thermal stratification and more limited mixing compared to winter.
- For Serpentine Dam with high failure of mine sediment controls, there was also limited change in suspended sediment between the non-mining and mining scenarios for either winter or summer 10% AEP events. Suspended sediment increases of up to ~1 mg/L and ~0.3-0.4 mg/L were simulated for high failure in mine sediment controls for the summer and winter 1% AEP inflow events, respectively.

GHD (2022) has assumed that Total Suspended Solids are comparable to Turbidity NTU in a 1:1 ratio. The hydrodynamic modelling findings indicate that Serpentine Dam suspended sediment and therefore turbidity concentrations are sensitive to high levels of failure in mine sediment controls during a major storm (greater than a 10% AEP or ten year return period) event, as the existing and proposed mining would comprise a sufficient proportion of the catchment. GHD (2022) noted that elevated levels of inorganic suspended sediments of up to 1 mg/L (equivalent to about 1-2 NTU) are not expected to affect disinfection efficacy.

7.2.3.2 Catchment Turbidity Data Statistical Correlation

Recognising that catchment water runoff turbidity targeted modelling required data calibration, Alcoa engaged *Data Analysis Australia* (DAA 2023; Appendix 10) to statistically evaluate turbidity data with catchment and mining characteristics, in particular sub-catchment clearing and terrain slope. The aim was to develop a data-based understanding on high turbidity event correlations and determine what mitigation, in addition to existing controls, may be required through:

- Understanding the relationship between catchment features, including mining and rehabilitation, and turbidity events.
- Understanding the relationship between drainage failures and contributing factors, including characteristics of sub-catchments and the wider catchment in which they occur.
- Investigating any differences between mined and rehabilitated areas and undisturbed areas in relation to their susceptibility to drainage failures.

Available data was obtained, spanning 27 turbidity monitors over the period January 2016 to September 2022. Data gaps were addressed and the data was 'cleaned' to remove readings that could be attributed to faults or periods where equipment was inoperable and ensure it was in an appropriate format for modelling.

A preliminary correlation analysis considered the influence of key variables where turbidity events or drainage failures have and haven't occurred. The correlation analysis included the below variables:

- Mined versus undisturbed sub-catchments.
- Sub-catchment characteristics present during events, including area cleared and slope.
- Maturity levels of rehabilitation, including Leaf Area Index (LAI).

Statistical modelling determined which variables had significant impact on turbidity events and if significant difference between the likelihood of drainage failures between mined areas, rehabilitation areas or undisturbed areas existed. This assessment aimed to develop a statistical data-based understanding on high turbidity event correlations with sub-catchment clearing area and terrain slope gradient to determine what mitigation, in addition to existing controls, may be required.

Key conclusions are:

- Catchment slope has a significant, positive effect on both the occurrence or number of high turbidity events, with more events occurring in catchments with higher mean slope. However, there is no statistical indication of an appropriate maximum slope threshold.

- Rainfall has a significant, positive effect on both the occurrence and number of high turbidity events and their number using any model, with more events in wetter months.
- When only total percentage cleared area (including subsequently rehabilitated areas) is considered, it has no effect on the chance of high turbidity events occurring or on the number of high turbidity events if they occur.
- When the percentage area cleared but not rehabilitated is considered, it is found to have a significant positive effect on the occurrence of events but not on their number.
- When both clearing and rehabilitation are considered, percentage area rehabilitated has a significant negative effect on the chance of high turbidity events occurring.

Considering these results together, it is determined that the total percentage cleared area has no significant effect (negative or positive) on high turbidity events. However, the two components contribute in the following manner:

- Percentage cleared but not rehabilitated has a positive effect.
- Percentage cleared and rehabilitated has a negative effect.

The best-fitting model can be used to predict the expected number of events in different scenarios and can consider changes in a single factor, keeping all else constant. This shows that:

- Risk of high turbidity events increases with increasing areas of clearing in the absence of rehabilitation.
- Risk of high turbidity events decreases with increasing levels of rehabilitation.
- Risk of high turbidity events increases with increasing catchment mean slope.
- High turbidity events can be expected within uncleared catchments.

It is acknowledged that mining within an area increases the likelihood of high turbidity events, however rehabilitation decreases the risk. This statistical based assessment of catchment turbidity with sub-catchment and mining characteristics, together with other recent catchment turbidity related assessments by Alcoa (including Silberstein 2022), presents a substantial body of knowledge. Alcoa supports and will undertake further collaborative catchment turbidity research based on this established knowledge base, in consultation with the Bauxite Hydrology Committee.

7.2.3.3 Groundwater Induced Streamflow and Stream Zone Turbidity

Alcoa recognised the potential risk that catchment turbidity and sedimentation can be derived directly from mining activity and indirectly from clearing induced increased stream flow effect on bank erosion relative to natural condition. Alcoa partnered with *Hydrological and Environmental Scientific Solutions* (Silberstein 2022; Appendix 10) to conduct a catchment research literature review focusing on studies concerning land use change effects on stream zone erosion and turbidity. In particular, near stream erosion and resultant turbidity are potentially impacted through the following mechanisms:

- Groundwater rise may discharge directly to streams or may result in greater runoff generation on wetted areas, particularly in lower slope positions.

- These wetted areas are likely to generate more sediment mobilisation by modification to the structure and stability of the near stream material.
- Studies have noted that peak discharges often increase much more, and for longer periods after rehabilitation, than mean discharges and it is the high flow events most likely to cause bank erosion and sediment delivery to streams.
- The increased moisture content in stream bank soils, accompanying raised groundwater, can result in a reduction in bank stability such that bank erosion may increase, even without an increase in the size of flow events over historical levels.

The preliminary conclusions of the literature review outline there is limited availability of data from the south-west of Western Australia on sediment mobilisation and turbidity in streams resulting from land use changes. The recommendations in the literature review report seeks to identify targeted collaborative research for stream zone generated turbidity cause and effect, and specific technical controls for consideration within Alcoa Drainage Design Manual.

7.2.4 Increased sediment from erosion of post-mining landforms

Mine development involves stripping and stockpiling the superficial soils, blasting or ripping the caprock layer then removing the bauxite caprock and friable fragmental layers. Following the completion of mining, rehabilitation is undertaken including pre-ripping of compacted floors to at least 1.2 m, landscaping batters, spreading overburden and topsoil (typically 300 mm combined depth), then contour ripping to create a furrowed surface.

The net effect of bauxite mining of Jarrah forest soils is the removal of an approximately 4-6 m thick layer of caprock and friable fragmental material, and replacement of the seed rich topsoil and overburden over a ripped, friable substrate of sandy loams and clays. The total depth of friable material created is about 1.5 m, including topsoil, overburden and ripped substrate.

The establishment of a 1.5 m thick friable layer of topsoil, overburden and ripped substrate provides a comparable, though generally thicker, stratum than the topsoil and overburden present above the caprock prior to mining. The friable layer enables development of a dense root structure of Jarrah forest vegetation as occurs in the topsoil and overburden present prior to mining. There is expected to be a partial loss of soil water capacity due to the removal of the bauxite friable fragmental layer, which comprised about 2 m of loamy soils that previously were accessed by deep and medium rooted vegetation. Loss of this layer represents approximately 10% of the regolith thickness, however the loamy layer may have had a higher plant available water than that of the underlying mottled and pallid clays. Loss of the bauxite caprock layer is not expected to substantially reduce the soil water capacity, as the layer was primarily cemented material that provided discrete pathways for water and roots to enter the underlying un-cemented layers.

Loss of the bauxite friable fragmental layer has not been observed to result in impaired growth or health of rehabilitation (Browers et al 2012). Monitoring of rehabilitation has demonstrated the successful establishment and persistence of an LAI of 2-2.5, comparable to that of un-mined Jarrah forest. Monitoring has also indicated a floristic diversity of about 80% to 100% of un-mined forest, declining weed cover and sustained understorey coverage. The results of monitoring collectively demonstrate that Alcoa's rehabilitation establishes and persists, including during drought and

heatwave events, indicating that the 1.5 m thick friable substrate over regolith containing ancient root channels is an effective growth medium. Alcoa research has indicated that mine rehabilitation vegetation is expected to be sustained over the long term with resilience to climate change comparable to that of the un-mined Jarrah forest. Mine rehabilitation is therefore expected to provide long-term protection of soils from erosion and associated sediment discharge to streams and reservoirs.

Mengler et al (2006) surveyed topsoil and overburden samples in rehabilitated mine pits at the Huntly Mine. The survey indicated predominantly sandy gravel texture, comprising an average of 60% gravel (>2 mm diameter, range 38%-78%), 38% sand (2-0.02 mm diameter, range 24%-65%) and 3% silt and clay (<0.02mm diameters, range 0%-6%) for the Mine. Due to the predominant sandy gravel texture, the soils had calculated low erodibility coefficients (RUSLE equation K factors) averaging 0.009 (range 0.000-0.019).

The skeletal topsoil and overburden materials are distinct to most agricultural soils and mining waste due to the low combined clay and silt contents and very high gravel contents, which develop with time a protective surface layer of gravel covering 70 - 80% of the land surface. The high porosity and coarse texture also enable rapid infiltration of rainfall within the topsoil, overburden and ripped regolith material. However, thinly applied topsoil and overburden can be mixed with finer grained pit floor materials during contour ripping, which can introduce more erodible (and potential dispersive) clayey material into the shallow subsurface surface. The regolith beneath the ripped zone generally comprises lower permeability sandy loams and clays, therefore rainfall infiltration is limited to the water storage in the overburden and ripped zoned, accordingly surface runoff occurs following extended rainfall periods that fill up the permeable materials.

Gullies form in the rehabilitated landform through an erosion sequence (Mengler et al 2006). The fine-grained content is displaced from the coarser topsoil/overburden, depositing within the furrows and filling their volume such that surface water overflows and erodes through the fine-grained materials in downslope furrows. The gully that is initially created in the fine-grained materials concentrates flow and creates knickpoints that enable erosion of the coarser topsoil/overburden and underlying ripped regolith materials.

Analysis of gully erosion at the Huntly, Willowdale and Boddington bauxite mines suggested a minimum catchment of 0.3 ha for gully development, with gully volumes typically remaining small (20-100 m³) but potentially increasing for higher slopes (> 10°) and shallower topsoil/overburden placement (< 200 mm). Erosion was highest in the first two to three years following rehabilitation completion until rehabilitation establishes, though there was a lack of long-term data with which to compare the erodibility of rehabilitation to that of un-mined Jarrah forest (Mengler et al 2006). For the period at higher risk of erosion, the major triggers for gully erosion were identified as:

- Directing excessive off-site runoff into the rehabilitation.
- Poor surface completion (e.g., ripping that does not adhere to contours) that concentrates flow or impairs infiltration.
- Insufficient depth of returned topsoil and overburden (< 200 mm combined).

7.2.5 Increases in stream salinity due to mining-induced saline groundwater discharge

Salinity has been identified as a water quality risk as saline water is not potable, and small increases in salinity can affect the aesthetic of the source water. Salinity can have a wider ecosystem impact due to its effect on plant growth/health.

Rainfall varies across ML1SA, being highest to the west near the Darling Scarp and declining to the east. Mean annual evaporation exhibits an approximate inverse trend, increasing to the east, which results in the accumulation of salts in deep soils and increasing groundwater salinity (Schofield et al 1989). By comparison, groundwaters are fresh in the high rainfall zone near the Darling Scarp. The intermediate rainfall zone (IRZ), which has a long-term average of 900–1100 mm/year, has recorded groundwater that is sufficiently shallow such that clearing of native vegetation has the potential to result in the rise of saline groundwater and its discharge into streams (Dixon et al 2019).

The potential for bauxite mining to result in stream salinity was recognized in the 1970s and led to the development of the Joint Intermediate Rainfall Zone Research Program (JIRZRP)²⁷. Several experiments were conducted under the JIRZRP, including the Trial Mining Project (TMP). The TMP involved the study of the effects of mining and rehabilitation during 2003-2011 in the upper catchments of the Serpentine and Dandalup rivers. The TMP findings indicated an almost complete absence of response to mining in either streamflow or stream salinity (Croton et al 2011). It was concluded that the lack of response was due to the decline in groundwater levels in the regolith and that the groundwater rise from mining was insufficient to cause saline groundwater discharge into streams (Croton et al 2011). Similar findings were reported for other catchments in the IRZ that were subject to forest thinning experiments over a comparable period (Kinal and Stoneman 2011).

Dixon et al (2019) investigated the effects of mining and rehabilitation in the Serpentine Dam catchment using the LUCICAT catchment hydrology model. Dixon et al (2019) modelled a 'no-mining' scenario and two scenarios of mining at nine and 12% of the catchment, under two climate scenarios of average rainfall (914 mm/year) and low rainfall (841 mm/year). The modelled results indicate that streamflow salinity is expected to decrease during mining then increase during rehabilitation. The modelling predicted an inverse trend in streamflow yield, an increase in streamflow during mining, and a decrease during rehabilitation (Dixon et al 2019). Dixon et al (2019) predicted that mining may increase reservoir salinity by up to 3% compared to the no-mining case, which is within acceptable limits.

Streamzone monitoring of mined and un-mined catchments has been undertaken as part of the TMP, with surveys conducted by WRM in 2005, 2007, 2009, 2011, 2014 and 2019 (WRM 2020). Streamzone monitoring involved sampling and comparative analysis of macroinvertebrates, as indicators of potential impacts to aquatic biodiversity. Analyses included univariate and multivariate analysis of species-level metrics including total taxa richness, EPT²⁸ richness, functional feeding groups and Bray-Curtis similarity (WRM 2020).

WRM (2020) concluded that the analyses did not indicate significant differences between the macroinvertebrate communities of sites in mined and un-mined catchments. There was a greater variation in total species richness and EPT taxa richness within the groups of sites in mined and un-

²⁷ <https://www.water.wa.gov.au/water-topics/water-quality/managing-water-quality/effects-of-mining-bauxite-hydrology>

²⁸ EPT Richness estimates water quality by the relative abundance of three major orders of stream insects that have low tolerance to water pollution: *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies).

mined catchments rather than between the groups, indicating that the fauna is more dependent on natural habitat characteristics and localised anthropogenic disturbance at each site.

7.2.6 Changes to hydrological regimes

Groundwater rise associated with clearing and mine pit development is expected. The increase in groundwater level is attributed to removal of native vegetation. Current monitoring data indicates:

- Conceptually, natural groundwater surface geometry mimics terrain surface geometry noting water levels are 15-25 m bgl in higher elevation terrain and relatively lower in stream zones. The water level gradient flattens beneath higher elevation terrain.
- Seasonal fluctuation of 1-5 m is expected, with winter measured water levels assumed to substantively represent the seasonal high.

Research (Grigg (2017)) on the impact of bauxite mining on catchment hydrology, using historical Alcoa mining data, considered three catchments:

- Mined (5 year period of mining and rehab).
- Intense thinning of tree cover by timber harvesting.
- Control catchment, not subject to either mining or recent forestry disturbance

The three catchments were monitored for rainfall, streamflow, groundwater and Leaf Area Index (LAI) over a 36-year period. The nature of responses to mining appear to have been:

- Overall catchment LAI declined between about 1997 and 2005, with the peak change of about 60% reduction occurring in around 1999, and gradual recovery thereafter until around 2005 - 2006 when pre-mining LAI levels were reported.
- LAI changes in the mined parts of the catchment were more significant, with LAI reducing effectively by 100% for a 2 to 3 year period, before recovering over a further 1 to 4 years to or above pre-mining levels.
- Groundwater level rises were noted in response to clearing, with the rises in upper catchment mid-slope locations peaking at 2.5-5 m between 1999 and 2003; slightly higher peaks of 2.5-5.5 m in lower slope and valley edge locations, peaking around 2003; lowest response was observed in streamzone locations near catchment outlet, in range 0.5-1.5 m.
- After peaking, groundwater levels gradually declined to or slightly below the pre-mined levels by 2008.
- Thus, the peak groundwater levels were reported between 2 and 6 years after commencement of clearing, and full recovery to pre-mined levels after 11 years.
- Mining caused a peak response in catchment streamflow of 225 mm or 18% of rainfall before returning to pre-mine levels 11 years after mining commenced. Changes in streamflow were closely associated with an expansion and subsequent contraction of the groundwater

discharge area in the valley floor, which in turn was primarily driven by changes in LAI and rainfall.

The study completed by Nixon et al (2019) investigated the potential effects of Alcoa's mining on stream flows and salinity into the Serpentine Reservoir. A conceptual catchment hydrology model was used to consider long-term mine plans and accounted for a changing climate over a 40 year planning horizon.

Two scenarios were considered – clearing (inclusive of mining and rehabilitation) nine and 12 percent of the entire Serpentine catchment. Model results showed that, regardless of the mining case or future climate, the projected change in inflows due to mining was no greater than approximately 2 GL/year in any one year, or 5% of flow on an annual average basis. Both increases and decreases in flow were observed over the time series relative to the unmined alternative.

Similar groundwater and stream zone changes are expected as a result of the mine plan. The scale of impacts is not expected to be significantly different to those occurring historically.

7.2.7 Contamination for spills and/or leaks from storage and handling of hazardous materials and waste

Herbicides and fertilisers are utilised by Alcoa in rehabilitation and weed control. Hydrocarbons and other chemicals are used within equipment and maintenance areas. All substances could interact with the environment from storage, use and spills.

The Mine is a diesel-only fuel site, with no storage or handling of unleaded petrol. Diesel is predominantly used for haul trucks, excavators and other large earthmoving equipment, and to a lesser extent for light vehicles. The storage and handling of diesel creates a potential hazard for spillage of diesel that may enter reservoirs.

A large volume diesel spill may result in water quality impacts in the stream zone downstream of the spill as well as the upper reservoir prior to substantial mixing and attenuation. Localised impacts within the stream zone may impact aquatic fauna that occur seasonally during stream flow, as well as the condition of riparian vegetation. Impacts within the upper reservoir may affect aquatic fauna that reside in the perennial waterbody, including native fish, freshwater crayfish and potentially populations of Carters Freshwater Mussel.

7.2.7.1 Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) – Source Elimination

Alcoa introduced C6 Aqueous Film Forming Foams (AFFF) as a fire suppressant on its heavy vehicle mining fleet in 2013-2014 (which at the time was understood to be 'PFAS free') in response to safety concerns following a fire incident on a heavy vehicle.

In 2019, Alcoa became aware that the C6 AFFF contained low concentrations of PFAS compounds conducted a review of fluorine-free foams available in Australia through a comprehensive due diligence process, including independent laboratory testing, which identified five fluorine-free foams. These five foams were subsequently approved for use under Schedule 10 of the *Materials and Substance in Contact with Drinking Water factsheet*.

Replacement of the C6 AFFF with approved fluorine-free foam across both Huntly and Willowdale mines was completed in December 2021.

7.2.8 Contamination from pathogens

Pathogen contamination of drinking water can have significant effects on human health, if pathogen risks are not mitigated. Potential sources include:

- Sewage overflow during on-site treatment.
- Washout of treated effluent from an irrigation area.
- Subsurface leaching of treated effluent.
- Direct faecal deposition in a riparian zone by a staff member with asymptomatic cryptosporidiosis.
- Use of bushland for toileting pathogens.
- Sewage treatment of workforce sewage pathogens, nutrients and suspended solids.
- Irrigation of treated effluent over bushland near construction compound and mine facilities.
- Mobile ablutions facilities.
- Pump out and transport of raw sewage for off-site disposal.
- Raw sewage leaks during tanker collisions.
- WWTP process upsets / failure resulting in reduced treatment efficacy / higher contaminant loading.
- Waste solid and liquid waste generation from construction and operational activities.
- Nutrients, hydrocarbons, metals, pathogens, surfactants, plastics, suspended solids.
- On-site waste disposal.

A surface hydrology model and associated DWRA is under development. The Huntly DWRA was expected to be completed early 2024, however has been delayed to allow thorough consultation with MMPLG. The predicted outcome for pathogen contamination on Public Drinking Water Sources will be considered. However, this MMP is not expected to be significantly different to current practises.

7.2.9 Big Brook Causeway

The Big Brook Causeway (previously referred to as Serpentine Dam Causeway) is an existing, critical piece of haul road infrastructure for the Huntly mine. The causeway provides access to the eastern side of the Myara region by crossing Big Brook, which feeds Serpentine Dam.

The Causeway was approved by the MMPLG and constructed over the summer of 2012/2013. It was subject to implementation of the Big Brook Causeway Construction and Operational Plan, which was informed by a risk assessment conducted by Professor Barry Hart (Water Science 2008). On the recommendation of the Water Corporation, Alcoa committed to maintain a 100 m buffer between the Big Brook Causeway and the Serpentine Dam reservoir top water level (TWL).

In August 2021, the water level came within 100m of Big Brook Crossing and the Water Corporation directed Alcoa to cease its operation. A revised risk assessment, including controls, was prepared by Alcoa and agreed with Water Corporation allowing operations to recommence in September 2021.

A conceptual area for an alternative Big Brook Crossing location was included in the 2021-2025 MMP. Alcoa has undertaken a process of options identification (FEL²⁹ 1) and options selection (FEL 2) to develop a comprehensive risk reduction solution to mitigate the removal of the 100 m trigger level for the Big Brook Causeway.

Alcoa engaged with Water Corporation and DWER via an extraordinary MMPLG meeting in December 2022 to review and endorse engineering upgrades of the Causeway, updated Big Brook Causeway Operational Plan and updated Big Brook Causeway Risk Assessments.

A consolidated package of the actions from the extraordinary MMPLG meeting, including potential groundwater interaction technical memorandum, revised clearing area, referenced technical reports, and approvals process memorandum was provided to MMPLG members in March 2023.

A revised conceptual area is included in this MMP, following a detailed design process, which resulted in a decrease in the clearing area. The revised clearing area has been identified to enable the implementation of a range of additional risk mitigation controls. The actual clearing has since been significantly reduced to enable the implementation of the proposed engineering upgrades and risk mitigation controls (primarily upgrades to existing sump capacity) in accordance with the preliminary engineering design presented to the MMPLG in December 2022. Revised documents reflecting the decreased conceptual clearing area were provided to MMPLG members in June 2023 and are included in Appendix 14.

Clearing within the extended Big Brook Causeway Conceptual Clearing Area will only occur if an agreement on the additional controls is reached between Alcoa, WC and DWER through endorsement of the Big Brook Causeway Operational Plan 2022 and associated risk assessment by the MMPLG.

7.2.10 Cumulative Impacts

7.2.10.1 Past and present activities

The NJF subregion has been subject to environmental impacts from a range of past and present activities, including (in order of area of disturbance):

- Agriculture.
- Timber harvesting.
- Prescribed burning.
- Bauxite and gold mining.
- Plantations.
- Water supply reservoirs.

Agriculture and timber harvesting have caused widespread impacts including:

- Loss of biodiversity and habitat from permanent clearing.
- Spread of *Phytophthora* Dieback in forested areas from timber harvesting.
- Agricultural impacts to soils including erosion, salinity, compaction and acidification.
- Secondary salinity impacts to the Murray and Avon rivers from permanent clearing.

Mining has caused impacts as follows:

- Short to medium term ecological and amenity impacts during operations and until rehabilitation establishes.
- Rehabilitation restoring varying biodiversity, ecological integrity and landscape quality.

Prescribed burning is undertaken to reduce the severity and extent of wildfires, which can have significant ecological, water quality and amenity impacts.

Water supply reservoirs have caused localised loss of incised river valley landforms and vegetation and widespread disruption to aquatic fauna migrations and dispersal, however they have created perennial waterbodies that provide refuges for aquatic fauna.

7.2.10.2 Reasonably foreseeable future activities

Reasonably foreseeable future activities within the NJF subregion include approved and proposed mining. Jarrah forest cleared for mining will be rehabilitated, with the time from clearing to rehabilitation variable dependent upon if area is used for mining or long-term infrastructure.

The WA Government has announced an end to native forest logging in 2024, at which point FPC will continue its independent logging activities within areas that have been approved for mining.

Prescribed burning is expected to continue within the subregion in accordance with the WA Government's strategy to reduce fuel loads and minimise the likelihood and severity of large scale wildfires.

Other future activities within the subregion may include future urban or rural residential development and infrastructure development and agriculture, which are expected to be relatively minor and subject to regulation under Part V of the EP Act.

7.2.10.3 Water Cumulative Impacts

A breakdown of Alcoa's existing and future clearing impacts is included in Table 7-14. The Huntly Ten Year Mine Plan consists of the Revised Proposal clearing within Myara North and Holyoake. The Willowdale Ten Year Mine Plan predominately consists of ore shells, which may under-estimate clearing requirements. The conceptual clearing buffer and areas historically endorsed under FCAs, which are not considered likely to be cleared are shown, however are excluded from future mine area totals.

The Huntly Mine lies predominantly in the PDWSAs. Some minor clearing occurs in the Serpentine River un-regulated catchment, with total future mined areas potentially contributing 2% of disturbance to the catchment.

The majority of Huntly's clearing is associated with the Serpentine Dam catchment, with potential future clearing impacting 21% of the catchment. Whilst rehabilitation is currently 6%, this proportion is expected to increase as rehabilitation rates increase.

The North Dandalup catchment also has a higher portion of potential future clearing (31%), however the majority (26%) is rehabilitated with only 567 ha of open and approved areas and the 24 Month Clearing Schedule contributing a further 142 ha. The Conjurunup Creek Pipehead Dam catchment has the highest portion of potential future impact, at 43%. However, the majority of this area (41% of the 43% disturbance) is already rehabilitated.

The majority of Willowdale's clearing is associated with the Samson Brook and Stirling Dam catchments. Future clearing impacts to Samson Brook catchment consist 29% of the catchment, however 18% of this is already rehabilitated. Future clearing impacts to Stirling Dam catchment will consist of 8%.

Table 7-14: Overview of indicative cumulative impacts to Inland Waters

Mine	Catchment	Catchment area (ha)	Open areas		Rehabilitated Areas		24 Month Clearing Schedule		FCA Endorsed Areas		Five Year Mine Plan		Ten Year Mine Plan		Total future mined area (ha)	Proportion of catchment total future mined (%)
			Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)	Area (ha)	Proportion of catchment (%)		
Huntly	Canning River Catchment Area	3,922	56	1.4%	1,606	41.0%	8	0.2%	0	0.0%	-	-	8	0.2%	1,678	42.8%
	Conjurunup Creek Pipehead Dam Catchment Area	3,116	303	9.7%	436	14.0%	53	1.7%	148	4.8%	53.6	1.7%	-	-	846	27.2%
	Dirk Brook Water Reserve	15,165	534	3.5%	3,936	26.0%	142	0.9%	118	0.8%	114.0	0.8%	7	0.0%	4,733	31.2%
	Gooralong Brook Water Reserve	66,490	2,953	4.4%	3,847	5.8%	1,463	2.2%	522	0.8%	1,222.7	1.8%	3,910	5.9%	13,395	20.1%
	North Dandalup	2,885	71	2.5%	97	3.4%	-	-	-	-	-	-	-	-	169	5.8%
	Serpentine Dam	31,675	8	0.0%	2,174	6.9%	9	0.0%	-	-	-	-	2,457	7.8%	4,649	14.7%
	Serpentine Pipehead Dam	3,854	41	1.1%	577	15.0%	10	0.3%	-	-	-	-	-	-	628	16.3%
	South Dandalup Dam	127,107	3,967	3.1%	12,673	10.0%	1,686	1.3%	789	0.6%	1,390	1.1%	6,381	5.0%	26,097	20.5%
	South Dandalup Pipehead Dam Catchment Area	1,838	2	0.1%	108	5.9%	-	-	-	-	-	-	3	0.2%	114	6.2%
	Wungong Brook	7,755	583	7.5%	1,410	18.2%	103	1.3%	50	0.6%	74.9	1.0%	56	0.7%	2,228	28.7%
	Subtotal	25,366	608	2.4%	22	0.1%	603	2.4%	198	0.8%	266.1	1.0%	439	1.7%	1,938	7.6%
Willowdale	Bancell Brook Catchment Area	34,958	1,193	3.4%	1,541	4.4%	706	2.0%	248	0.7%	341	1.0%	499	1.4%	4,279	12.2%
	Harvey Dam Catchment Area	3,922	56	1.4%	1,606	41.0%	8	0.2%	-	-	-	-	8	0.2%	1,678	42.8%
	Samson Brook	3,116	303	9.7%	436	14.0%	53	1.7%	148	4.8%	53.6	1.7%	-	0.0%	846	27.2%
	Stirling Dam	15,165	534	3.5%	3,936	26.0%	142	0.9%	118	0.8%	114.0	0.8%	7	0.0%	4,733	31.2%
	Subtotal	66,490	2,953	4.4%	3,847	5.8%	1,463	2.2%	522	0.8%	1,222.7	1.8%	3,910	5.9%	13,395	20.1%

7.3 Mitigation

Alcoa's environmental management incorporates the mitigation hierarchy, which is (in order of priority):

- Impact avoidance
- Impact minimisation
- Rehabilitation.

A risk-based approach has been undertaken to align with Alcoa's environmental management system and management plans. Associated mitigation actions are provided in Table 7-15 as a risk register and risk assessment methodology is provided in Appendix 3

Alcoa is commitment to risk avoidance and will:

- Limit actual MMP-related clearing of native vegetation will be limited to 800 ha per calendar year for the duration of the current MMP (Commitment 1)
- Not undertake any clearing for mining within 1km of the top water level of any water reservoir in Myara Central and Myara South (Commitment 2).
- Not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024 (Commitment 3)
- Not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (excludes rehabilitation activities, and access) (Commitment 4).
- Not undertake any new pit clearing in any areas with an average pit slope greater than 16% within any Reservoir Protection Zone (RPZ, 2km from reservoir top water level) (Commitment 5)
- Clearing within 2km of Serpentine Dam top water level or within Serpentine Pipehead Catchment, must be either rehabilitated, stabilised, or have drainage controls in place within the first rehabilitation season available. (Commitment 6).
- Relinquish 1,231 ha of FCAs endorsed prior to 1 September 2023, 1,016 ha in Huntly, and 214 ha in Willowdale (Commitment 7).

Alcoa is committed to continuous improvement with regards to baseline surveys, mitigation measures and monitoring. An associated improvement roadmap is shown in Figure 7-11 and details improvement projects included in this section. A framework has been developed (Figure 7-12) to detail interactions between improvement projects, the mine planning process and documentation. Key activities in the improvement roadmap include:

- Consultation and endorsement of the Drainage Design Manual by the MMPLG. The Drainage Design Manual is the basis of design to ensure the design and construction of mining pits, haul roads and associated infrastructure does not impact on the surrounding environment and

PDWSAs. Alcoa will use the Drainage Design Manual and field data in the development of Drainage Control Management Plans (DCMPs). DCMPs will be provided for FCA submissions for pits or haul roads within the public drinking water catchment areas and will include an assessment against the Groundwater Risk Assessment Framework (2021 Forest Clearing Advice 23 March 2022) (Commitment 15).

- Undertaking a catchment scale, risk-based approach through the development and implementation of a Catchment Risk Assessment Tool. The output of this tool is a spatial risk assessment that will identify high risk areas of potential impacts to drinking water and can be utilised to plan and review mitigation measures.
- Improving understanding of groundwater changes from the Groundwater Stewardship Strategy. In particular, the development of the Predictive Groundwater Tool is considered to provide a scientific methodology for clearing induced groundwater rise and rehabilitation recovery, to natural trend.
- Developing and implementing a Water Resources Management Plan (WRMP) detailing management objectives and targets, with associated management measures. The WRMP includes a monitoring programme to identify any potential impacts to key water values, which will be updated as further improvement programs are undertaken. The WRMP should be considered a draft, as MMPLG consultation and approval is required, however, implementation has commenced. Alcoa will implement the current draft WRMP, and revise and implement an updated WRMP within six months after receiving finalised written feedback from MMPLG (Commitment 21).

Alcoa considers the reconstitution of the Bauxite Hydrology Committee (BHC) to be a key component to ensure relevant and representative scientific studies and research to improve water related knowledge are undertaken. Alcoa is committed to reconstituting the BHC with an independent chair by 1 July 2024 (Commitment 13). In addition, Alcoa will consult with BHC on the development of a full mining cycle planning approach, cumulative catchment scale risk assessment methodology and development of the Drainage Design Manual and Rehabilitation Design Manual (Commitment 14).

Some areas of the 24 Month Clearing Schedule will not meet WRMP requirements including:

- 24 months of surface and groundwater data will not be obtained prior to clearing of some moderate and high priority groundwater areas in FCAs. In the interim, a modelled groundwater level will be utilised with ongoing monitoring to ensure accuracy. However, from late 2025 onwards, monitoring data will be provided in FCAs, as it becomes available.
- Establishment of reservoir monitoring locations. This requires consultation and approval by WC, then procurement and installation. Implementation could occur within 18 months.

- DWRA's are being developed for Huntly and Willowdale, but are not yet completed. The Huntly DWRA was scheduled to be completed in early 2024, however has been delayed to allow thorough consultation with MMPLG.

Figure 7-11: Water Management Improvement Plan

Legend			Indicative Schedule											
In Progress	Consultation	Complete	Implementation	2023			2024				2025			
				Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		Expected Completion												
Water	Water Management													
	Water Resources Management Plan (WRMP)	Q2 2024												
	Water Monitoring Framework	Complete												
	Water Monitoring - Proof of Concept Plan	Q2 2024												
	Water Monitoring Program	Q4 2025												
	WA Mining & Haul Road Design Manual	Complete	Peer Review											
	<i>Field Infiltration Rate Test Program</i>	Q4 2023												
	Catchment Sediment Literature Review	Complete												
	Catchment Turbidity Data Statistical Correlation (DAA Report)	Complete												
	Catchment Scale Risk Assessment Tool	Q1 2024												
	Groundwater Stewardship Strategy													
	<i>Water Handling Technical Assessment</i>	Q4 2023												
	<i>Regolith Depth Mapping (Geophysics Assessment)</i>	Q3 2025					Phase 1						Phase 2	
	<i>Groundwater Predictive Tool - Continuous Improvement</i>	Q4 2023												
	Rehabilitation Water Model Report (Water Storage Criteria)	Q3 2023												
	<i>Field Infiltration Rate Test Program</i>	Q4 2023												
	Myara Central													
	Groundwater													
	Huntly Hydrological Modelling and Drinking Water Risk Assessment	Q3 2024												
	Groundwater Drilling Program	Ongoing												
	Surface Water													
	Turbidity Monitor Installation	Ongoing												
	Turbidity Monitoring Data	Ongoing												
	Willowdale													
	Groundwater													
Willowdale Hydrological Modelling and Drinking Water Risk Assessment	Q3 2024													
Groundwater Drilling Program	Ongoing													
Surface Water														
Turbidity Monitor Installation	Ongoing													
Turbidity Monitoring Data	Ongoing													
O'Neil														
Groundwater														
Groundwater Drilling Program	Ongoing													
Surface Water														
Turbidity Monitor Installation	Ongoing													
Turbidity Monitoring Data	Ongoing													

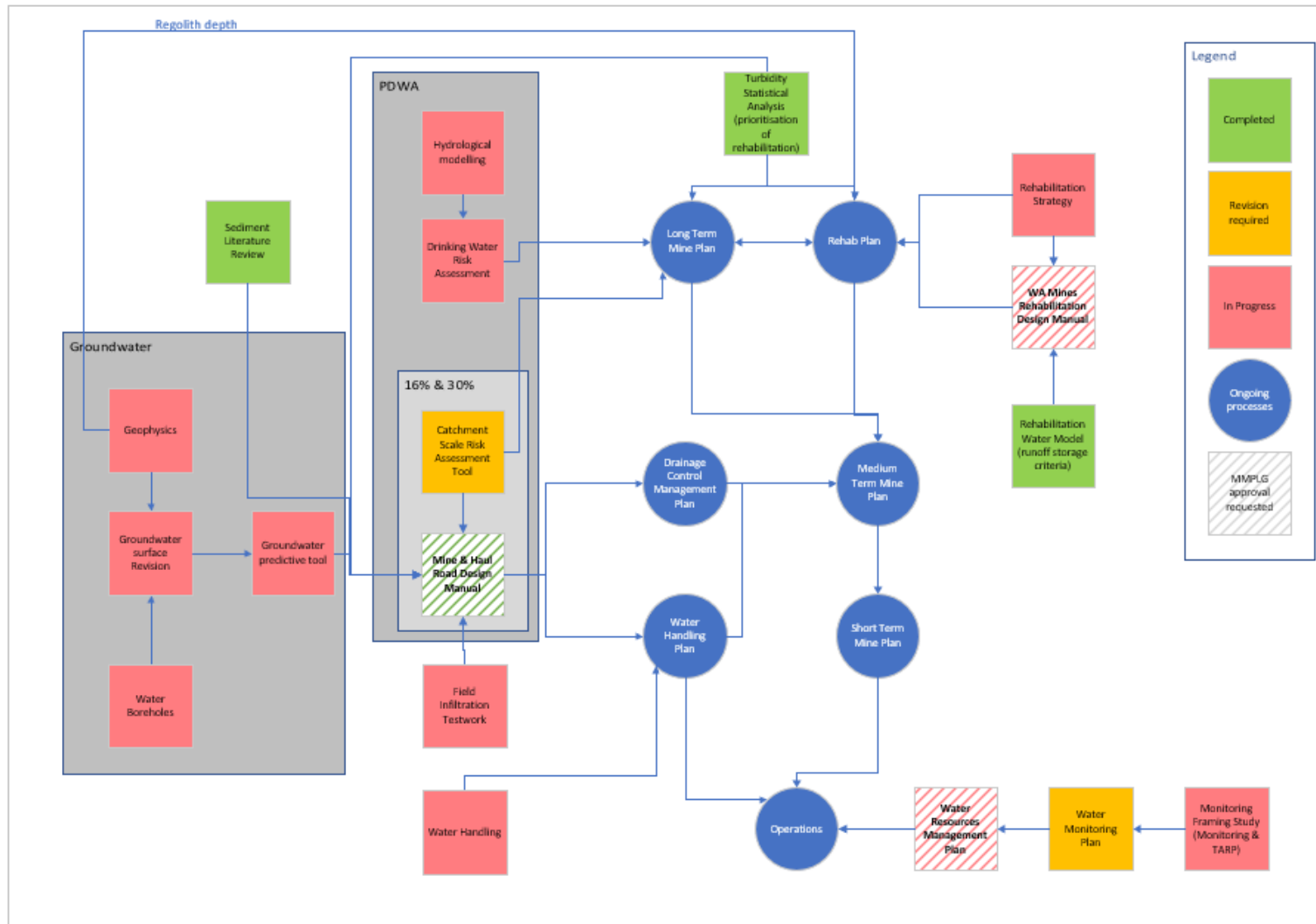


Figure 7-12: Water Management Framework

Table 7-15: Avoidance and minimisation of potential impacts to inland waters

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Clearing vegetation resulting in change to the hydrological system (e.g., may result in groundwater rise).	<p>Death to vegetation, change in local vegetation communities.</p> <p>Groundwater rise results in expression of groundwater containing high salinity causing increase in salinity of downstream receptors i.e., groundwater/surface water PDWSA</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Implementation of Drainage Design Manual. Implementation of Rehabilitation Design Manual. Groundwater monitoring program - water level and chemistry. Groundwater level model (Leapfrog) informs mine plan (pit shapes etc.). Groundwater risk layer (catchment risk assessment tool). Drainage control management plans (pit-by-pit). Regular pit inspections. Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. Active water management plan to be developed. End to end risk assessment and mitigation process. Rehabilitation strategy prioritises areas based on risk with an increased rate of rehabilitation. Implementation of Water Resource Management Plan. Groundwater and surface water site prioritisation. Groundwater and surface water monitoring program. Predictive groundwater model. 		Medium
Risk of bacterial contamination of groundwater and/or surface water as a result of human pathogens	Localised contamination of surface water and/or groundwater.	<ul style="list-style-type: none"> No clearing or mining activities within the Pipehead Dam catchment. 	<ul style="list-style-type: none"> Where practicable, personnel should use designated ablution block facilities, if this is not possible then biological waste must be bagged and disposed of at a designated disposal location outside of the RPZ. Personnel management: <ul style="list-style-type: none"> Reservoir Protection Zone Management Plan (AUACDS-2053-5554). 		Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> ○ A Permit to Work in Close Proximity to Water Catchment Areas will be sought where work activities are carried out near a reservoir. ○ Fit for work policy includes restriction to RPZ for personnel with gastrointestinal symptoms. ○ Minimise worker access in stream zones. ○ Worker training and awareness around hygiene practises within the RPZ. 		
Drill rigs and support vehicles impact ground vegetation increasing the risk of erosion and turbidity.	Localised erosion and increased turbidity of surface water.	<ul style="list-style-type: none"> • No exploration drilling within 100m buffer for mapped streamzones. 	<ul style="list-style-type: none"> • DBCA approval process for bore installation (DAS). • Groundwater bore installation - utilise small tracked machines where possible. • Exploration Drill rigs are designed to minimise impact on vegetation: <ul style="list-style-type: none"> ○ Good ground clearance ○ Small compact machine ○ Large tyres to minimise compaction ○ 4WD to minimise slippage/wheel spin. • Maximise use of and park light vehicles on existing tracks or clearings. • Report significant trees or unusual vegetation. 	<ul style="list-style-type: none"> • Report created tracks that have had high use to assess if additional rehabilitation requirements are required. • Report highly disturbed areas to assess if additional rehabilitation requirements are required. 	Medium
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from heavy machinery	Cumulative contamination of surface water and/or groundwater resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> • No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. 	<ul style="list-style-type: none"> • Vehicle access to RPZ requires an authorised permit. • Maintenance programs & pre-start checks. • Pre-mobilisation inspections. • Re-fuelling procedure. • Personnel inductions / training - LOC and spill response. • Chemical approval process. • Engineering and design controls. • Authority to proceed procedure for contractors. • Regular audits & inspections. 	<ul style="list-style-type: none"> • Spill kits and spill remediation equipment kept available. • Emergency response team and procedure. • Remediation Validation Procedure. 	Medium
Removal of vegetation increasing the risk of erosion and turbid water discharge prior to the implementation of long term mitigative controls (e.g., water shots and water storage sumps).	<p>Localised erosion and increase in turbidity of surface water.</p> <p>Cumulative erosion and increase in turbidity of surface water.</p>	<ul style="list-style-type: none"> • No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). 	<ul style="list-style-type: none"> • Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine's drainage controls, winterisation, and state 	<ul style="list-style-type: none"> • 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		<ul style="list-style-type: none"> ○ 100 m buffer zone for mapped Stream Vegetation. ● 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<p>of readiness to cope with the heavy rainfall event.</p> <ul style="list-style-type: none"> ● Minimise mining in areas of high slope and areas with high cleared areas with a high percentage of unrehabilitated (or) open areas. ● Staged clearing and development minimises open areas. ● Mine surface water control designs (detailed in Drainage Design Manual) informed by hydrological studies (flow, infiltration diversion for mine planning storage purposes): <ul style="list-style-type: none"> ○ Drainage shots, also called water shots, comprise shallow (~1.8 m) blasted or ripped ground on the downslope perimeter of mine pit, if required by risk rating. Drainage shots capture and infiltrate surface runoff within the blasted voids. ● Ensure Design Manual implementation, including the following key controls: <ul style="list-style-type: none"> ○ Woody windrows (vegetation stockpiles) are aligned on the contour to interrupt downslope drainage. ● Development and implementation of Drainage Control Management Plans (DCMPs) as per Develop Water Resource Sensitive Zone Plan (AUACDS-2053-4109) for all increased risk (as per WC Working Arrangement) mining operations located within OCA1 and OCA2. DCMPs include: <ul style="list-style-type: none"> ○ Pits Risk Ranking contents. ○ Drainage Control trigger assessments. ○ Pit specific drainage control designs. ○ Planned development mining and rehabilitation schedule. ○ Drainage protection shot design. ○ Groundwater levels in close proximity to the pit. ○ Other drainage control measures. ● Clearing to preferentially occur outside of winter months. ● Groundwater Interception Assessment identifies when a designed pit is likely to intercept groundwater based on an interpreted maximum groundwater level. 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<p>Pits that are identified as likely to intercept groundwater must be designed to ensure adequate surface water containment volume to a specified rain event and must have a rehabilitation plan established prior to clearing.</p> <ul style="list-style-type: none"> • Active water management plan to be developed. • End to end risk assessment and mitigation process. • Rehabilitation strategy prioritises areas based on risk with an increased rate of rehabilitation. • Minimise stream crossings, where possible. • Permit system is in place to minimise risk associated with installation of stream crossings. • Clearing or construction activities within stream zones will occur during summer or autumn months, as far as practicable. • Stream crossing appropriately designed to minimise impacts and potential for erosion with appropriate surface water controls. • Regular pit inspections. • Implementation of Water Resource Management Plan. • Groundwater and surface water site prioritisation. • Groundwater and surface water monitoring program. • Predictive groundwater model. 		
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from heavy machinery	Cumulative contamination of surface water and/or groundwater resulting in impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> • No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> • Vehicle access to RPZ requires an authorised permit. • Maintenance programs & pre-start checks. • Pre-mobilisation inspections. • Re-fuelling procedure. • Personnel inductions / training - LOC and spill response. • Chemical approval process. • Engineering and design controls. • Authority to proceed procedure for contractors. • Regular audits & inspections. 	<ul style="list-style-type: none"> • Spill kits and spill remediation equipment accessible. • Emergency response team and procedure. • Remediation Validation Procedure. 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Increased risk of erosion and turbid water discharge (unique factors include overburden and topsoil management, and the absence of some controls implemented during the mining stage e.g. sumps and trenches).	<p>Localised contamination of surface water and/or groundwater.</p> <p>Cumulative contamination of surface water and/or groundwater resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. Minimise mining in areas of high slope and areas with high cleared areas with a high percentage of unrehabilitated (or) open areas. Staged clearing and development minimises open areas. Mine surface water control designs (detailed in Design Manual) informed by hydrological studies (flow, infiltration diversion for mine planning storage purposes): <ul style="list-style-type: none"> Drainage shots, also called water shots, comprise shallow (~1.8 m) blasted or ripped ground on the downslope perimeter of mine pit, if required by risk rating. Drainage shots capture and infiltrate surface runoff within the blasted voids. Implementation of Drainage Design Manual. Development and implementation of Drainage Control Management Plans (DCMPs) as per Develop Water Resource Sensitive Zone Plan (AUACDS-2053-4109) for all increased risk (as per WC Working Arrangement) mining operations located within OCA1 and OCA2. DCMPs include: <ul style="list-style-type: none"> Pits Risk Ranking contents. Drainage Control trigger assessments. Pit specific drainage control designs. Planned development mining and rehabilitation schedule. Drainage protection shot design. Groundwater levels in close proximity to the pit. 	<ul style="list-style-type: none"> 	Medium
Drainage failure, discharge from containment sumps, diffuse discharge from operational areas resulting in discharge of water containing high turbidity, hydrocarbons, PFAS.	Cumulative contamination of surface water and/or groundwater resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> mining operational activities (excludes infrastructure) within applied buffer zones for: 	<ul style="list-style-type: none"> Minimise mining in areas of high slope and areas with high cleared areas with a high percentage of unrehabilitated (or) open areas. 	<ul style="list-style-type: none"> 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		<ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> • Mine surface water control designs (detailed in Design Manual) informed by hydrological studies (flow, infiltration diversion for mine planning storage purposes): <ul style="list-style-type: none"> ○ Drainage shots, also called water shots, comprise shallow (~1.8 m) blasted or ripped ground on the downslope perimeter of mine pit, if required by risk rating. Drainage shots capture and infiltrate surface runoff within the blasted voids. ○ In-pit sumps and trenches (as per design manual). • Implementation of Drainage Design Manual. • Development and implementation of Drainage Control Management Plans (DCMPs) as per Develop Water Resource Sensitive Zone Plan (AUACDS-2053-4109) for all increased risk (as per WC Working Arrangement) mining operations located within OCA1 and OCA2. DCMPs include: <ul style="list-style-type: none"> ○ Pits Risk Ranking contents. ○ Drainage Control trigger assessments. ○ Pit specific drainage control designs. ○ Planned development mining and rehabilitation schedule. ○ Drainage protection shot design. ○ Groundwater levels in close proximity to the pit. • Work packs developed for each pit which outline the controls for each stage of mining (development and mining stages). • Regular pit inspections. • Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. • Active management of water to prevent overflow (pumping etc.). 		
Change to stormwater / surface water flow outside of the approved clearing boundary, resulting in impacts to streamzone vegetation	A death or change in vegetation communities resulting from either increased or decreased stream flow.	<ul style="list-style-type: none"> • No mining operational activities (excludes infrastructure) within applied buffer zones for: 	<ul style="list-style-type: none"> • Stream zone mapping (locations and vegetation). 		Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
and/or catchment inflow		<ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> ● Implement drainage designs as per DCMPs and/or drainage design manual. ● Groundwater and surface water monitoring program. ● Predictive groundwater model. ● Active water management plan to be developed. ● End to end risk assessment and mitigation process. ● Rehabilitation strategy prioritises areas based on risk with an increased rate of rehabilitation. 		
Discharge of water containing contaminants of concern e.g. nutrients/fertilisers	Cumulative impact to surface and/or groundwater resulting in changes to ecological communities and/or eutrophication of downstream surface or groundwater.	<ul style="list-style-type: none"> ● No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. ● No mine facilities, wastewater and sewage treatment plants inside the RPZ. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> ● Fertiliser program (measured fertiliser application, concentration and mix approved by DBCA). ● Fertiliser program execution on non-rain days/dry part of year- during optimal time of year for uptake of nutrients by plants (Spring). ● Fertiliser maps produced for the contractor - Overview Map, Individual Helipad Maps - showing all pits to be fertilised from the one helipad location, and Individual map - where greater detail for specific pits is required. ● Pre-mobilisation inspections. ● Authority to proceed procedure for contractors. ● Audit of run sheets, Cross check of volume of fertiliser applied per pit. 	<ul style="list-style-type: none"> ● 	Medium
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from banks, bunds, pipes or other potential discharge sources. Discharges during delivery or offtake.	Localised contamination of surface water and/or groundwater.	<ul style="list-style-type: none"> ● Workshops, fuel bays, ablution facilities etc. designed to be located outside of RPZ. ● AFFF containing PFAS prohibited from coming to site. 	<ul style="list-style-type: none"> ● Separate stormwater and wastewater networks. ● Concrete sump network associated with washdown facilities. ● Personnel inductions / training - LOC and spill response. ● Chemical approval process. ● Authority to proceed procedure for contractors. ● Regular audits & inspections. ● Bunding, Evac system. ● General housekeeping. ● Impermeable surface on workshop floors. ● Red alert procedure, is a system which is designed as an early warning of forecast for 	<ul style="list-style-type: none"> ● Spill kits and spill remediation equipment kept accessible. ● Emergency response team and procedure. ● Remediation Validation Procedure 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			intense rainfall events, allowing mine personnel time to review the mine's drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. <ul style="list-style-type: none"> • Roofed bunded areas (outdoor storage areas have roofing to prevent water egress). • 3rd party annual Dangerous Goods Depot inspections. • Maintenance programs & pre-start checks. • Pre-mobilisation inspections. • Personnel inductions / training - LOC and spill response. • Engineering and design control. • Regular audits & inspections of waste and dangerous goods transport providers. • Vehicle Maintenance Programs 		
Discharge of water containing contaminants of concern e.g. PFAS, hydrocarbons	Localised contamination of surface water and/or groundwater.	<ul style="list-style-type: none"> • No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> ○ 200 m buffer zone from reservoir top water level (OCA1). ○ 100 m buffer zone for mapped Stream Vegetation. • Workshops, fuel bays, ablution facilities etc. located outside of RPZ. • No mine facilities, wastewater and sewage treatment plants inside the RPZ. • 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> • DWER licence conditions - sample requirements, discharge requirements (specified discharge points). • Inspections and maintenance - Water Crew and Environmental Dept. regular inspections. • Treatment plant and associated sump networks constructed and engineered with applicable design standards. • Maintain freeboard in treated water sumps. • Active water management. • Prohibition on use of PFAS containing AFFF-removes further introduction of PFAS into wastewater/ stormwater system from AFFF use. • Water meter calibrations (annual)- accurate metering of discharge volumes. • Annual liner inspections of lined sumps associated with licenced wastewater treatment facility. • Sumps designed and constructed as per the Drainage Design Manual. • Regular sump inspections. • Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine 	<ul style="list-style-type: none"> • 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. <ul style="list-style-type: none"> Active management of water to prevent overflow (pumping etc.). Sump cleanout procedure. 		
Clearing vegetation with an extended period prior to rehabilitation resulting in change to the hydrological system (e.g., may result in groundwater rise).	Death to vegetation, change in local vegetation communities.	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.	<ul style="list-style-type: none"> Implementation of Drainage Design Manual. Implementation of Rehabilitation Design Manual. Groundwater monitoring program - water level and chemistry. Groundwater level model (Leapfrog) informs mine plan (pit shapes etc.). Groundwater risk layer (catchment risk assessment tool). Drainage control management plans (pit-by-pit). Regular pit inspections. Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. Implementation of Water Resource Management Plan. Groundwater and surface water site prioritisation. Groundwater and surface water monitoring program. Predictive groundwater model. Active water management plan to be developed. End to end risk assessment and mitigation process. 	<ul style="list-style-type: none"> Rehabilitation strategy prioritises areas based on risk with an increased rate of rehabilitation. 	Medium
Clearing vegetation with an extended period prior to rehabilitation resulting in change to the hydrological system (e.g., may result in groundwater rise).	Increased in turbid water discharge (e.g., groundwater expression to surface, groundwater connection to sumps reducing storage capacity). Groundwater rise results in expression of groundwater containing high salinity causing	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. 	<ul style="list-style-type: none"> Minimise mining in areas of high slope and areas with high cleared areas with a high percentage of unrehabilitated (or) open areas. Mine surface water control designs (detailed in Drainage Design Manual) informed by hydrological studies (flow, 	<ul style="list-style-type: none"> Rehabilitation plan optimisation. 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
	increase in salinity of downstream receptors i.e. groundwater/surface water PDWSA.	2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.	infiltration diversion for mine planning storage purposes): <ul style="list-style-type: none"> ○ Drainage shots, also called water shots, comprise shallow (~1.8 m) blasted or ripped ground on the downslope perimeter of mine pit, if required by risk rating. Drainage shots capture and infiltrate surface runoff within the blasted voids. ● In-pit sumps and trenches (as per design manual). ● Implementation of Drainage Design Manual. ● Development and implementation of Drainage Control Management Plans (DCMPs) as per Develop Water Resource Sensitive Zone Plan (AUACDS-2053-4109) for all increased risk (as per WC Working Arrangement) mining operations located within OCA1 and OCA2. DCMPs include: <ul style="list-style-type: none"> ○ Pits Risk Ranking contents. ○ Drainage Control trigger assessments. ○ Pit specific drainage control designs. ○ Planned development mining and rehabilitation schedule. ○ Drainage protection shot design. ○ Groundwater levels in close proximity to the pit. ● Work packs developed for each pit which outline the controls for each stage of mining (development and mining stages). ● Regular pit inspections. ● Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. ● Active management of water to prevent overflow (pumping etc.). ● Catchment risk assessment tool - potentially implement a higher level of conservatism with respect to areas that have both higher groundwater risk and higher salinity. 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Risk of bacterial contamination of groundwater and/or surface water as a result of human pathogens	Localised contamination in proximity to drinking water off-take resulting in impact to public drinking water source quality with potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Where practicable, personnel should use designated ablution block facilities, if this is not possible then biological waste must be bagged and disposed of at a designated disposal location outside of the RPZ. Personnel management: <ul style="list-style-type: none"> Reservoir Protection Zone Management Plan (AUACDS-2053-5554). A Permit to Work in Close Proximity to Water Catchment Areas will be sought where work activities are carried out near a reservoir. Fit for work policy includes restriction to RPZ for personnel with gastrointestinal symptoms. Minimise worker access in stream zones. Worker training and awareness around hygiene practises within the RPZ. 	<ul style="list-style-type: none"> 	Low
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from heavy machinery	<p>Localised contamination of surface water and/or groundwater.</p> <p>Localised contamination of PDWSA in proximity to drinking water off-take resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Vehicle access to RPZ requires an authorised permit. Maintenance programs & pre-start checks. Pre-mobilisation inspections. Re-fuelling procedure. Personnel inductions / training - LOC and spill response. Chemical approval process. Engineering and design controls. Authority to proceed procedure for contractors. Regular audits & inspections. 	<ul style="list-style-type: none"> Spill kits and spill remediation equipment kept available. Emergency response team and procedure. Remediation Validation Procedure. 	Low
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from heavy machinery	Localised contamination of surface water and/or groundwater.	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Vehicle access to RPZ requires an authorised permit. Maintenance programs & pre-start checks. Pre-mobilisation inspections. Re-fuelling procedure. Personnel inductions / training - LOC and spill response. Chemical approval process. Engineering and design controls. Authority to proceed procedure for contractors. Regular audits & inspections. 	<ul style="list-style-type: none"> Spill kits and spill remediation equipment accessible. Emergency response team and procedure. Remediation Validation Procedure. 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Change to stormwater / surface water flow outside of the approved clearing boundary, resulting in impacts to streamzone vegetation and/or catchment inflow	Increased stream flow resulting in stream erosion and increased turbidity.	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. No mine facilities, wastewater and sewage treatment plants inside the RPZ. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Stream zone mapping (locations and vegetation). Implement drainage designs as per DCMPs and/or drainage design manual. Groundwater and surface water monitoring program. Predictive groundwater model. Active water management plan to be developed. End to end risk assessment and mitigation process. Rehabilitation strategy prioritises areas based on risk with an increased rate of rehabilitation. 	<ul style="list-style-type: none"> 	Low
Discharge of water containing contaminants of concern e.g., nutrients/fertilisers	Localised impact to surface and/or groundwater resulting in changes to ecological communities and/or eutrophication of downstream surface or groundwater.	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. No mine facilities, wastewater and sewage treatment plants inside the RPZ. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Fertiliser program (measured fertiliser application, concentration and mix approved by DBCA). Fertiliser program execution on non-rain days/dry part of year- during optimal time of year for uptake of nutrients by plants (Spring). Fertiliser maps produced for the contractor - Overview Map, Individual Helipad Maps - showing all pits to be fertilised from the one helipad location, and Individual map - where greater detail for specific pits is required. Pre-mobilisation inspections. Authority to proceed procedure for contractors. Audit of run sheets, Cross check of volume of fertiliser applied per pit. 	<ul style="list-style-type: none"> 	Low
Loss of containment	Localised contamination of PDWSA in proximity to drinking water off-take resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> No further clearing or mining activities within Serpentine Pipehead Dam Catchment from month/year (once rehabilitation is complete no further mining or rehabilitation activities unless remediation works are required). Workshops, fuel bays, ablution facilities etc. located outside of RPZ. 	<ul style="list-style-type: none"> Vehicle access to RPZ requires an authorised permit. Maintenance programs & pre-start checks. Pre-mobilisation inspections. Re-fuelling procedure. Personnel inductions / training - LOC and spill response. Chemical approval process. Engineering and design controls. Authority to proceed procedure for contractors. Regular audits & inspections. 	<ul style="list-style-type: none"> Spill kits and spill remediation equipment kept accessible. Emergency response team and procedure. Remediation Validation Procedure. 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> Speed restrictions apply (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). Volume restrictions for hydrocarbon volumes (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). 3 stage sumps. Sump cleanout program. Active water management of sumps. 		
Discharge of water containing contaminants of concern e.g. PFAS, hydrocarbons	<p>Cumulative contamination of surface water and/or groundwater resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.</p> <p>Localised contamination of surface water and/or groundwater.</p> <p>Cumulative contamination of surface water and/or groundwater resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. No mine facilities, wastewater and sewage treatment plants inside the RPZ. Workshops, fuel bays, ablution facilities etc. located outside of RPZ. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Sumps designed and constructed as per the Drainage Design Manual. Regular sump inspections. Red alert procedure, is a system which is designed as an early warning of forecast for intense rainfall events, allowing mine personnel time to review the mine’s drainage controls, winterisation, and state of readiness to cope with the heavy rainfall event. Active management of water to prevent overflow (pumping etc.). Sump cleanout procedure. 	<ul style="list-style-type: none"> 	Low
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from vehicles/equipment	Contamination of PDWSA and/or Pipehead Dam	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Vehicle access to RPZ requires an authorised permit. Maintenance programs & pre-start checks. Pre-mobilisation inspections. Re-fuelling procedure. Personnel inductions / training - LOC and spill response. Chemical approval process. Engineering and design controls. Authority to proceed procedure for contractors. Regular audits & inspections. Speed restrictions apply (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). Volume restrictions for hydrocarbon volumes (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). 3 stage sumps. 	<ul style="list-style-type: none"> Spill kits and spill remediation equipment kept accessible. Emergency response team and procedure. Remediation Validation Procedure. 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<ul style="list-style-type: none"> Sump cleanout program. Active water management of sumps. 		
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from drill rigs or other vehicles.	<p>Localised contamination of surface water and/or groundwater</p> <p>Cumulative contamination of surface water and/or groundwater</p> <p>Localised contamination in proximity to drinking water off-take resulting in impact to public drinking water source quality with potential disruption to drinking water supply and/or human health impacts.</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1). 100 m buffer zone for mapped Stream Vegetation. 2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024. 	<ul style="list-style-type: none"> Vehicle access to RPZ requires an authorised permit. Maintenance programs & pre-start checks. Pre-mobilisation inspections. Re-fuelling procedure. Personnel inductions / training - LOC and spill response. Chemical approval process. Engineering and design controls. Authority to proceed procedure for contractors. Regular audits & inspections. Speed restrictions apply (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). Volume restrictions for hydrocarbon volumes (Dangerous Goods & Hazardous Materials MP AUACDS-2053-5535). 3 stage sumps. Sump cleanout program. Active water management of sumps. 	<ul style="list-style-type: none"> Spill kits and spill remediation equipment kept accessible. Emergency response team and procedure. Remediation Validation Procedure. 	Low
Loss of containment (hydrocarbons, oils and lubricants, hydraulic fluids) from drill rigs or other vehicles.	Localised erosion and increased turbidity of PDWSA in proximity to drinking water off-take resulting in Impact to public drinking water source quality resulting in potential disruption to drinking water supply and/or human health impacts.	<ul style="list-style-type: none"> No mining activities within the Pipehead Dam catchment. Buffer zone near streamzones for Exploration Drilling (50m). 	<ul style="list-style-type: none"> Training for Exploration personnel. DBCA approval process for bore installation (the DAS). Groundwater bore installation - utilise small, tracked machines where possible. Exploration Drill rigs are designed to minimise impact on vegetation: <ul style="list-style-type: none"> Good ground clearance; Small compact machine; Large tyres to minimise compaction; 4WD to minimise slippage/wheel spin. Maximise use of and park light vehicles on existing tracks or clearings. Report significant trees or unusual vegetation. Develop groundwater monitoring bore installation procedure. 	<ul style="list-style-type: none"> Report created tracks that have had high use – to be assessed for rehabilitation. Report highly disturbed areas – to be assessed for rehabilitation. 	Low
Loss of containment and/or discharge of effluent exceeding quality criteria	Localised contamination of surface water and/or groundwater.	<ul style="list-style-type: none"> No mining activities within the Pipehead Dam catchment. 	<ul style="list-style-type: none"> Sewage Treatment Plants: 	<ul style="list-style-type: none"> 	Low

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
		<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1) provides potential for pathogen dilution, die-off from solar exposure and predation. 100 m buffer zone for mapped Stream Vegetation to encourage filtration. No sewage treatment plants inside the RPZ or within stream zones. <ul style="list-style-type: none"> No swimming or un-authorized immersion in drinking water reservoirs. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Ongoing maintenance and monitoring of Sewage Treatment Plants. DWER Licences for sewage treatment plants stipulates design and operational controls. Buffer zone of >50m around land irrigation area. Surface irrigation only, no sub-surface discharge. Drip irrigation used. Secondary treatment including chlorination and UV disinfection. Sewage infrastructure is not located in steep slopes or within proximity to stream zones. 		
Non-compliance with water abstraction licence conditions	<p>Impacts to downstream vegetation.</p> <p>Impact to surface water resource.</p>	<ul style="list-style-type: none"> No mining operational activities (excludes infrastructure) within applied buffer zones for: <ul style="list-style-type: none"> 200 m buffer zone from reservoir top water level (OCA1) provides potential for pathogen dilution, die-off from solar exposure and predation. 100 m buffer zone for mapped Stream Vegetation to encourage filtration. <p>2023 – 2027 MMP Five Year Clearing Schedule includes no new pit clearing within 1 km of the reservoir Top Water Level and cessation of mining after Q2 2024.</p>	<ul style="list-style-type: none"> Annual downstream vegetation monitoring (photograph points) (Huntly only). Water Abstraction Licences (RIWI Act). Water Operating Strategy. Water meter calibrations (annual). Regular inspections of water abstraction points. Regular recording of abstraction volumes. Maintenance of water abstraction infrastructure e.g. pumps. 		

7.3.1 Turbidity

7.3.1.1 Catchment Performance Review

A series of reviews were undertaken to determine the impact of mining operations on the local catchments. The reviews provided a detailed interpretation of data that has been collected over a period of years as well as published research in the area. The aim of the reviews was to determine correlations of catchment performance that can be attributed to mining operations, and to ensure that implemented water management controls are appropriate and perform to the required standards. These reviews form the foundation of the technical assessment which has led to a risk-based management approach outlined in section 7.3.1.2.

Alcoa has undertaken a targeted risk review in relation to sub-catchment clearing for the purpose of risk event identification and identification of associated risk controls relative to catchment turbidity risk. These specifically address the identified constraints relating to slope and sub-catchment clearing. The sub-catchment surface water risk events and risk controls are outlined within Table 7-16. Design measures identified through this process form the basis for the risk management process.

Table 7-16: Sub-catchment clearing induced turbidity risk review

Spatial extent and constraint	Risk event	Consequence	Design Measures
Local mine pit (area) Sub-catchment clearing (<30%)	Surface water runoff design underestimates the cleared catchment area leading to inadequate storage feature capacity and uncontrolled release	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	WA Mining and Haul Road Drainage Design Manual: Mine floor catchment hydrology defined by terrain analysis and assessment of adjacent mining, rehabilitation, forest areas to evaluate runoff inclusion
Local mine pit Terrain gradient <16%	Pit development clearing and topsoil/overburden removal leaving exposed caprock prior to bauxite removal with potential uncontrolled surface water runoff	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	WA Mining and Haul Road Drainage Design Manual: Drainage protection slot design process includes upslope and downslope controls according to risk based assessment derived from water model
Local mine pit Sub-catchment clearing (<30%)	Surface water runoff design underestimates surface water contribution from forest and/or upslope mining areas leading to inadequate storage feature capacity and uncontrolled release	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	WA Mining and Haul Road Drainage Design Manual: requires surrounding terrain character assessment for detailed drainage design

Spatial extent and constraint	Risk event	Consequence	Design Measures
Local mine pit Sub-catchment clearing (<30%)	Surface water runoff design over-estimates mine floor infiltration rate leading to inadequate storage feature capacity and uncontrolled release	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	<p>WA Mining and Haul Road Drainage Design Manual: allows for material character infiltration rate assessment relative to observed infiltration rates within the range 18mm/day to 30mm/day</p> <p>Water balance scenario modelling completed to evaluate storage containment effectiveness relative to range of design event storage capacities and range of infiltration rates (Advisian 2022 review) for Dwellingup 1980-2021 daily rainfall record; based on current knowledge the mine floor storage design basis contains >99% of 41 year rainfall record</p> <p>Additionally, a Field Infiltration Rate Test Program will be implemented to compile and maintain comprehensive dataset for design review and iteration (Plan Do Check Act)</p>
Local mine pit Terrain gradient <16%	Surface water runoff design under-estimates mine floor sedimentation carry into storage features leading to inadequate storage feature capacity and uncontrolled release	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	<p>WA Mining and Haul Road Drainage Design Manual: includes sedimentation considering 10% slope gradient (maximum practicable working surface gradient) effect using Revised Universal Soil Loss Equality (RUSLE) on storage feature containment and maintenance frequency</p>
Local rehabilitation Terrain gradient <16%	Rehabilitation slope geometry and subsurface preparation does not consider requirements for re-establish Jarrah forest deep infiltration and storage and landform erosion stability during early stage (2-3 years) rehabilitation while forest floor system restores	Uncontrolled release from mining into downslope and stream zones with water quality above threshold	<p>WA Mining and Haul Road Drainage Design Manual: pre-mining conceptual design to assess the achievement of slope gradient; detailed design considering deep pre-ripping, contour ripping with ridge and furrow development; no slope>20 degrees, 20 degrees for 20m horizontal run only, all other <15 degrees;</p>

Spatial extent and constraint	Risk event	Consequence	Design Measures
Local mine pit hydrogeology Sub-catchment clearing (<30%)	Pit development clearing induces groundwater rise leading to groundwater inundating surface water runoff containment features rendering ineffective against design, leading to uncontrolled release	Turbidity and sediment laden water released into adjacent forest and/or stream zone and depending on proximity water supply dam	WA Mining and Haul Road Drainage Design Manual: design to avoid inundation, contingency plan for containment features to be separate with pumping plan (Groundwater Stewardship Strategy) Groundwater stewardship strategy collaborative development and implementation leveraging existing groundwater interaction risk management controls to 1) seek greater understanding of the localised and compartmentalised groundwater system 2) define long term agreed management approach
Local mine pit hydrogeology Sub-catchment clearing (<30%)	Exceeds capacity of dedicated groundwater collection features leading to uncontrolled release	Turbidity and sediment laden water released into adjacent forest and/or stream zone and depending on proximity water supply dam.	WA Mining and Haul Road Drainage Design Manual: design to avoid, contingency plan for containment features to be separate with pumping plan (Groundwater Stewardship Strategy)
Local mine pit hydrogeology Sub-catchment clearing (<30%)	Pit development clearing induces groundwater rise which has potential to increase stream flow above natural trends (daily volume and/or peak flows) through downslope discharge and greater runoff due to greater saturate area with potential therefore to increase stream bank erosion above natural trend	Turbidity and sediment laden water generated within stream zone depositing downgradient within the catchment and depending on proximity water supply dam.	Preliminary literature review findings indicate no new technical design measures required with collaborative targeted research recommendation

Spatial extent and constraint	Risk event	Consequence	Design Measures
Sub-catchment Sub-catchment clearing (<30%)	Saline groundwater rise into streamlines leading to saline water quality stream flow	Saline water carried through stream line and depending on proximity water supply dam	Groundwater Stewardship Strategy include borehole full suite analysis (salinity)

7.3.1.2 Risk-based management approach

Approximately 95 percent of the Huntly and Willowdale mine areas are located within PDWSAs. A critical enabler of Alcoa's ongoing operations is its management of mining activities to prevent impact on these PDWSAs.

Due to changes to the IWSS, and acknowledging the increasing risk factors in some mining areas (such as increased slope), Alcoa is working closely with the WC and DWER to identify and manage emerging risks over and above the Water Working Arrangements (Version 5, 2019) requirements. In 2020, feedback from the DWER and WC identified general concern and increased risk to the PDWSA catchment due to the portion of high-slope mining and level of sub-catchment clearing nominated within the initial Five Year Mine Plan.

Parts of the current 24 Month Clearing Schedule are located within areas considered by the DWER and the WC to present an increased risk to the catchment area within the Huntly mine region as they contain:

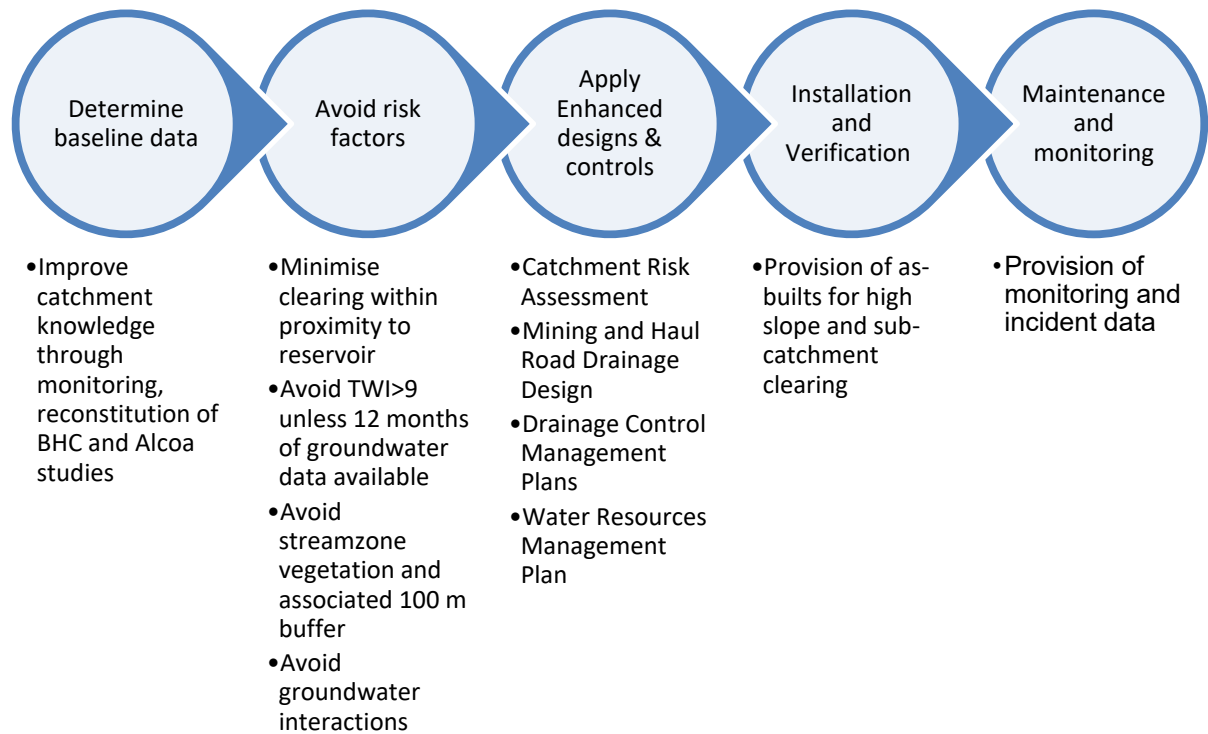
- Areas with slope greater than 16%; or
- Sub catchments in which mining disturbance is greater than 30% of the total sub catchment area.

Alcoa considers that with the risk-based approach and enhanced management controls outlined in this MMP, these areas can be safely mined and rehabilitated to minimise risk to PDWSAs to as low as reasonably practicable. Further detail on the risk-based approach and enhanced drainage design controls are described in detail in this MMP.

To address concerns of the MMPLG to mine in these areas, Alcoa proposes a risk-based management approach (Figure 7-13) as part of the ongoing MMP approval and FCA endorsement process. Alcoa's risk-based approach involves doing all things reasonably practicable to ensure that leading environmental practices are adopted as part of its operations.

This risk-based approach is supported by the development of technical workstreams to address knowledge gaps and uncertainties. The workstreams have guided, and will continue to guide, the development of knowledge, technical solutions and improvement projects that are targeted to manage catchment protection risks associated with slope, catchment clearing and groundwater management.

Figure 7-13: Risk based management approach key steps



7.3.1.3 Baseline data requirements

As detailed in (Sections 7.1 and 7.2), Alcoa has undertaken significant studies and research into the receiving environment, that provides sound basis for the assessment and risk controls provided in this MMP. Alcoa remains focussed on opportunities to continue to improve understanding of catchment dynamics and impacts and obtaining further data in that regard. As such, Alcoa has committed to reconstituting the BHC (Commitment 13). Consultation will occur with the BHC to develop the full mining cycle planning approach, cumulative catchment scale risk assessment methodology, Drainage Design Manual, Rehabilitation Design Manual and any other relevant technical studies or documents (Commitment 14). Further information on other Alcoa initiated water-related studies is provided in Sections 7.3.1.5, 7.3.1.6, 7.3.1.9, 7.3.2.1 and 7.3.2.2.

Another opportunity is the development of baseline data, focussing on site specific information to ensure adequate engineered controls and a catchment and sub-catchment activities to further minimise impacts.

The following data will be obtained to inform specific designs and incorporated into mine and haul road designs:

- Site specific infiltration rates.
- Baseline surface water data.
- Known information on groundwater levels in the area.
- Information from drilling programs relating to regolith depth.

7.3.1.4 Avoidance of risk factors

The Water Working Arrangements agreement between Alcoa, DWER and WC (Version 5, 2019) is the framework under which Alcoa manages its mining operations within the PDWSAs including management of mining adjacent to reservoirs, as defined below:

- **Operational Control Area 1 (OCA1):** A 200 m buffer that extends perpendicular from the reservoir TWL. Access to OCA1 is generally prohibited except for the purposes of constructing, maintaining or travelling along roads or infrastructure, which are approved within the MMP, Five Year Mine Plan or FCAs – or for the purpose of safety inspections prior to blasting activities.
- **Operational Control Area 2 (OCA2):** A 300 m extension perpendicular from OCA1 (total of 500 m from the TWL). OCA2 extends a further 500 m upstream along reservoir tributaries (to an extent of 1,000 m) from the reservoir. Proposed mining and clearing activities within OCA2 are subject to submission of an environmental management plan (or equivalent document) to ensure Alcoa's activities have no impact on the water resource. Alcoa have previously used Drainage Control Management Plans (DCMPs) to undertake this risk assessment and outline controls to mitigate each identified risk.

Alcoa has historically applied variable width buffers to stream zone vegetation, based on the order of the watercourse and proximity to reservoirs as outlined above. The mine plan does not include any mining in the stream zone buffers but does provide allowance for infrastructure corridors i.e., haul roads, of which disturbance to stream zones is minimised. Alcoa will implement a 100 m buffer around streamzone vegetation to minimise impacts to surface water.

As part of the mine plan, Alcoa will consider other key risk factors, and minimise impacts where possible, including:

- Topographical Wetness Factor greater than 9, which are typically found in association with stream zones, unless 12 months of groundwater data is available (at least one record within post-winter to indicate highest groundwater level) (Commitment 16)
- High potential for groundwater interaction through the implementation of a groundwater separation distance from the base of the pit.
- Streamzone vegetation and an associated 100 m buffer.
- No new mining activities will occur within OCA2. Minor infrastructure clearing (17 ha) will occur within OCA2, which is associated with the Big Brook Crossing upgrade and haul road re-alignments. The Big Brook Crossing clearing is related to the existing drainage sump network and discussed further in Section 7.2.9.
- Not undertake any clearing for mining within 1km of the top water level of any water reservoir in Myara Central and Myara South (Commitment 2). Clearing for infrastructure, monitoring and rehabilitation activities will still occur within this area.

- Not undertake any MMP-related mining activities within 1km of the top level of any water reservoir in Myara Central and Myara South after 1 July 2024 (Commitment 3). It should be noted that infrastructure, monitoring and rehabilitation activities will still occur within this area. Minimal disturbance within 1 km of the Serpentine Dam reservoir Top Water Level (TWL), with only an additional 1 ha of new disturbance included in the 24 Month Clearing Schedule.
- Not undertake any clearing for mining or exploration, and mining and exploration activities within the Serpentine Pipehead Catchment (Commitment 4). It should be noted that rehabilitation activities will still occur within this area.
- Not undertake any new pit clearing in any areas with an average pit slope greater than 16% within any Reservoir Protection Zone (RPZ, 2km from reservoir top water level) (Commitment 5).

As rehabilitation has been shown to decrease high turbidity event risk (DAA 2023), Alcoa will endeavour to minimise open areas within the public drinking water source area, with a priority placed on proximity to the reservoir (Commitment 6), through rapid rehabilitation.

To provide better protection of the drinking water supply to Perth's IWSS, Alcoa has ceased exploration activities and will not progress additional mine development approval applications within the Serpentine Pipehead Dam catchment. In addition, no further new pit clearing is included within 1 km of the Serpentine or North Dandalup reservoir Top Water Level, and cessation of mining is planned for Q2 2024.

7.3.1.5 Catchment Risk Assessment

Alcoa is developing a catchment risk assessment tool, which will consider potential hazards to PDWSAs and other factors to evaluate mining related catchment risk. This is an iterative process that will allow refining of the model to ensure it is more accurate on the completion of each subsequent iteration.

The risk assessment will further improve the understanding of inherent and residual risks within Alcoa's operations and ensure that the appropriate level of mitigations are applied. This will support the mine planning process and ongoing management of operational risks.

Iteration 1 of the model has been completed and developed a framework to provide an initial 'proof of concept' for review and feedback by internal and external stakeholders. Iteration 1 focuses on assessment of relevant water quality contaminants, sources, pathways which could combine to present a risk to the PDWSA reservoirs. Contaminants of concern include:

- Turbidity.
- *E. Coli* and pathogens.
- Hydrocarbons.
- Fire ash.
- PFAS.
- Salinity.

The basic steps undertaken for the assessment are:

- Step 1 – Delineate the stream network, catchment and sub-catchment boundaries.
- Step 2 – Upload the current and future mine plan.
- Step 3 – Undertake an assessment utilising a range of spatial inputs to identify inherent risks (i.e. risk assessment without mitigative controls applied).
- Step 4 - Undertake a risk assessment with controls applied to understand the residual risk.

The output of the process is a spatial risk assessment with outputs available in GIS format and results summarised in a source-pathway-receptor table.

The process allows assessment of each individual sub-catchment and allows aggregation of sub-catchments to determine an overall assessment of the cumulative effects of mining along each stream network.

Future iterations of the project will refine the tool to improve functionality and accuracy.

7.3.1.6 WA Mining and Haul Road Drainage Design Manual

The WA Mining and Haul Road Drainage Design Manual, (the Manual, Appendix 16) has been updated from past versions, and guides the design of drainage facilities to serve the mine and haul roads. Darling Range hydrology, with and without bauxite mining, is well documented, including several decades long research catchment studies, in relation to key hydrological processes at local and regional scale³⁰. Processes include infiltration, surface runoff, groundwater. The Manual outlines Alcoa's approach to drainage management in relation to these processes, with feedback and action outlined in Table 7-17.

The purpose of the Manual is to outline the design process for pit and haul road drainage control to manage catchment surface water runoff quality within the agreed water quality trigger. The Manual is derived from risk-based or failure mode-based assessment relative to key factors of concern, and

³⁰ Borg et al 1987a. Stream and ground water response to logging and subsequent regeneration in the southern forest of Western Australia : interim results from paired catchment studies.

Borg et al 1987b. Stream and ground water response to logging and subsequent regeneration in the southern forest of Western Australia : Results from four catchments.

Ruprecht 1991. Soil water investigations within the native Jarrah forest and rehabilitated bauxite minepits in south-west Australia.

Bari and Croton 1997. The effect of bauxite mining on the infiltration characteristics of darling range soils

Mengler et al 2006. Erosion resistant landform design for steep slopes in rehabilitated bauxite mines

Croton and Reed 2007. Hydrology and Bauxite Mining on the Darling Plateau

Kinal and Stoneman 2012. Disconnection of groundwater from surface water causes a fundamental change in hydrology in a forested catchment in south-western Australia.

Grigg 2017. Hydrological response to bauxite mining and rehabilitation in the Jarrah forest in south west Australia.

Kinal and Grigg 2020. On the contribution of groundwater to streamflow in laterite catchments of the Darling Range, south-western Australia

[unpublished; Alcoa consultancy engagement with Ruprecht and Dundon independent review] Silberstein 2022. The impact of land use change on sediment mobilisation and stream turbidity: a review

considers the extensive research catchment studies, to manage catchment turbidity. The drainage design assessment is conceptualised within Figure 7-14; with associated description of each failure mode identified by Alcoa and the subsequent control contained within the manual (Figure 8-12).

It contains Basis of Design information, design criteria and detailed design methodologies required to provide the designs. Endorsement of the Manual will ensure standard minimum design criteria is applied to all proposed pit designs. Alcoa considers the Drainage Design Manual is sufficient to minimise drainage failures. To improve transparency with regards to its implementation, DCMPs will be developed for all pit and haul roads within public drinking water areas (Commitment 15).

Figure 7-14: Drainage design assessment conceptualisation based on identified failure modes

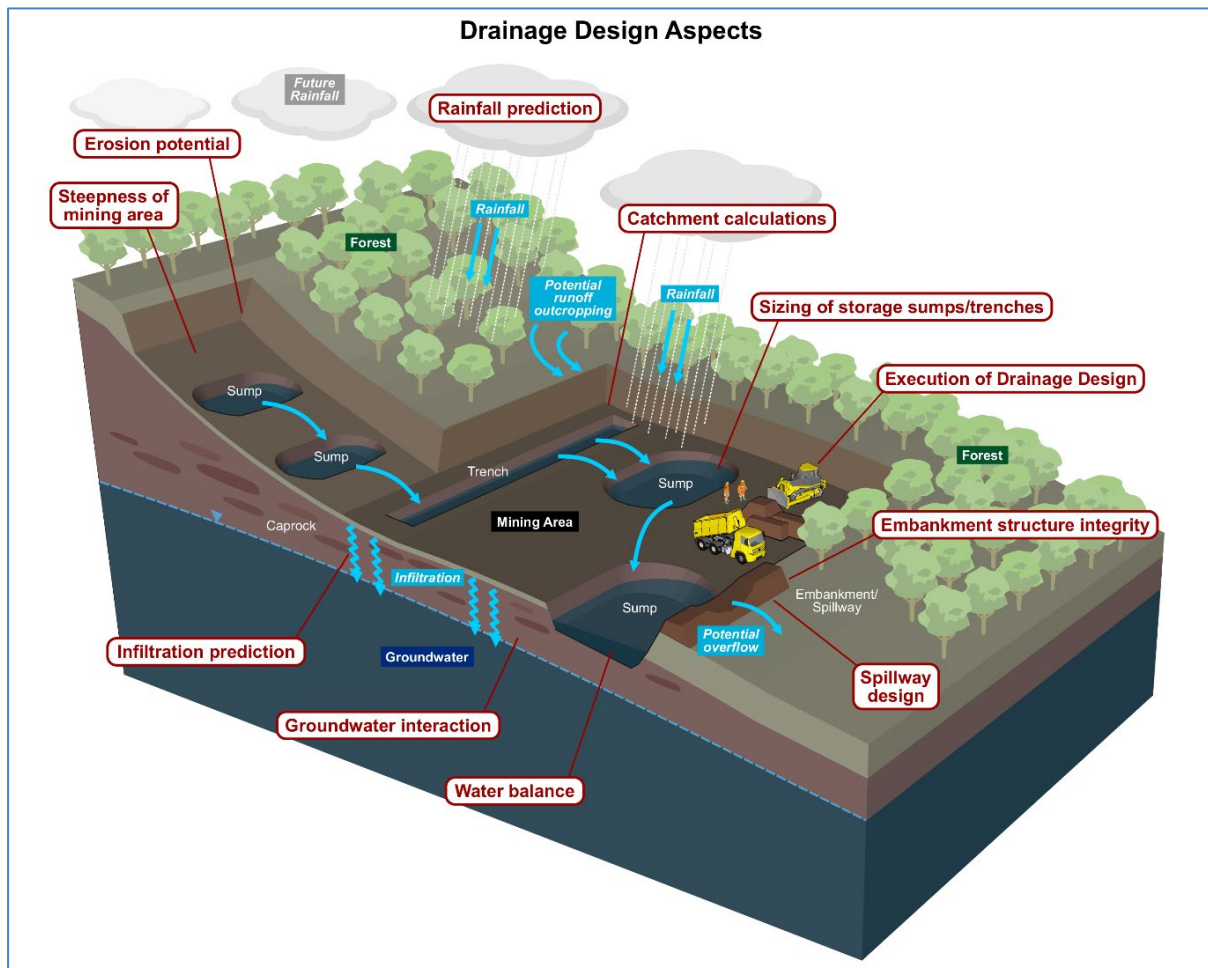


Figure 7-15: Drainage control failure modes identified by Alcoa and the subsequent control contained within the manual

DESIGN ASPECT	FAILURE MODE	RATIONALE	IMPACT OF FAILURE	CONTROL	DRAINAGE MANUAL REFERENCE
Rainfall prediction Water balance	Design rainfall basis without water balance	Winter rainfall series accumulated storage	Accumulated water storage exceeds single design event storage increasing frequency of release	Winter rainfall series developed based on: a) 40 years actual rainfall (1980 onwards including TC Bobby 1982) b) dry, wet, average years grouping	Appendix B – Design Rainfall Appendix C - Daily water balance (for pit) Appendix D – Assessment of pit design criteria
Rainfall prediction Storage sump/trench sizing Spillway design Embankment structure integrity	Design rainfall basis exceeded	Rainfall volume > exceeds storage design	No controlled release structure or controlled release structure in place and turbid water conveyance	Risk factor dependent Initial design criteria is 1% AEP 24-hour with rainfall sequences overlay to assess performance, if risk assessment deems necessary. Risk factor considerations include (amongst others): - consider mining exposure duration - greater design events impact on the broader catchment - dilution of the possible sediment plume with clean flow from the undisturbed catchment	Chapter 2. Design criteria Chapter 3. Design aspects Chapter 4. Spillway Design Appendix C - Daily water balance Appendix H supports decision on design rainfall
Storage sump/trench sizing Infiltration prediction	Storage feature infiltration rate	Volume > containment	Insufficient containment volume increasing frequency of release	Infiltration rates are challenging to determine without detailed site-specific investigations and measurements. When site-specific data is not available, estimate infiltration rate by characterisation of typical soil properties. Infiltration rates are estimated based upon literature and current experience for common soil types. Development of site investigation and data evaluation is in progress.	Chapter 3 (Current Infiltration Estimates) Chapter 4 (Pit storage design) Chapter 5 (Infiltration and Sedimentation sump design)
Erosion potential Infiltration	Mining surface runoff coefficient	Volume > sedimentation > containment	Assumption lower than actual underestimates storage feature containment volume required	Conservative values of runoff coefficient applied.	Chapter 2. Design criteria Chapter 3. Design aspects Chapter 4. (Estimate of soil loss)
Catchment calculations Erosion potential Storage sump/trench sizing Water balance	Surface flow model area	Area > volume > sedimentation > containment	Assumption lower than actual (incorrect mining area calculation, failing to consider adjoining mining areas) underestimates storage feature containment volume required	QA/QC of design work Audits of performance of constructed systems	Chapter 4. (Estimate of soil loss) Chapter 5. (Infiltration and Sedimentation sump design) Appendix C - Daily water balance Alcoa internal QA/QC
Mining area steepness Erosion potential	Mining surface slope gradient and material type	Slope > velocity > shear stress > sedimentation > containment loss	Underestimated sedimentation accumulation within storage feature contributing to lower than design basis storage	RUSLE method to be used to evaluate the soil loss Collect field data on sediment build-up Testing on erosion of local soils	Chapter 4. (Estimate of soil loss) Chapter 4. (Storage Volume)
Groundwater interaction Storage sump/trench sizing Infiltration prediction	Groundwater rise	Inundation > containment loss	Unexpected groundwater rise, potentially reaching the surface within lower slope storage features, resulting in containment loss and infiltration over-estimation	Assessment of groundwater interaction with surface water management structures, by combining topography and currently available groundwater monitoring data.	Chapter 3. Design aspects Alcoa groundwater stewardship strategy development to improve groundwater interaction risk assessment
Execution of drainage design Storage sump/trench sizing	Execution QAQC	Design > execution > QAQC check > containment	Storage feature not built to design	QA/QC Dedicated Alcoa 'drainage management' team	Alcoa water planning practitioners and dedicated drainage management team to manage, supervise, QAQC

The Manual is structured to describe the design process for mine pit storage design and haul road sump design. The basic considerations for each are:

- Mine pit storage design
 - Design objective is to maintain catchment water quality (turbidity trigger 25 NTU >1 hour)
 - Minimum storage design capacity based upon:
 - design rainfall event of 24 hours 1% AEP plus.
 - minimum 15% volume factor of safety.
 - Includes a minimum freeboard of 0.5 m.
 - Infiltration rate 18-30mm/day assumed based on literature and observed field rates; Alcoa field infiltration rate test program provides basis for routine design basis iteration.
 - Storage capacity design predicted to contain an indicative >99% daily rainfall runoff (<1% controlled spillway release volume).
 - Spillway design for controlled water release during above design basis rainfall that includes a downslope assessment for flow energy dissipation control and turbidity measurement.
 - Includes trigger actions prioritised for ‘terminal’ sumps based upon storage capacity prioritisation. Effectively this prioritises pits with smaller in-pit storage volume, with a heavy reliance on constructed drainage structures.
- Haul road storage design
 - Design objective is to maintain catchment water quality (turbidity trigger 25 NTU >1 hour).
 - Minimum storage design capacity based upon design rainfall event of 72 hours 1% AEP; in contrast to mine pit broken surfaces, the haul road water model assumes no catchment infiltration.
 - Haul road sump storage capacity is based on a Sump Design Tool allowing infiltration rate inclusion, sump geometry and freeboard allowance for additional storage capacity.
 - Storage capacity design predicted to contain an indicative 90-95% daily rainfall runoff (5-10% controlled spillway release volume) based upon 50mm/day infiltration rate with targeted water handling for lower infiltration rate locations to manage storage capacity design extent; selected haul road sump water quality monitoring informs water handling planning and haul road storage design review.

- Spillway design for controlled water release during above design basis rainfall that includes a downslope assessment for flow energy dissipation control and turbidity measurement.
- Includes trigger actions prioritised for sumps based upon storage capacity prioritisation.

The design process incorporates sub-catchment clearing and terrain slope gradient:

- Sub-catchment clearing: outlines the process to define drainage design hydrology and groundwater, including design assessment of adjacent cleared, uncleared, rehabilitated areas.
- Slope: outlines the storage design consideration for sedimentation carry and storage containment capacity loss due to slope gradient and run length; the evaluated sedimentation is based upon 10% mine floor gradient (maximum working surface gradient) and 100m slope run length into storage.

Items added to the Manual include:

- Storage capacity effectiveness water balance modelling was completed in relation to Dwellingup 1980 to 2021 daily rainfall records. This was completed for a range of infiltration rates. The design event storage capacities were evaluated to support the current design basis rationale. Routine design basis review in future is proposed (for example new infiltration rate information) to validate the designed storage performance.
- The inclusion of methods to estimate the sediment retention efficiency of a sedimentation sump design and water balance assessments to determine the capacity of infiltration sumps.
- Spillway design for mine pit storage structures including downslope assessment of controlled release water velocity and control measures and turbidity monitoring.
- Development of the haul road Sump Design Tool; including infiltration rate specific to sump locations.
- The inclusion of groundwater aspects including groundwater interaction and current infiltration estimates.
- Planning drainage capacity assessment for prioritising active management of sumps based on their capacity, to prioritise those sumps with minimum requirement capacity storage volume.

Spillway design and the associated broader, downslope assessment on water energy dissipation control measures and monitoring is a critical layer of control within mine pit water management. The design objective for the spillway controlled release structures is to minimise the likelihood of excessive sediment load in these releases. This can occur if failure of the containment structure takes place. The spillway hydraulic design follows standard industry design principles and detailed design methodology which include:

- Design storm event for controlled passage of water based upon the storage capacity AEP event (for example 1% AEP).
- Spillway capacity for mine pit up-gradient storage features is assumed at overflow level at the start of the storm event.
- Spillway embankment crest level based upon spillway design peak water level plus wave runoff allowance for 10% AEP or 300 mm freeboard.
- Once the spillway outflow structure has been sized, a daily water balance, using the historical rainfall record, may be undertaken for selected pits to validate the hydraulic performance of the containment system within the pit and the likelihood (risks) of controlled release events.

7.3.1.6.1 Turbidity Risk Failure Mode Effect Analysis (FMEA)

Alcoa has partnered with *Advisian* to develop a turbidity risk failure mode effect analysis (FMEA), which aims to:

- Outline an exhaustive set of failure modes relative to high turbidity within the catchment.
- Include the mining and rehabilitation phases.
- Determine the engineering controls contained in the WA Mining and Haul Road Drainage Design Manual (the Manual) that are aimed to control each failure mode.
- Illustrate failure mode locations relative to mining operations.

This analysis has been the risk-based failure mode foundation upon which the Manual is developed to ensure drainage design controls adequately map to failure modes. The analysis is included in the Manual in Appendix 16.

7.3.1.6.2 Drainage Design Water Balance Scenario Modelling

A review was conducted of the current design criteria used to determine storage volumes. It focused on assessing if the current basis of design for drainage design was appropriate. The review aimed to determine if the current criteria would hold the majority of historic rainfall events. A water balance tool was developed to assess performance.

To validate the drainage design criteria, a real mine pit was used as an example case to test and evaluate the range of mine pit water balance outcomes relative to design capacity and infiltration rates. The selected test case (Kisler 5 pit) has a mining area catchment of 7.2 hectares. Figure 7-16 shows the Kisler 5 mine pit surface water model general arrangement, illustrating the storage features (C1-C10) derived to manage surface runoff where C10 is terminal storage.

A number of scenarios were developed, including:

- Evaluation of storage volumes based on 24 hour 1% AEP and 72 hour 1% AEP design rainfall events.
- Sensitivity analysis using three infiltration scenarios, being 24 mm/day (current design criteria), 12 mm/day (half current criteria) and 48 mm/day (double current criteria).

- Identification of the year with the largest outflows and determination of what criteria would prevent outflows.

The infiltration rate range was informed by an Advisian 2022 program to determine the infiltration rate of 10 mine pits at the Huntly mine. This program included a literature review of infiltration studies specifically relating to bauxite mining in the Darling Range, including Croton and Bari (1997) Croton and Tierney (1996), Raper and Croton (1996) and Sharma and Barron (1987).

The general outcome of the literature review showed that infiltration rates are influenced by a variety of factors, including stratigraphy, groundwater levels and slope. Hydraulic conductivity is therefore dependent on the geological layers being intercepted, groundwater height (which varies throughout the year) and where a mine pit is located on the slope (there is higher infiltration at the top of the slope, compared to the base of the slope).

The identified typical infiltration rates varied between 3mm/day in clay zones to 50 – 60 mm/day. It was determined that the design criteria applied to drainage structures by Alcoa, being 24 mm/day, was well within this range and will be applied as a consistent rate for design.

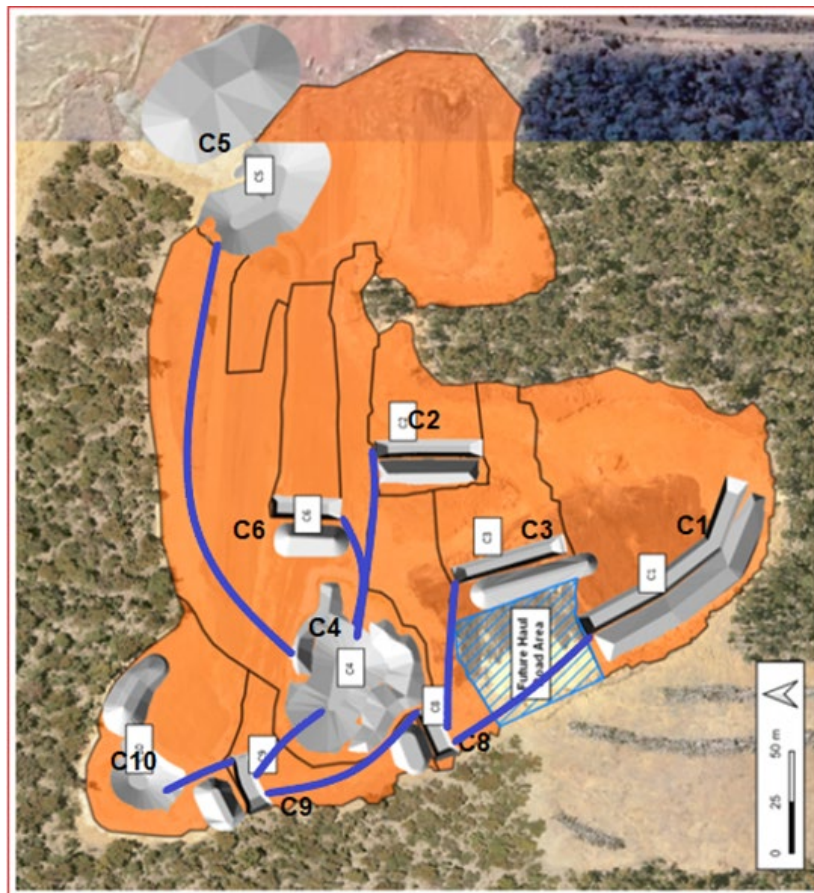


Figure 7-16: Kisler 5 mine pit surface water model general arrangement

Rainfall data from Dwellingup BOM Station No 9538 for the period 1980 to 2021 (Figure 7-17) and Wokalup Research Station daily evaporation (Figure 7-18) was utilised to assess the suitability of the design criteria. This includes the significant rain event in 1982 associated with Cyclone Bruno, which had a daily rainfall of 160 mm.

The daily water balance was calculated using the average daily precipitation, negligible evaporation loss and a constant infiltration rate. Designs were developed using no freeboard and assuming no loss from sedimentation. The water balance considers water present from the previous day, allowing an adequate estimate of how water storage devices will perform over the wetter winter periods.

The model showed that, under the current design criteria of a 24 hours 1% AEP event with a constant 24 mm/day infiltration rate (within the Advisian 2022 derived 18 mm/day to 30mm/day infiltration rate range from literature and site observation), 99.7% of rainfall runoff would be captured over the period 1980 to 2021 (Figure 7-19).

Of the three mechanisms to control water storage without overflow (catchment and storage, infiltration, and evaporation), infiltration provides the greatest opportunity to control water levels. Given the significance of infiltration rate on mine pit water balance outcomes a Field Infiltration Rate Test Program has been developed (Section 7.3.1.6.3) to ensure design storage capacity remains effective relative to observed infiltration rate range.

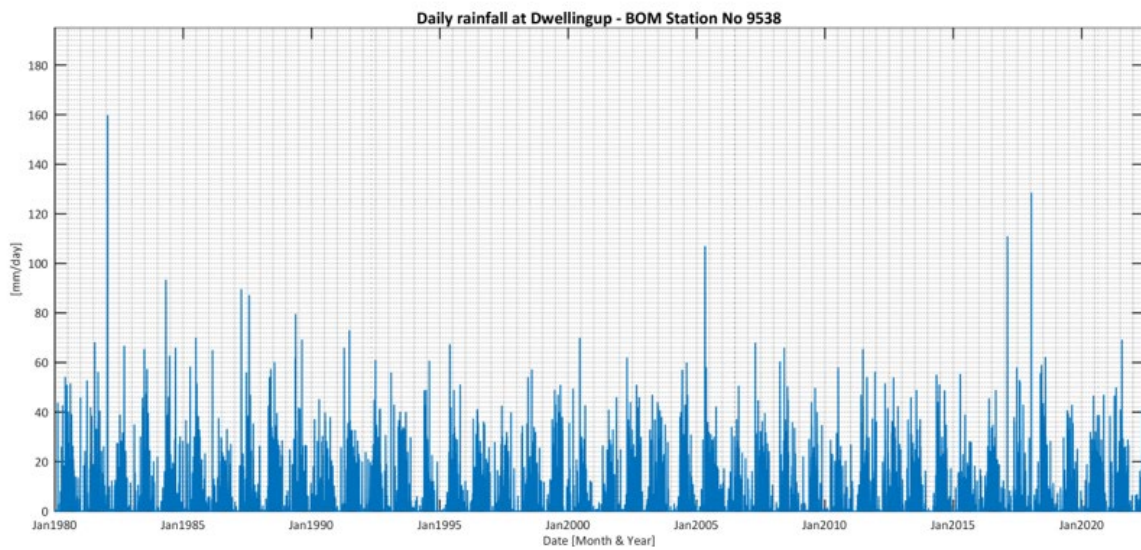


Figure 7-17: Dwellingup BOM Station No 9538 daily rainfall

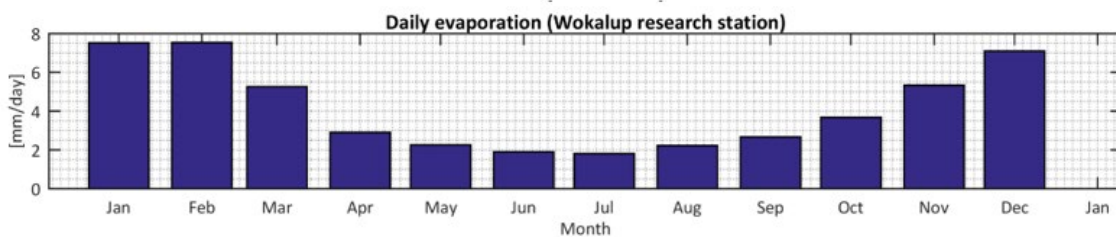


Figure 7-18: Wokalup research station daily evaporation

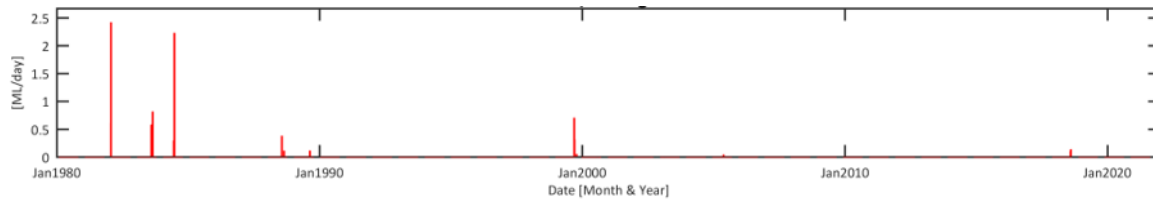


Figure 7-19: Kisler 5 mine pit predicted water balance

Kisler 5 mine pit predicted water balance outcomes for the C10 terminal storage feature showing spillway controlled release volume (ML/day) distribution relative to 1980 to 2021 daily rainfall (the aggregated controlled release volume equates to >99% rainfall runoff containment).

The significance of infiltration rate on mine pit water balance outcomes extends beyond the intrinsic hydraulic conductivity of mine floor material type to consideration of groundwater level relative to storage features. The water balance scenario modelling using Kisler 5 mine pit was extended to include a scenario where groundwater elevation was assumed in close proximity to the base elevation of C10 terminal storage capacity. To simulate the water balance for comparison, the infiltration rate for C10 storage was assumed 12mm/day while all other storages upslope (C1-C9) maintained 24mm/day infiltration rate with all other model inputs held the same.

The water model outcomes showed 97.3% rainfall runoff containment (compared with 99.7% assuming all storages at 24mm/day infiltration rate) with predicted spillway controlled release events occurring more frequently at small volume scale relative to rainfall runoff contained. Figure 7-20 shows the Kisler 5 mine pit predicted water balance outcomes for the C10 terminal storage feature with 12mm/day infiltration rate with all other C1-C9 storage 24mm/day infiltration rate. The predicted increase in spillway controlled release water volume and frequency, by assuming the lowest elevation C10 terminal storage infiltration rate is affected by proximal groundwater beneath, demonstrates the significance of infiltration rate. This highlights the importance of spillway design, including downslope terrain assessment, for water energy dissipation control measures and monitoring requirements, and groundwater stewardship strategy implementation.

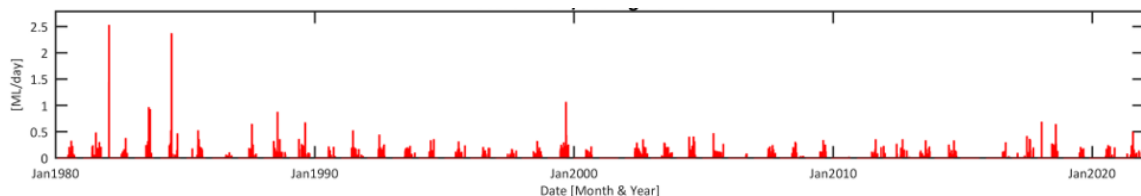


Figure 7-20: Kisler 5 mine pit predicted water balance outcomes

The review showed that the basis of design for the Manual is appropriate and the following factors should remain in place:

- Use of the 24 hour 1% AEP storm event as the design basis.
- Minimum 0.5m freeboard.
- Infiltration rate of 24 mm/day; noting the Field Infiltration Rate Test Program implementation for design iteration.

7.3.1.6.3 Field Infiltration Rate Test Program

Following the Mine Pit and Haul Road Design Assessment, it was identified that infiltration was a significant factor in controlling water storage. A field infiltration rate test program has been developed for review and implementation to conduct field testing for infiltrations within mine pit storage, haul road storage and rehabilitation surfaces.

The program commenced in Q1 2023 and will be used to inform the design of future drainage structures and validate existing drainage structures. To support program development a proposed investigation framework and methodology has been prepared by Advisian. Alcoa will develop the programmatic detailed field scope and field execution plan for extensive field infiltration rate dataset development and ongoing update for mine drainage and rehabilitation design iteration.

The program will further improve Alcoa's knowledge of field hydraulic conductivity associated with materials encountered in mine pits, haul road sumps and rehabilitation. This knowledge will inform the drainage design manual.

7.3.1.6.4 Independent Technical Assurance Review

In the process of developing the Manual, consultation was sought from John Ruprecht and Peter Dundon. During development of the Manual, two separate reviews were conducted, which included:

- Mining and haul road Basis of Design, including tabulated assumptions covering design capacity, area, slope sedimentation, runoff, freeboard, spillway, trigger actions.
- Mining spillway design, including methodology and rationale.
- Mining storage water balance scenario modelling (Wittwer 8 case study).

Results from these specialist reviews were incorporated into subsequent revisions of the Manual. Concluding recommendations and actions currently underway to ensure implementation are shown in Table 7-17.

Table 7-17: Design Manual feedback

Recommendation	Actions
<p>Downslope drainage assessment</p> <p>Alcoa must extend beyond downslope of clearing with consideration of</p> <p>1) spillway controlled release turbidity and erosion control and monitoring to observe actual performance and</p> <p>2) clearing induced groundwater rise on forest and stream zone</p>	<p>Included as part of the Groundwater Stewardship Strategy</p>
<p>Groundwater</p> <p>Alcoa must move toward more reliable and dynamic groundwater level knowledge in advance of planned mining for seasonal fluctuation assessment and basis for clearing induced rise prediction / anticipation</p>	<p>Included as part of the Groundwater Stewardship Strategy and the groundwater monitoring program</p>
<p>Infiltration and recharge</p>	<p>Included in the Field Infiltration Rate Test Program, subject to Dr John Ruprecht and Peter Dundon</p>

Recommendation	Actions
Alcoa must compile comprehensive observed knowledge and take account for seasonal variation within environmental conditions such as infiltration assumptions within drainage design	advisory as well as BHC consultation.

7.3.1.6.5 Implementation of the Manual

The Manual, coupled with Installation and Verification and Maintenance and Monitoring, presents a system of work to manage catchment water quality runoff. The Manual outlines the basis of design for conceptual and detailed drainage design for execution through prescribed water engineering methodology and design requirements specific to the location, size and construction requirements for drainage control measures of mine pits and haul roads.

7.3.1.6.6 Application of Catchment Performance and Technical Reviews

A number of the above technical reviews have fed into the basis of design for the risk management processes outlined in Section 4.6.6. These represent a change in management at the mines to improve performance.

To demonstrate the process and ensure effectiveness, Alcoa has selected a mine area at the Huntly mine, referred to as Wittwer 8, D112_23 notice area for use as a working example of how the risk-based drainage design manual will be applied and demonstrate the expected outputs. Wittwer 8 D112_23 mining area has been selected as it is in an area that is yet to be cleared, and allows a lifecycle approach to the case study. Opportunities to use this area as a research project will also be considered. Application of the Drainage Manual for the Wittwer 8 area has been included in Appendix 17.

7.3.1.7 Installation and Verification

Installation of drainage control structures will occur through the mine development process. Verification that installation of structures has been to the prescribed design will occur through a constructed survey, to ensure that controls on the ground are adequate.

Alcoa considers the Drainage Design Manual is sufficient to minimise drainage failures. To improve transparency with regards to its implementation, DCMPs will be developed for all pit and haul roads within public drinking water areas (Commitment 15). In addition, within high slope and high sub-catchment cleared areas (>16% average slope and >30% sub-catchment clearing), the following will occur as per Commitment 16:

- Provision of pit and drainage control as-builts and details on any design variations to the Mine Operations Group twice a year, at least 4 months apart
- Provision of surface water and groundwater data as per an agreed monitoring schedule and any drainage or Loss of Containment events, to DWER and Water Corp. It's recommended the agreed schedule is incorporated into the WRMP.
- Provision of conceptual rehabilitation designs to the Mine Operations Group six months after FCA approval, for areas with average pit slope greater than 16%

7.3.1.8 Maintenance and Monitoring

Ongoing maintenance of drainage structures will occur as per mine operation processes. This will include regular desilting of long-term devices to ensure that storage capacity is maintained. Verification of devices will occur via ongoing targeted post-cleanout surveys, to ensure desilting returns the device to its design state.

Monitoring of structures will determine if trigger actions are identified which require active management.

7.3.1.9 Groundwater Stewardship Strategy

Alcoa recognises the requirement for improved groundwater management and is seeking to understand the system hydrogeology and groundwater level change in response to clearing and return to natural trends with rehabilitation. The objective of the strategy is to develop the preferred management approach for surplus groundwater. This approach will manage mining groundwater interaction and PDWSA runoff quality risk during the pre-mining phase through the active mining phase to rehabilitation and completion criteria.

The concept of surplus groundwater relates to clearing induced groundwater rise from natural condition which would normally be lost through forest evapo-transpiration.

Alcoa has initiated the groundwater stewardship strategy through preliminary opportunity framing to identify key strategic components. The intent is for collaborate with MMPLG on developing and maturing the groundwater stewardship strategy toward an agreed management approach. The key strategic components and early technical work underway are outlined below in Table 7-18.

Table 7-18: Groundwater Stewardship strategy strategic components

Key Component	Description
Orebody Knowledge Geophysics	<p>A landscape scale airborne geophysics for regolith depth, bedrock and clay layer definition is proposed. The expected outcome includes an improved hydrogeological and groundwater interpretation.</p> <p>In addition, a local ground scale geophysics is proposed for targeted interpretation.</p> <p>The outcomes from the proposed geophysics programme will inform the regolith depth following bauxite removal and a local scale hydrogeological model. In addition, it is expected to further improve Alcoa's understanding of mine pit and groundwater interaction risk.</p>
Borehole Groundwater Hydrographs	Borehole location planning and installation for several year seasonal fluctuation hydrograph trend prior to clearing
Predictive Tool	Groundwater risk is currently assessed using the vertical distance between depth of mining and estimated groundwater levels as a primary criterion. A geological model was developed using geological data obtained from mineral resource investigations (15m grid resolution) and from observations in previous mining areas. The geological model was used to inform the hydrogeology of the new mining and surrounding areas.

Key Component	Description
	<p>Depth to groundwater and seasonal fluctuations in groundwater were evaluated through analysis of existing groundwater monitoring bore data and depth to groundwater was extrapolated between bores to form an estimate of groundwater levels in the geological profile. This allowed for the development of a purpose-built three-dimensional, continuous groundwater surface to be incorporation within the geological model.</p> <p>It has been identified that mine water management would benefit from an alternate, easy to use groundwater level predictive tool tailored to the hillslope based upon, but not limited to, rainfall, LAI, clearing extent and duration, terrain slope.</p> <p>This tool aims to be simple, transparent, uncertainty-based, targeting hillslope pit scale extents and likely Excel-based. Therefore, the critical component to this study is to define simplified relationships between the governing hydrogeological, geomorphological and possibly vegetation mapping-based parameters, making use of the readily available data and other more sophisticated tools existing for the site, and capture these simplified relationships within Excel.</p> <p>This tool will be used to predict clearing induced groundwater rise and rehabilitation recovery to natural trend and will be utilised within the Drainage Design Manual. The first iteration of the tool is expected in late 2023 and is considered a live process, which will be updated once additional information (from water hydrographs and potential geophysics programmes) is available.</p>
Mining Approach	Consideration to mining practices and processes amenable to manage groundwater interaction risk within agreed risk profile
Water Handling	<p>Consideration of handling options including:</p> <ul style="list-style-type: none"> • Controlled release for catchment protection • Selective harvest (pumping) for operational offsets • Avoidance

While the groundwater stewardship strategy is under development, borehole groundwater measurements with limited time series will be the basis of groundwater interaction assessment for future mining areas drawing on historical research catchment range of clearing induced groundwater rise. Mining areas for imminent FCA application will be preferentially selected where existing borehole groundwater data is available to inform final pit design and adaptive management measures.

7.3.2 Catchment Protection

7.3.2.1 Surface hydrology model and DWRA

GHD (2022) undertook a quantitative assessment of risks to the drinking water reservoir for the future Huntly mine and an associated Drinking Water Risk Assessment (DWRA). This work focused on the Myara North and Holyoake mine regions, which are not included in the 24 month or Five Year Mine Plans. However, the Myara North region is located within the Serpentine Catchment. Alcoa proposes

to revise the surface hydrology model and associated DWRA to reflect Huntly mining operations and Willowdale mining operations in consultation with the MMPLG.

7.3.2.2 Rehabilitation Design Manual

Alcoa is undertaking further refinement of its rehabilitation practises through the development of a Rehabilitation Design Manual to provide rehabilitation design criteria. It will aim to integrate a broad knowledge base, including previous technical work, to distil this data into practical rehabilitation design criteria. The rehabilitation design criteria will be integrated into the mine planning process, in addition to providing guidance on rehabilitation execution. To minimise drainage events, consideration will be given to interactions between catchment area, slope angles and lengths. Surface and water modelling is expected to inform the rehabilitation design criteria.

A desktop review has been completed and a technical evaluation has commenced, which consists of:

- Development of a conceptual model showing the factors affecting rehabilitation.
- A rehabilitation water model assessment to better understand the surface water components of the conceptual model.
- A numerical model to determine runoff event frequency, rates and volumes and determine water storage capacity required for rehabilitation designs.
- Erosion modelling to provide a quantitative assessment of erosion rates and better understand erosion risk.

A Rehabilitation Design Manual will then be developed in consultation with the MMPLG.

7.3.2.3 Samson Dam Causeway

Haul road and conveyor access to the Orion crusher, from the Willowdale Mine entrance and main workshop, is via a causeway across Samson Dam. The Samson causeway infrastructure assists in managing surface water storage for the Willowdale Mine and is managed in accordance with the approved operating strategy 'Willowdale Mine Operational Strategy, Surface Water Licence 0061024, June 2022'.

A spill recovery shed is located at the Samson Dam causeway to facilitate prompt response to spills. The shed contains spill recovery equipment, instructions, and contact information to use in the event of a spill. An emergency drill is run annually to assess the procedure for responding to a spill on the causeway.

7.3.2.4 Sewage Treatment and Hydrocarbon Storage

Sewage water is treated using biological aeration treatment units that incorporate disinfection. A monitoring program and maintenance contract is in place to ensure treated water meets the requirements for its intended re-use or release to the environment. The released and treated water is reticulated over areas of the forest to encourage infiltration.

Hydrocarbons are stored in above-ground tanks in accordance with the *Dangerous Goods Safety Act 2004*. Oily wastewater from the workshops, fuel bays and vehicle wash-down facilities is collected and treated to remove hydrocarbons and detergents.

At Huntly and Willowdale mining operations, the treated water combines with stormwater collected from light vehicle roads and parking areas, roof water and general surface runoff. All water is collected before being re-used for haul road watering, vehicle wash down and workshop hose down.

An Emergency Response Plan is in place to ensure a rapid response to a pollution emergency. Hydrocarbon Management and Spill Response Training is mandatory for all production and maintenance personnel. Areas impacted by chemical and hydrocarbon spills resulting from mining and associated activities are remediated and recorded in the environmental incident reporting system.

Alcoa has implemented a spill reduction initiative to minimise spill incidents. Details of these are provided in the AER.

7.3.2.5 Contaminated Sites Assessment

In January 2021, Alcoa's Huntly Bauxite Mine, McCoy, Myara, Willowdale Bauxite Mine, Arundel and Orion workshop areas, and their immediate surrounds, were classified by DWER as 'Possibly Contaminated – Investigation Required' under the *Contaminated Sites Act 2003*.

A contaminated sites assessment of both Huntly and Willowdale mine sites began in Q4 2020. Alcoa is undertaking a detailed site investigation which is scheduled for completion by 2024.

7.3.2.6 Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) – Water Treatment and Re-use

Alcoa has developed and implemented Interim PFAS Water Management Strategies for WA mining operations at Huntly and Willowdale. The key objective is to manage PFAS-affected water and to minimise impact to the drinking water catchment and the environment.

Huntly's interim management strategy focuses on the treatment of PFAS-affected water to non-detect levels for re-use on-site via a temporary water treatment plant which was constructed in November 2020. Validation sampling occurs at the PFAS water treatment plant via an autosampler for every 0.5 ML of throughput. This forms a composite sample for approximately 5 ML of water that is discharged to the clean water batching dams. All treated water is batched and confirmed to non-detect levels for all 28 ultra-trace PFAS suite species, as specified in PFAS National Environmental Management Plan 2.0 (PFAS NEMP V2.0), prior to re-use for operational purposes.

Huntly's permanent solution has commenced under a capital project, and it is in the early design and options analysis stage. The solution will comprise of permanent PFAS-affected water treatment plants, solids handling and/or treatment, and associated infrastructure.

Willowdale's interim management strategy requires the storage of PFAS-affected water on-site or disposal off-site to an appropriately licenced facility.

Willowdale's permanent solution has commenced under a capital project. These facilities will be incorporated into the existing licenced wastewater treatment and discharge system. Alcoa has submitted a works approval application under Part V of the *Environmental Protection Act 1986* which is under assessment by DWER.

7.3.3 Monitoring

7.3.3.1 Catchment surface and groundwater monitoring

Alcoa have initiated early project engineering to develop and implement a systematised and continuous water monitoring program for trigger action response. This will consider the existing catchment monitoring network and improvements to other areas of monitoring. This includes the intent to implement or upgrade network of sensors for mine drainage controls (e.g. haul road storage, mine pit storage and rehabilitation), stream zones and groundwater bores with data gathered to trigger automated alerts to enact the required response, as defined in trigger action response plan (TARP). Alcoa propose to embed a risk-based ranking for water monitoring so that future operations are equipped with the right sensors at the right time and are included in the capital budget (for mine infrastructure) and operational budget (for mine development).

7.3.3.2 Turbidity Monitoring

Alcoa has a turbidity monitoring program (Table 7-19) to assess the performance of mine stormwater management and to better understand catchment performance.

Table 7-19: Turbidity Monitoring Program

Aspect	Details
Compliance monitors	Located immediately upstream of neighbours or public water supply storage reservoirs in accordance with the operational requirements agreed in the Water Working Arrangements. Where telemetry is available, live data is transmitted to site to allow for a quick response to investigate elevated readings. Where transmission via telemetry is restricted, data is downloaded monthly or after every 20 mm or greater rain event. Agreed reporting limits are set by the DWER and WC, and all monitored turbidity events greater than 25 nephelometric turbidity unit (NTU) for an hour or more are reported.
Local monitors	Positioned upstream from the compliance monitoring points. Local monitors provide information on the performance of the drainage infrastructure of the mine. They are generally located in streams below haul road crossings or in a series of large mine pits.
Visual checks	Visual Checks of the turbidity control structures are completed when significant rain is predicted and daily during rainfall periods to ensure runoff and turbidity are controlled.
Turbidity Events	All turbidity events above the agreed reporting limits are investigated to determine the root cause and associated corrective actions, where possible. Events with confirmed mining contributions are reported to DWER and the WC within 24 hours of identification. All identified events are reported to DWER and WC in the monthly report as required by the Water Working Arrangements and are incorporated into the Environmental Review submitted to JTSI each year.

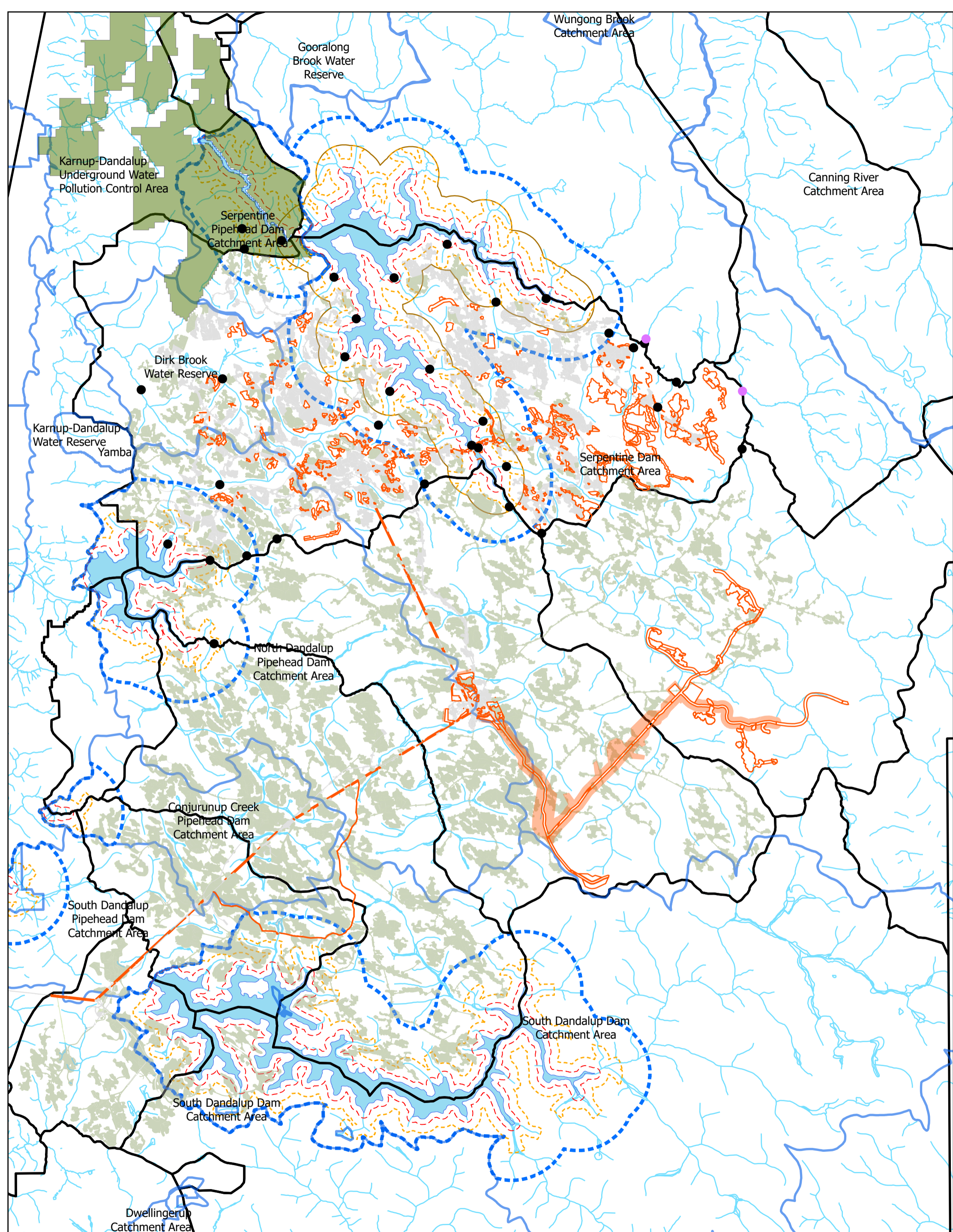
Alcoa undertakes a detailed, annual review of the turbidity monitoring network to ensure implementation of turbidity monitors on all streams flowing from the mine site into the drinking water supply reservoir. From a review undertaken in 2022, an additional 14 turbidity monitors for the

Serpentine Main Dam and North Dandalup Dam catchments were installed to support the Huntly Mine. An additional four turbidity monitors were installed at Willowdale Mine within the Stirling Dam catchment.

Alcoa has also acquired 30 portable turbidity monitors to enable monitoring in streams that do not yet have a fixed monitor and enable detailed turbidity event investigation to isolate the source for turbidity events where a source is not apparent.

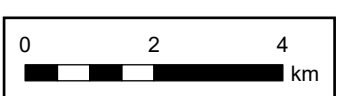
All areas included in this MMP will have a turbidity monitor installed prior to commencement of clearing. Alcoa is progressively installing turbidity monitors for all planned clearing areas and targets installation of monitors associated with the 2025 planned clearing areas in 2023 to enable collection of 2 years of pre-clearing data. The location of the planned and existing monitors is provided in Figure 7-21 and Figure 7-22.

Clearing to facilitate access to and installation of fixed turbidity monitors is included in the Conceptual areas. Typically, 8m² is required for installation of the fixed infrastructure (jetty and solar panel / communications equipment). Where access is required, a 3.5-5 metre wide track will be installed as a single lane forest track.



Legend

Turbidity Monitors - Proposed	Reservoir Top of Water Line (TWL)	Streams
Turbidity Monitors - Installed	1km Radius from Reservoir TWL	Mining Regions
24 Month Clearing Schedule	OCA1	Rehabilitation
Conceptual Clearing Buffer	OCA2	Cleared Areas
Catchments	Reservoir Protection Zone (RPZ)	National Parks

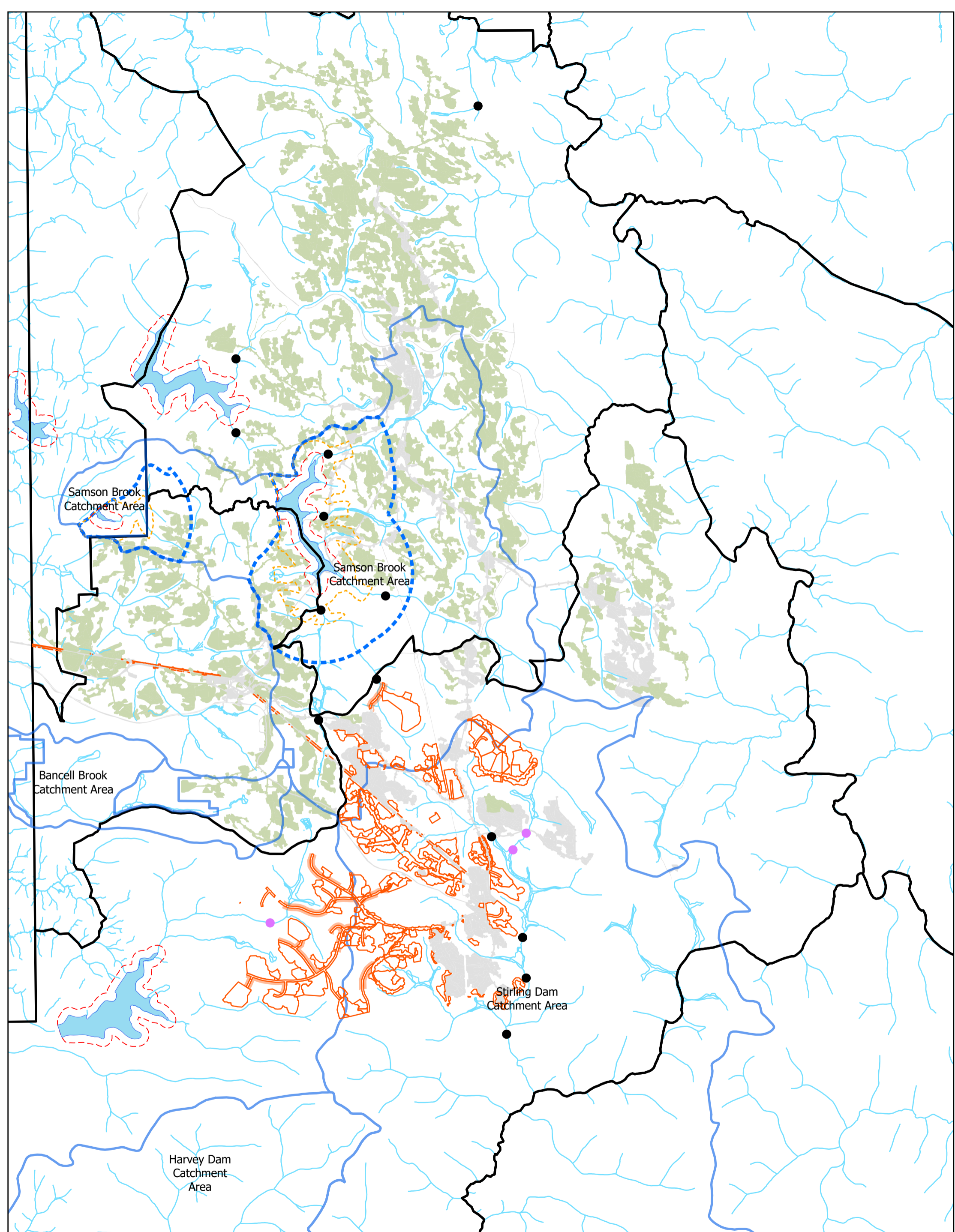


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Figure 7-21: Surfacewater monitoring network – Huntly

Scale: 1:117,352

Date Printed: 1/11/2023



Legend

Turbidity Monitors - Proposed	Catchments	Streams
Turbidity Monitors - Installed	Reservoir Top of Water Line (TWL)	Mining Regions
24 Month Clearing Schedule	OCA1	National Parks
Conceptual Clearing Buffer	OCA2	Rehabilitation
	Reservoir Protection Zone (RPZ)	Cleared Areas



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Figure 7-22: Surfacewater monitoring network – Willowdale

Scale: 1:85,380	Date Printed: 2/11/2023
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7.3.3.3 Groundwater Monitoring

Alcoa has installed groundwater monitoring bores to facilitate groundwater investigation, typically for groundwater level monitoring (Appendix 19) but may include water quality assessment, with the aim of working towards providing at least 2 years of data ahead of mining. Where 2 years of data is not available, at least one groundwater level is used to develop a modelled groundwater level to inform pit designs. As this program has recently commenced Alcoa is installing bores to investigate groundwater in areas included in this MMP. Development of a regional baseline monitoring programme is also occurring.

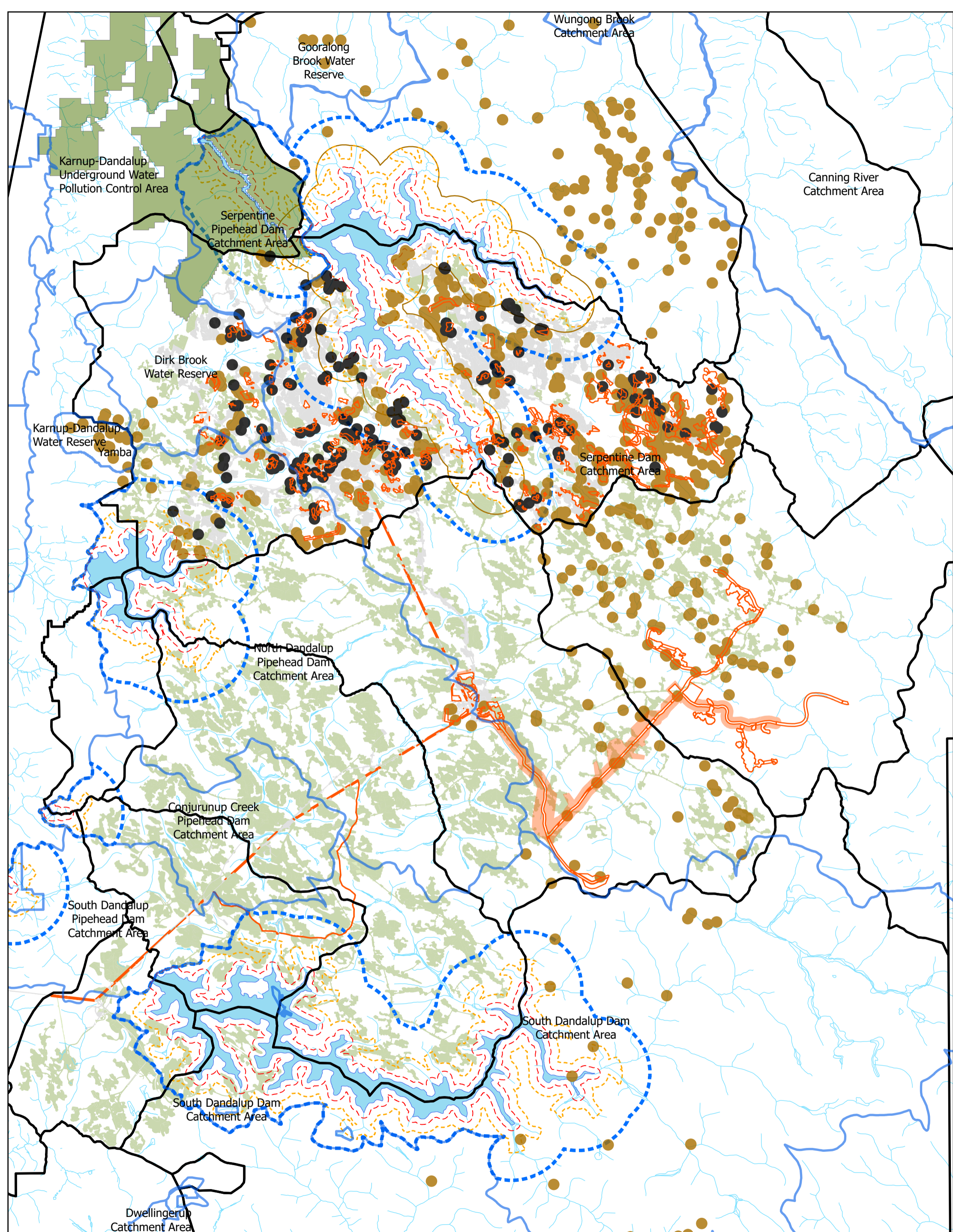
Bores are constructed in accordance with Minimum Construction Guidelines for Water Bores in Australia (National Uniform Drillers Licencing Committee, 2020). Typically, bores are constructed upslope and downslope of proposed clearing areas to facilitate development of a groundwater transect.

Bores are installed using appropriate drilling methodologies (e.g., air core, sonic, or similar suitable method for the geology and installation requirements). Any waste generated during bore installation is removed from site. Bore installation is managed as per the exploration drilling low disturbance requirements, and in accordance with Alcoa/DEC Working Arrangements (DEC now DBCA) 2015, and associated limitations on vegetation disturbance (i.e., tree diameter), soil disturbance and dieback management procedures.

Ongoing monitoring of bores will (depth to groundwater and water quality) provide a good understanding of fluctuations in groundwater due to seasonal variation and influence from mining activities.


Correspondence regarding proposed monitoring bore locations to support the previous 24 month mine clearing schedule for Huntly and Willowdale was provided to MMPLG on 11 November 2022 for consultation and endorsement prior to commencement of program of work. As a result of revision to the 24 Month Clearing Schedule, revisions to the monitoring bore plan are required. A revised monitoring bore locations plan is now provided to support the final 24 Month Clearing Schedule as shown in Figure 7-23 and Figure 7-24. Ongoing consultation with MMPLG is expected to ensure adequate bore locations are implemented. The bore locations should be considered indicative and may change depending on regulatory feedback and appropriate approvals.

Due to the urgency associated with the monitoring program, it is anticipated that the drilling program can be supported outside of the MMP approval process through DBCA approvals, as detailed in Section 1.5.4. This will ensure data can be obtained to support the immediate lodgement of the required FCAs.



Legend

Groundwater monitoring bore	Reservoir Top of Water Line (TWL)	Streams
● Drilled	1km Radius from Reservoir TWL	▭ Mining Regions
● Not drilled	--- OCA1	▭ Rehabilitation
▭ 24 Month Clearing Schedule	--- OCA2	▭ Cleared Areas
▭ Conceptual Clearing Buffer	--- Reservoir Protection Zone (RPZ)	▭ National Parks
▭ Catchments		



0 2 4 km

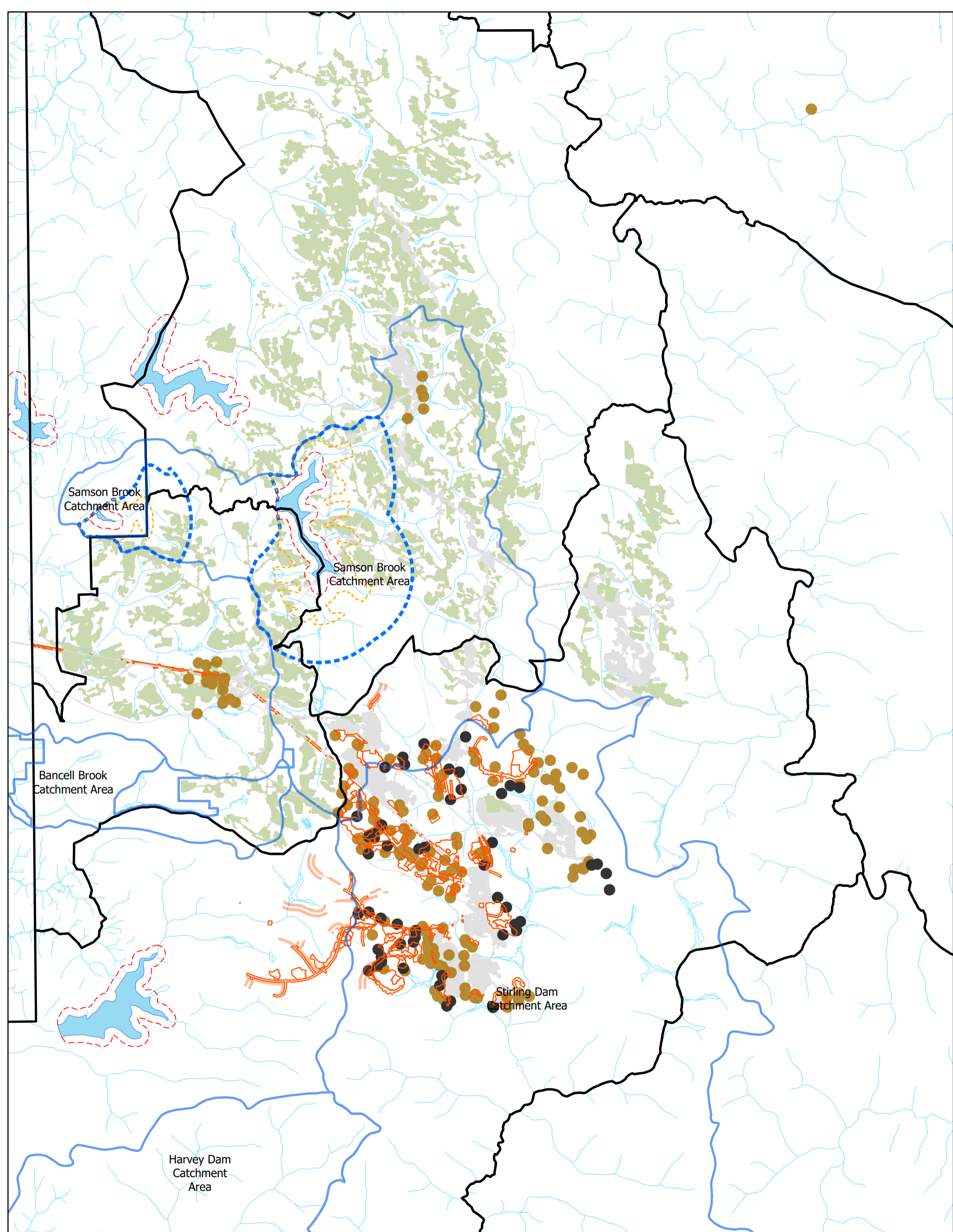


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Figure 7-23: Groundwater monitoring bore network - Huntly

Scale: 1:117,352

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Legend

Groundwater monitoring bore	Reservoir Top of Water Line (TWL)	Streams
● Drilled	○ OCA1	▭ Mining Regions
● Not drilled	○ OCA2	▭ National Parks
▭ 24 Month Clearing Schedule	▭ Reservoir Protection Zone (RPZ)	▭ Rehabilitation
▭ Conceptual Clearing Buffer		▭ Cleared Areas
▭ Catchments		



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Figure 7-24: Groundwater monitoring bore network - Willowdale

Scale: 1:85,380

Date Printed: 2/11/2023

7.4 Assessment of impacts

Alcoa has undertaken a risk-based approach to assess impacts. The risk assessment methodology tables can be found in Appendix 3 .

The direct impacts to PDWSA catchments from 24 Month Clearing Schedule are considered to be medium, with the 24 Month Clearing Schedule being less than 3% of each catchment. Direct impacts to PDWSA catchments associated with the 24 Month Clearing Schedule are:

- 2% of Serpentine PDWSA with total mining impacts to the catchment consisting of 13% (of which 6% is rehabilitated)
- 1% of North Dandalup PDWSA with total mining impacts to the catchment consisting of 31% (of which 26% is rehabilitated)
- 1% of Samson PDWSA with total mining impacts to the catchment consisting of 27% (of which 18% is rehabilitated)
- 2% of Stirling PDWSA with total mining impacts to the catchment consisting of 5% (of which 0.1% is rehabilitated)
- Minor impacts to the Conjurunup Creep Pipehead, Dirk Brook Water Reserve, South Dandalup Dam and South Dandalup Pipehead PDWSAs, with less than 2% of impact associated with the 24 Month Clearing Schedule.

Alcoa have committed to not mine in the Serpentine Pipehead Dam PDWSA, which has the highest risk associated with direct faecal deposition and turbidity. It is also proposed to:

- Cease new mine pit clearing within 1 km of the reservoir immediately and cease mining within 1 km after Q2 2024.
- More selectively mine between 1 km and the RPZ boundary to avoid deeper and wider pits within the RPZ.
- Undertake no additional clearing at greater than 16% slope within the RPZ.
- Prioritise rehabilitation within the Serpentine Dam RPZ.
- Minimise clearing inside of the RPZ through move to O'Neil mine region

Alcoa will implement risk-based mine drainage controls in all disturbed areas, in accordance with Alcoa Drainage Management Manual and Haul Road Sump Design Manual. GHD (2022) noted that elevated levels of inorganic suspended sediments of up to 1 mg/L (equivalent to about 1-2 NTU) are not expected to affect disinfection efficacy.

Increases in surface water turbidity are expected, in particular, high turbidity events increase when open areas (excluding rehabilitation) and slope increases. Alcoa has developed an improvement plan, management and monitoring plan to minimise any impacts to PDWSAs. A risk-based approach is undertaken within constrained areas, with additional details provided within FCAs. Multiple barriers

are implemented to prevent impacts to downstream drinking water reservoirs. The resulting risk will be medium.

The potential impacts from turbidity in rehabilitated areas will be lower than active mine areas. Rehabilitation vegetation establishment is expected to provide long-term soil protection from erosion and rehabilitation design will maximise water infiltration and retention. Rehabilitated mine pits will be designed and executed to prevent overflow during a 1% 24hr AEP event.

The impacts of expected minor increases to stream salinity are considered low. Research indicates that streamflow salinity is expected to decrease during mining then increase during rehabilitation. However, an inverse trend in streamflow yield is expected with an increase in streamflow during mining, and a decrease during rehabilitation. The predicted increase in reservoir salinity, of up to 3% compared to the no-mining case, is within acceptable limits.

The potential impacts from contamination from hazardous materials and pathogens is considered medium. Industry standards management actions are implemented, with additional avoidance of the RPZ and OCA1 and OCA2 areas.

8 Air Quality

8.1 Receiving environment

8.1.1 Baseline monitoring

The Huntly monitoring station (Yamba) is located within the Myara mine region and consists of a High Volume Air Sampler (HVAS) and Beta Attenuation Monitor (BAM). Total Suspended Particles (TSP), particulate matter less than 10µm in aerodynamic equivalent diameter (PM10) and particulate matter less than 2.5µm in aerodynamic equivalent diameter (PM2.5) is monitored at these locations. Willowdale mine does not currently have any monitoring stations.

A weather station for the Huntly mine is located approximately 9km WNW of the Myara crusher. The Willowdale weather station is located at Nanga Dell, approximately 6 km north of the Orion crusher. Specialised weather forecasts for mining operations are received, which include rain and wind forecasts.

8.1.2 Existing air quality

Air quality within the region is considered to be typical of a rural area. The dominant dust sources influencing air quality in the local area include:

- Mine operations – including dust from stockpiles, blasting, bauxite handling and haulage, truck and equipment movements, crushing and conveying and any burning activities.
- Agriculture activities – including wind eroded dust from cleared areas.
- Motor vehicle emissions – from combustion of fuel in mining and non-mining vehicles and equipment.
- Domestic fuel burning - gas, liquid, solid.
- Regional events - such as dust storms, dust events during harvest, prescribed burning and wildfires.

Ambient Total Suspended Particulates (TSP), PM₁₀ and PM_{2.5} data was sourced from the Alcoa Yamba Drive dust monitoring station installed and operated by Ecotech Pty Ltd and managed by Alcoa. Concentrations recorded over the period March 2018 to February 2019 are summarised in Table 8-1.

Table 8-1: Yamba Drive Ambient air quality concentrations, March 2018 to February 2019

Pollutant	Averaging period	Measured concentration (µg/m ³) with extreme dust events removed
TSP	24 hour maximum	69.0
	Annual average	20.2
PM ₁₀	24 hour maximum	47.3
	Annual average	15.0
PM _{2.5}	24 hour maximum	20.3
	Annual average	4.5

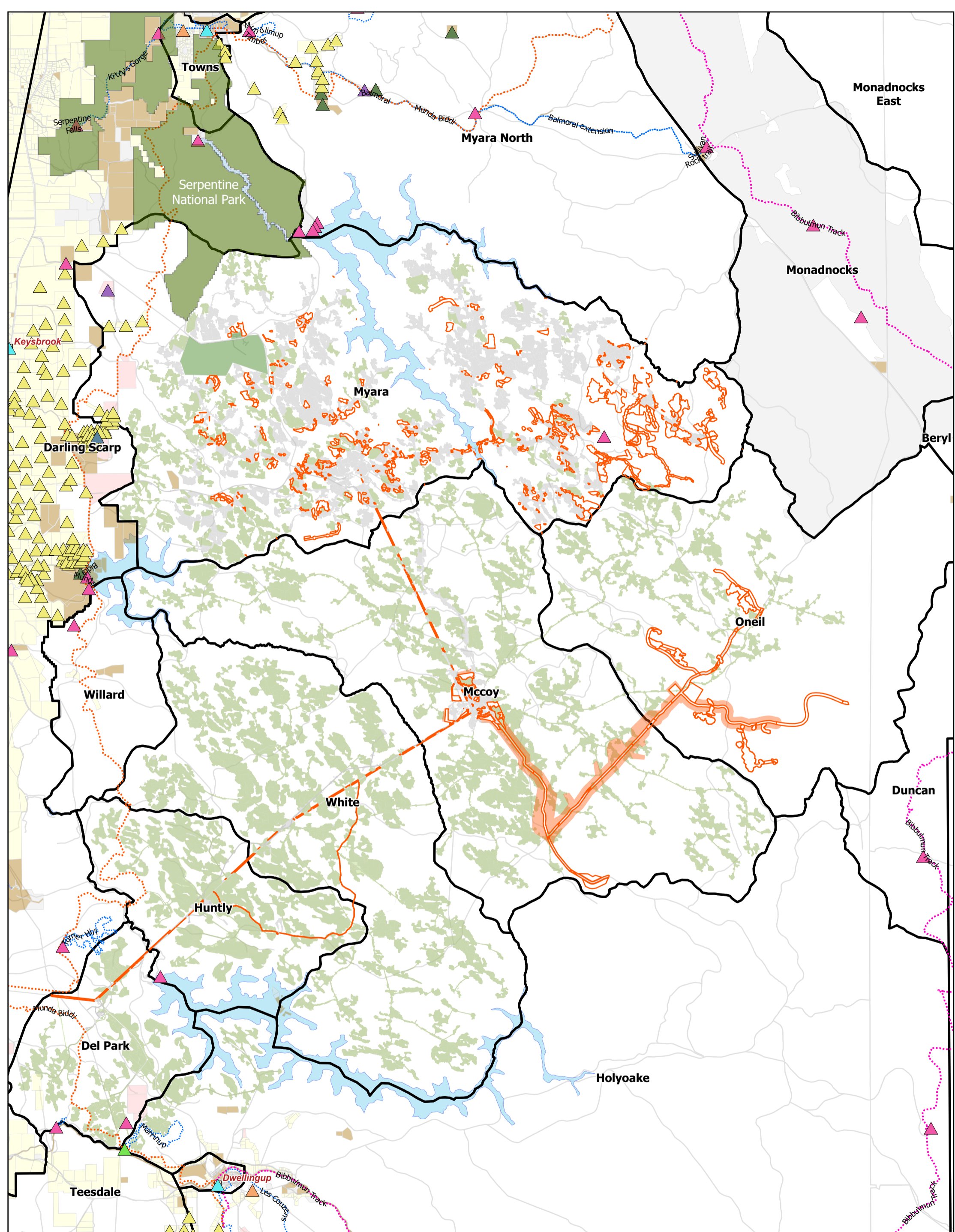
8.1.3 Sensitive receptors

Consistent with the NSW EPA (2016 and 2022) Approved Methods, sensitive receptors were defined as a location where people are likely to work or reside and may include a dwelling, school, hospital, office or public recreation areas. A review of aerial photography identified nearby sensitive receptors, with consideration given to Jarrahdale and Dwellingup townsites, rural properties, overnight campsites (e.g. along the Bibbulmun Track) and other dust sensitive receptors.

A total of five sensitive receptors were identified for the Huntly mine and eight for the Willowdale mine within 2 km of the 24 Month Clearing Schedule's mining and haul road activities (Figure 8-1 and Figure 8-2):

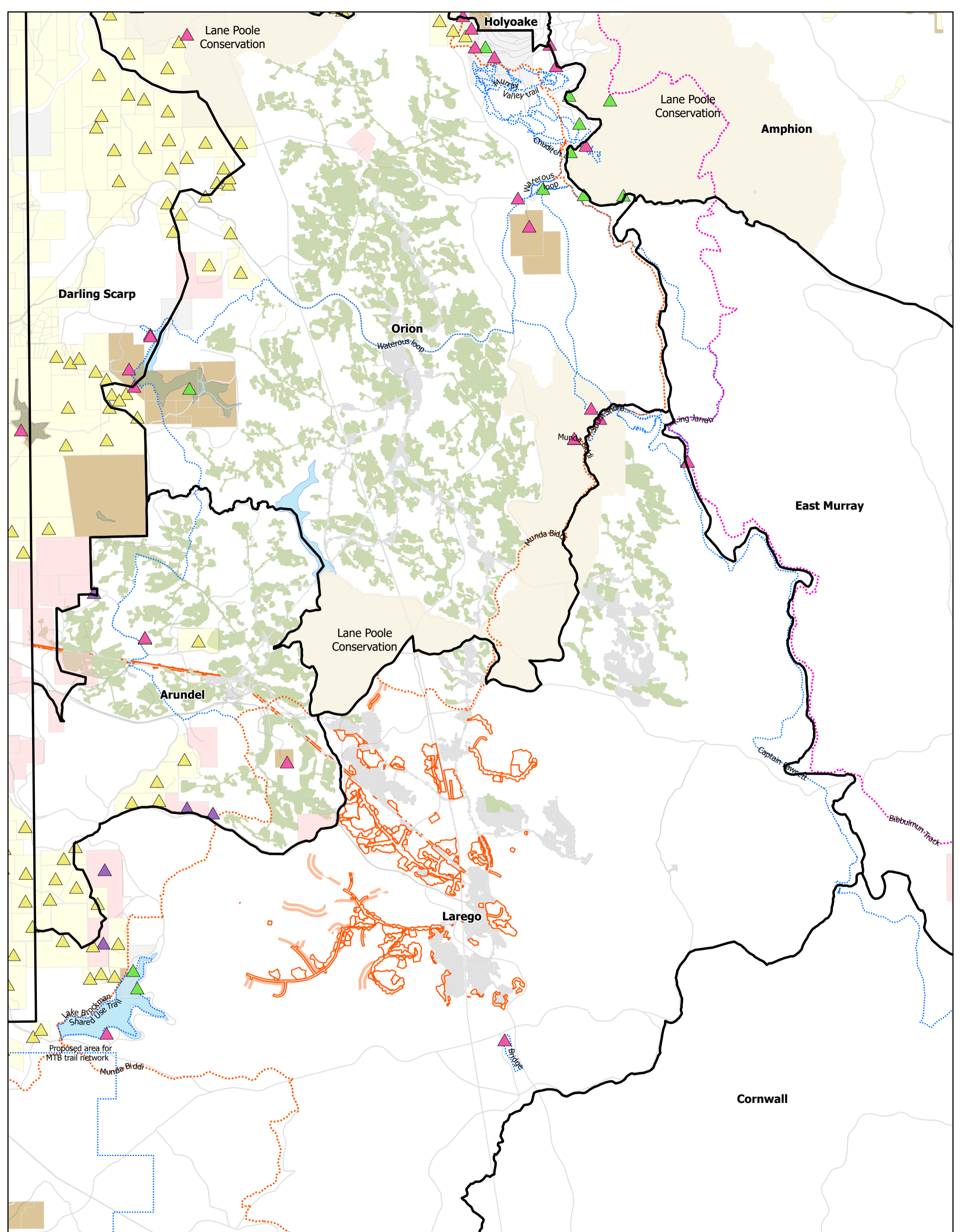
- Serpentine Dam lookout, café, playground and picnic area.
- Mount Solus.
- Six private properties surrounding Larego.
- Mt William recreation facility.
- Hoffman Mill recreation facility.

Three Alcoa owned properties were excluded from this assessment.



24 Month Clearing Schedule	Sensitive Receptors	Mine	Mining Regions
Conceptual Clearing Buffer	Alcoa property	Private property	Major Dams
Land Tenure	Campsite	Recreation	Rehabilitation
Alcoa	Cemetery	Other	Cleared Areas
Government	City/Town		National Parks
Karnet	Government property		Conservation Parks
Private			
Reserve			

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Figure 8-1: Sensitive receptor locations - Huntly	
Scale: 1:117,352	Date Printed: 1/11/2023



<ul style="list-style-type: none"> 24 Month Clearing Schedule Conceptual Clearing Buffer 	<p>Sensitive Receptors</p> <ul style="list-style-type: none"> Alcoa property Campsite Cemetery City/Town Government property 	<p>Legend</p> <ul style="list-style-type: none"> Mine Private property Recreation Other 	<p>Places</p> <ul style="list-style-type: none"> City/Town Bibbulmun Track Trail Munda Biddi 	<ul style="list-style-type: none"> Mining Regions Major Dams Rehabilitation Cleared Areas Conservation
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Alcoa

N

0 2 4
km

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Figure 8-2: Sensitive receptor locations - Willowdale

Scale: 1:85,380	Date Printed: 2/11/2023
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8.2 Potential environmental impacts

Clearing of native vegetation and soil disturbance from construction, operation and rehabilitation activities have the potential to impact air quality and associated amenity.

Dust is the primary air emission that could occur during mine development, mining and rehabilitation operations. Dust emissions occur from the following sources:

- Stripping, and stockpiling of topsoil and overburden.
- Drilling and blasting or ripping of caprock.
- Excavation and handling of caprock and friable/fragmental bauxite.
- Movements of excavators, dozers, loaders and scrapers in the mine pits
- Wheel generated dust from haul truck movements on unsealed surfaces.
- Transportation of material by conveyor.
- Graders maintaining haul routes.
- Loading and unloading at Run of Mine (ROM) stockpiles.
- Processing of bauxite material including crushing and sizing.
- Wind-blown dust emissions from uncovered stockpiles and cleared native vegetation/land and soil disturbance for mining activities.

Dust modelling has not been completed for the mine activities. The implementation of management measures, such as dust planning controls and targeted source mitigation measures (dust suppression) were considered to effectively reduce air quality impacts. Whilst sensitive receptors occur within 2 km, none are within 500m of haul roads or mine pits.

8.3 Mitigation

Alcoa's environmental management incorporates the mitigation hierarchy, which is in order of priority:

- Impact avoidance.
- Impact minimisation.
- Rehabilitation.

A risk-based approach has been undertaken to align with Alcoa's environmental management system and management plans. Associated mitigation actions are provided in Table 8-2 as a risk register and the risk assessment methodology is provided in Appendix 3 .

Alcoa remains focussed on opportunities to continue to improve understanding of air quality impacts and further obtain data in that regard. One of these opportunities is by developing a dust management plan, to further minimise impacts. Alcoa intends to achieve this opportunity by implementing an improvement plan which includes the following:

- Development of a dust model for the move to the O'Neil mine region to confirm potential impacts to sensitive receptors. The dust model report and outcomes will be provided in the

MMP submitted in 2024, prior to any mining activities. Dust monitoring will also be undertaken.

- Development of a Dust Management Plan in 2024.
- Dust deposition monitoring in association with vegetation health as per FVMP (Appendix 9) .
- Reconstitute the Bauxite Hydrology Committee (BHC) with an independent chair by 1 July 2024 (Commitment 13).
- Upon the establishment of the BHC, develop a full mining cycle planning approach and a cumulative catchment scale risk assessment methodology. Consultation will occur on the following (Commitment 14);
 - a. Development of the Drainage Design Manual; and
 - b. Development of the Rehabilitation Design Manual

Table 8-2: Avoidance and minimisation of potential impacts to air quality

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Uncontrolled emission of dust resulting in offsite impacts (including operations, blasting, conveyor trace and Refinery stacker)	Environmental pollution Non-compliance with legal and other requirements Non-compliance with internal standards Intensified regulatory scrutiny approvals / conditions to access ore Increase in community complaints Impaired vision for operators / community (dust close to boundaries) Health impacts (respiratory)	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Undertake dust suppression activities for high use of haul roads and conveyors as per internal dust management procedure. Maximise efficiency of loads when transporting ore (including haul trucks and conveyers). Use dust suppression measures on exposed areas where possible. Investigate alternatives for the wood waste burning of clearing residues to reduce the particulate emissions in the local airshed. Induction packages – the workforce will be made aware of dust generation and control measures. Routine housekeeping practices around central facilities and workshops will be implemented to reduce dust generation. Optimising blast charge sizing and spaces to avoid unnecessary energy 	<ul style="list-style-type: none"> Minimise open area footprint and rehabilitate or cover (using vegetation, rock, water and/or dust suppressant) exposed areas as soon as practicable 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			releases which has the potential to generate dust. <ul style="list-style-type: none"> The location of haul roads, conveyors, mine pits and other infrastructure gives consideration to separation distance from receptors to reduce air quality impacts. 		

8.4 Assessment of impacts

The mine activities are expected to have medium impacts to air quality. There is an absence of sensitive receptors within close proximity to the 24 month mine plan and management controls are considered adequate. Alcoa is committed to increasing monitoring associated with dust emissions.

9 Social Surroundings (Amenity)

9.1 Receiving environment

9.1.1 Baseline surveys

Alcoa has undertaken (or considered) key social surroundings (amenity) studies (Table 9-1). Historical noise modelling had also been completed for the Huntly region.

Table 9-1: Social Surroundings (Amenity) baseline studies

Year	Author	Survey name	Details
2021	GHD	Landscape and Visual Impact Assessment for Huntly Mine - Myara North and Holyoake	Landscape and visual impact assessment for the Revised Proposal
2021	Wood	Noise Assessment for Huntly Mine – Myara North and Holyoake	Noise modelling and assessment for the Revised Proposal
2023	GHD	Holyoake Mine Development – O’Neil East Landscape and Visual Impact Assessment	A draft report which assesses potential landscape and visual impacts of mining within the O’Neil region
2022	Wood	Mining Operations Noise Management Maps	Noise modelling was completed for the Larego mine region based on various pit locations and worst-case noise propagation.
2015	SVT Engineering Consultants	Environmental Noise Impact Assessment for the proposed mining operations at Larego region	<p>An environmental noise impact assessment for the proposed mining operations at Larego Region. The objective of the assessment was to determine if compliance is achieved for the proposed operations with the Environmental Protection (Noise) Regulations 1997 (the Regulations) and to identify noise contours to facilitate operational planning in line with the environmental requirements of the Regulations.</p> <p>An acoustic model was developed and nine sensitive receptors assessed for worst-case meteorological conditions.</p>

9.1.2 Townsites

Land use within the mine regions predominantly comprises State Forest and other forested land reserved for conservation and recreation and there are several towns in proximity to the mine regions:

- Keysbrook – Shire of Serpentine Jarrahdale.
- North Dandalup – Shire of Murray.
- Waroona – Shire of Waroona.

- Harvey – Shire of Harvey.

The towns are generally surrounded by pockets of rural properties. The townsites, surrounding rural properties and recreational trails and facilities are considered sensitive receptors to amenity impacts. Receptors associated with night-time occupation, including residences and recreational campsites, have a higher sensitivity, particularly with respect to noise levels.

There is a network of public roads, consisting of highways, roads and informal tracks throughout the mine regions. The road network is utilised for recreational, transport and land management purposes for a variety of users.

9.1.3 Recreational Trails and Facilities

Conservation and recreation reserves within proximity to the mine regions include:

- Serpentine National Park.
- Lane Poole Conservation Park and Reserve.
- Monadnocks Conservation Park.

Recreation facilities within proximity to the mine regions include:

- The Bibbulmun Track.
- The Munda Bididi Trail.
- Logue Brook Dam (also known as Lake Brockman).
- Hoffman Mill.
- Lake Navarino (Waroona Dam) is located within the inactive Orion mine region.
- Harvey Dam.

Logue Brook Dam is a recreational water body approximately 10 km west-southwest of the Larego crusher that supports:

- Irrigation water.
- DBCA-managed campsites for overnight stays.
- A privately-owned tourist park for overnight stays, permanent dwellings and associated café.
- Recreation and water ski areas.
- The Munda Bididi Trail.

DBCA-managed camping and associated recreation activities at Hoffman Mill were closed in 2022 due to noise, public safety and amenity impacts of the Larego operations. Alcoa recognises the important timber-mill heritage of Hoffman Mill and has committed to not mine the area designated as camping facilities and facilitates the annual Back To Hoffman reunion event. Alcoa will facilitate ad-hoc day-use access process for people affiliated with the heritage of the area.

9.1.4 Landscape and Visual Amenity

Via the Landscape and Visual Impact Assessment studies detailed in Table 9-1, three Landscape Character Units (LCUs) have been described within the mine regions:

- LCU1 – Darling Plateau Forest - Land use typically includes State Forest used for logging, conservation and tourism such as camping, walking and cycling trails. Key reserves include Lane Poole Conservation Park and Reserve, Serpentine National Park and Monadhocks Conservation Park. There is tourism value associated with the forest, Lane Poole Reserve, Monadhocks Conservation Park, Serpentine Dam, Logue Brook Dam, Munda Biddi Trail and Bibbulmun Track. There are several gravel roads and 4WD tracks, walking and cycling trails, and large water-storage dams. Views are typically enclosed apart from elevated areas along the Bibbulmun Track, some of which have panoramic views. Alcoa considers LCU1 as having a high landscape character value.
- LCU2 – Previous and Existing Mining – land use predominantly includes mining and associated infrastructure such as the existing Alcoa mines, the Boddington Gold Mine, and associated vegetation clearing within the Jarrahdale State Forest and Dwellingup State Forest. There are open views across cleared vegetation and a mining landscape. There are no specific values associated with LCU2 and it is considered as having a low character value. Following rehabilitation, closure and relinquishment the mine areas will transition to State Forest with comparable landscape character to LCU1.
- LCU3 – Darling Uplands Peri-Urban - Land use is typically residential within the built-up areas of the towns of Jarrahdale and Dwellingup and rural residential properties are located on the outskirts. There are retail and commercial areas within Jarrahdale and Dwellingup including general stores, cafes, and pubs. Views into the surrounding forests and distant undulating terrain make up a key quality of the area’s landscape character.

Dwellingup and Jarrahdale are growing trails towns that support outdoor activities within the surrounding natural environment. The Dwellingup Trails and Visitors Centre provides linkages to the Hotham Valley Tourist Railway (located within LCU3), Munda Biddi Trail and Bibbulmun Track. LCU3 is considered as having a high landscape character value.

Table 9-2 summarises the LCU landscape values and impacts of change.

Table 9-2: Summary of impacts to landscape character

Landscape Character Unit	Name	Landscape value	Susceptibility to change	Sensitivity to change
LCU1	Darling Plateau Forest	High	High	High
LCU2	Previous and Existing mining	Low	Low	Low
LCU3	Darling Uplands Peri-Urban	High	High	High

The Darling Plateau contains multiple sensitive receptors of varying levels of significance due to the valued natural setting and the quality seen throughout the surrounding forest and landscape. These

receptors include residents, track and trail users, recreational users, campers, tourists, and road users. The existence of these receptors raise concerns regarding the potential visual impact on the area generally, and on nearby communities, private properties, State Forest, tracks, trails, campsites, and roads.

Elevated viewpoints are considered to have a higher likelihood of visual amenity impacts.

A Desktop Review of potential impacts to landscape character has been completed for both mines.

The Willowdale mine region and surrounds are covered by forests and therefore views to mining will be effectively screened by vegetation. The following viewpoints were identified:

- The Mt William fire tower affords elevated views to the north and east over the Larego area.
- Zigzag, Willowdale and Driver Roads have clearing within close proximity, which is visible.

Within Huntly, various elevated viewpoints were identified:

- The Bibbulmun Track traverses the forested landscape, connecting Mount Cooke, elevated lookouts within the Monadnocks Conservation Park, Boonering Hill and Kimberling Hill.
- Mount Cooke (elevation of 582 m).
- Mount Solus (elevation of 572 m).
- Mount Wells (elevation of 542 m).
- Boonering Hill and Kimberling Hill (elevations of over 500 m).

Alcoa also considers viewpoints along public access roads in mine planning.

9.1.5 Noise and blast

An environmental noise model, developed for Myara mine region in 2009, identified the neighbouring properties most likely to be affected by mining operations. It was then used to assist the area's mine planning, with a 4 km buffer used for community consultation. Live operational noise monitoring is utilised to monitor and manage noise impacts.

The Willowdale Mine uses noise modelling to establish day and night mining areas and manage the risk of noise impacts on noise sensitive receptors. Equipment operating in noise sensitive mining areas is monitored by fixed noise monitors on or near private property in the Orion mining region.

Blast noise is monitored in the community and at neighbouring properties, which have been identified by the Blast Acoustic Model (BAM) as most likely to be impacted by a blast.

No detailed noise modelling on the 24 Month Clearing Schedule has been undertaken to determine noise sensitivity zones. In lieu of this, preliminary sensitivity zones developed for the Myara North and Holyoake regions for the Revised Proposal have been used to determine potential impacts. The zones were developed from identified sensitive receivers under assumed typical mining operations and preliminary mine plan information, to determine the noise reductions required to achieve the highest likelihood of compliant operations.

The sensitivity modelling has identified preliminary sensitivity zones (Table 9-3) and their zones of distances from sensitive receptors. Based on the above noise sensitivity zones, a 2 km distance has been adopted as a conservative screening criteria.

No detailed blast modelling on the 24 Month Clearing Schedule has been undertaken to determine noise sensitivity zones. In lieu of this, modelling undertaken for the Myara North and Holyoake regions for the Revised Proposal have been used to determine potential impacts, indicating that a distance of 1.2 km from blasting operations can result in exceedance of blast overpressure. Based on this, a 2 km distance has been adopted as a conservative screening criteria.

Sensitive receptors within 2 km of the 24 Month Clearing Schedule's mining and haul road activities were identified. Three sensitive receptors were identified for the Huntly mine and two for the Willowdale mine (Figure 8-1 and Figure 8-2) including:

- Serpentine Dam lookout and café.
- Mount Solus.
- Mt William recreation facility.
- Hoffman Mill recreation facility.

Alcoa owned properties were excluded from this assessment.

Table 9-3: Noise sensitivity zones

Zone	Sensitivity	Definition	Zone distance, m
Restricted mining zone	Severe	Zones adjacent to receivers. High risk of non-compliance and/or complaints. Compliance with Assigned Levels is likely to require no mining or highly restricted mining with extensive controls. Opportunistic mining may be possible under 'favourable' weather conditions. Careful management and noise monitoring will be required.	Day – 500 Night – 1,000
High specification low noise mining zone	High	Zones closest, but not adjacent, to receivers. Mining noise emissions are controllable through 'optimised mining' with a low noise fleet. Mining activities require evaluation through active modelling and customised noise control strategies for day and night.	Day – 1,000 Night – 1,500
Attenuated Mining Zone	Medium	Zones further away but still close to receivers. Mining required with noise controlled fleet. Activities require evaluation through active modelling to determine the risk of exceedance during night mining with customised noise control strategies	Day – 1,500 Night – 3,000
Standard Mining Zone	Low	Mining with Alcoa's existing fleet is possible without requiring additional noise controls or management	Day – >1,500 Night - >3,000

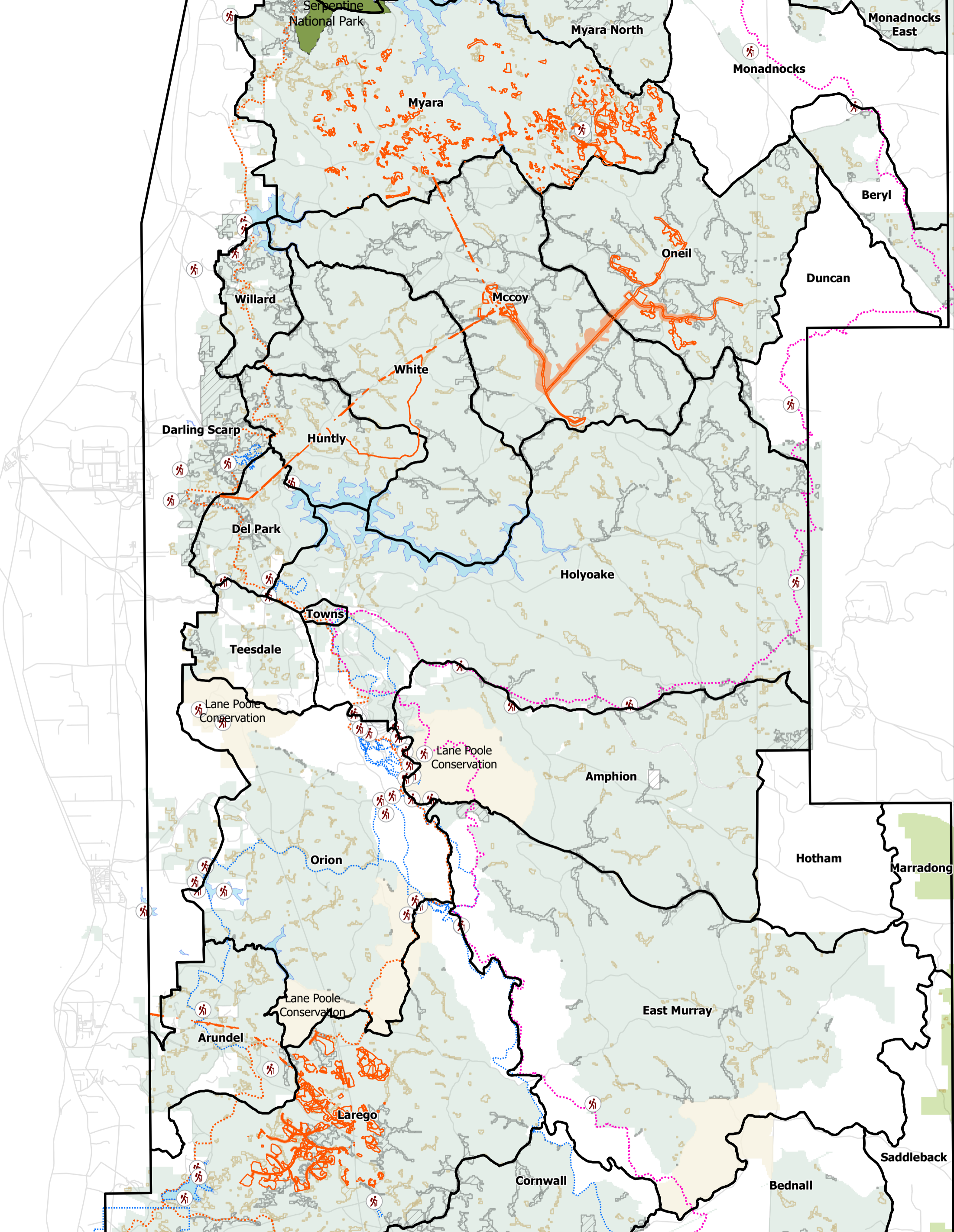
9.1.6 Informal Comprehensive Adequate Representative Reserves

An EIA is completed when proposed clearing for mining conflicts with Informal Comprehensive Adequate Representative (CAR) reserves. The EIA includes vegetation, fauna, and Aboriginal cultural heritage surveys. Mine plans are altered to minimise the impact of clearing on Informal CAR Reserve values.

A process has been developed to verify the values, determine the significance, and record accurate boundaries of Informal CAR Reserves where mining is proposed.

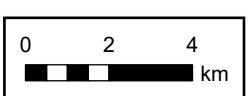
Currently, Informal CAR Reserves are mapped by 0.5 Ha pixels, representing a relatively coarse scale. As a result, some ore bodies and haul roads that have intersected mapped Informal CAR Reserves in the past have not actually impacted on the reserved ecosystem. Surrounding forest has been mapped as Informal CAR due to the mapping scale.

In these cases, Alcoa consults with DBCA to redefine the boundaries or to seek clarification that clearing will not directly impact on the targeted ecosystem. It is intended that this process will be undertaken in the future, specifically for various ore bodies intersecting Informal CAR Reserves in the Five Year Mine Plan. Following discussion with DBCA, if areas are still regarded as being Informal CAR Reserves, Alcoa will make a submission to the CAR Informal Reserve Evaluation Committee (CARIREC) to assess any proposed disturbance of the area. FCAs submitted bi-annually to the Mine Operations Group will contain detailed information on each of the Informal CAR Reserves areas requested for clearing. Potential Informal CAR interactions over the term of this plan are shown in Figure 9-1.



Legend

24 Month Clearing Schedule	Overnight campsites	Mining Regions
Conceptual Clearing Buffer	Trails	National Parks
Diverse Ecotype Zones CAR	Bibbulmun Track	Conservation Parks
CAR	Trail	Major Dams
Non-CAR	Munda Biddi	Forest Management Plan
		State forest
		Timber reserve



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Figure 9-1: Recreational facilities

Scale: 1:181,257

Date Printed: 2/11/2023

9.2 Potential Impacts

The following activities have the potential to impact social surroundings (amenity):

- Clearing of native vegetation.
- Construction, mining, refining and other operational activities including transport.
- The physical presence of infrastructure.
- Rehabilitation activities.

The mine activities may result in the following potential impacts to social surroundings (amenity):

- Impacts to amenity through construction and operational noise.
- Impact to visual amenity and sense of place from mining and refining operations and associated infrastructure including lighting.
- Impact on recreational use of areas due to direct disturbance, access constraints, noise, dust deposition and traffic.

9.2.1 Impacts to amenity through operational noise

Potential noise generating sources during construction and mining activities include:

- Fixed plant: ROM, crusher, diesel generators and overland conveyors.
- Mobile plant in mine pits and haul roads: excavators, haul trucks, loaders, graders, dozers, scrapers, blast drills, road trains, ancillary trucks, rock breaking excavators, watercarts.

The dominant noise sources affecting the received levels at sensitive receptors are the operational mobile equipment within mine pits and haul roads, and undertaking development and rehabilitation activities. Fixed plant is located relatively centrally within the mine regions and is generally further from sensitive receptors, thereby contributing less noise.

Noise levels will vary depending on the type of activity taking place and the environmental conditions. The Assigned Levels under the Noise Regulations vary depending on the time of day (Table 9-4).

Table 9-4: Assigned Levels at sensitive receptors

Time of Day	Assigned Level – L _{A10} dB(A)
0700 to 1900 hours Monday to Saturday	45
0900 to 1900 hours Sunday and public holidays	40
1900 to 2200 hours all days	40
2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35

Application of noise sensitivity zones (Table 9-3) is expected to prevent exceedance of night time Assigned Levels at any sensitive receptor. Whilst sensitive receptors occur within 2 km, no residential or overnight campsites are within 500m of haul roads or mine pits associated with the 24 Month Clearing Schedule, therefore are not within the Restricted Mining Zone. Only recreational facilities exist within 500m of haul roads or mine pits.

Blasting will occur on an approximately daily basis during mining, generating air blast noise and near field vibration. Mining associated with the 24 Month Clearing Schedule will not occur within 1.2 km of sensitive receptors. Based on daily assessments, a blast would not occur if the airblast noise maximum limit exceeds 120 dB(L).

9.2.2 Impacts to amenity from traffic

In the interest of safety, some public roads and forest access ways, within and adjacent to the mine regions, are closed and manned by sentries for short periods during blasting.

9.2.2.1 Huntly Mine

At Huntly, access along North Road remains open to allow public access from Huntly Road to the intersection with Whittaker Road. Access roads to the east of the McCoy and O'Neil mining regions will remain closed to the public until mining activity is complete.

Alcoa installed gates around the perimeter of the Myara region in April 2011. Access is closed to the public south of Kingsbury Drive and east of Scarp Road. Access plans were reviewed with DBCA and the WC to determine an appropriate boundary prior to the installation of gates. An extension of the Myara region will require a new access and gating plan be developed with DBCA in coming years.

A sealed road has been constructed to access the Myara offices and the crusher. The road runs from Scarp Road to the west of the Myara crusher site and can be accessed via Hines Road in North Dandalup. Large service vehicles and machinery are not permitted to access Myara from this road to reduce heavy vehicle interaction with surrounding neighbours. These vehicles must access the site via the haul road system from McCoy instead.

Access to Disease Risk Areas (DRA) within the mine is by a permit system for all vehicles. This system was developed through the Alcoa/DEC Working Arrangements.

9.2.2.2 Willowdale Mine

At Willowdale, access around the mining region is provided by Scarp Road on the western flank from Nanga Brook Road through to Willowdale Road. Access from Nanga Brook Road through to Nanga Road on the eastern boundary of the Orion mining region has been maintained via an underpass beneath the northern arterial mine haul road. Nanga Road provides public access north and south along the western boundary of the Lane Poole Reserve, outside of the mining area. An underpass is in place to maintain north-south access along Nanga Road, as Gibber Road was extended to reach the Keats Mining Region. A section of King Jarrah Track was also closed to the public for the period of Keats mining. However, the underpass on Nanga Road has a safety barrier to allow the thoroughfare of pedestrians/cyclists. In 2015, Nanga Road was deviated to meet Driver Road.

Willowdale Road provides public access from the South Western Highway to Zig Zag Road, which now diverts onto Nanga Road and Driver Road to access forest regions to the east. East-west access has been maintained along Driver Road via an underpass to enable access to Logue Brook Road on the

eastern boundary of the mine. From Willowdale Road the public can use Hoffman Road and then Dandenong Formation to head south along the western boundary of the mine. Kevron Road and Clarke Road form the southern boundary of the Larego mine region. Official access to Willowdale mine is via the security gate at the Arundel offices on Willowdale Road. The new Larego crusher site can be accessed via the Willowdale Road extension from Arundel. Approved personnel are granted access through the security gates using a personal identification number, which records personnel and contractor vehicular movement. Service vehicles and employees can also access the previous crusher region at Orion via Nanga Brook Road by using their personal identification number to operate the security gate.

9.2.3 Impacts to visual amenity from mining operations

Impacts to landscape character occur as a result of clearing and mine operation. Impacts to the Darling Plateau Forest and Darling Uplands Peri-Urban are expected as a result of additional clearing associated with the 24 Month Clearing Schedule. Both LCUs have high landscape value and are considered to have a high susceptibility and sensitivity to change. 1,703 ha of clearing associated with Huntly and 787 ha of clearing associated with Willowdale is expected to impact these LCUs.

Visual amenity impacts are also expected to occur and are considered to be higher at elevated viewpoints with public access and public access roads.

9.2.4 Direct impacts on recreational use of areas

The 24 Month Clearing Schedule is not expected to have any direct impacts on recreational areas or prevent access to recreational facilities. Clearing is associated with current mining regions which have already implemented access controls.

9.2.4.1 Public Recreational Management - Willowdale

The relocation of Alcoa's mining operations to the Larego region at the Willowdale mine site temporarily impacted formal public recreational areas like the Munda Biddi Trail. The relocation is causing long-term closure of Hoffman Mill as a camping site and day use area. As referenced by the Minister for State Development's previous MMP approvals this closure will be at a cost neutral basis for DBCA. The Munda Biddi Trail traverses the Larego area, and any future realignment would be required to be negotiated with DBCA.

9.2.5 Impacts to amenity from light spill

There are existing light sources in the vicinity of the mine regions:

- Alcoa mine facilities including permanent lighting at mine facilities and conveyor transfer stations, vehicle headlights and mobile light towers at operating mine pits.
- Townsites including North Dandalup, Keysbrook and Waroona and surrounding rural properties (which emit limited light).
- Other mines.

Due to the distance from towns, rural properties and overnight campsites, it is unlikely that lighting for the new mine facilities will have a significant impact on night time amenity. Mine pit lighting may

therefore cause impacts to night time amenity for rural properties close to the boundary of the mine regions. Mine pit lighting is unlikely to cause impacts to night time amenity at townsites, Logue Brook Dam, Lane Poole Reserve or at campsites on the Bibbulmun Track due to separation distances.

9.3 Mitigation

Alcoa's environmental management incorporates the mitigation hierarchy consistent, which is in order of priority:

- Impact avoidance
- Impact minimisation
- Rehabilitation.

A risk-based approach has taken to align with Alcoa's environmental management system and management plans. Associated mitigation actions are provided in Table 9-5 as a risk register and risk assessment methodology is provided in Appendix 3 .

Alcoa remains focussed on opportunities to continue to improve understanding of amenity impacts and further obtain data in that regard. One of these opportunities is by reviewing the noise sensitivity zones, to further minimise impacts. Alcoa intends to achieve this opportunity by implementing an improvement plan which includes the following:

- Noise and dust modelling for any encroachment within 2 km of a sensitive receptor will be implemented for O'Neil and the western portion of Larego. The study outcomes will be included in the MMP submitted in 2024.
- A review of noise sensitivity zones will be undertaken in 2024 as a result of revised noise and blast modelling.
- Visual Amenity Assessments for any encroachment within 2 km of a sensitive receptor will be implemented for O'Neil and the western portion of Larego. The study outcomes will be included in the MMP submitted in 2024.
- Increased community consultation is planned for the 2024 MMP submission on social surroundings impacts. It is intended to share key impacts and mitigations with neighbours in 2024.
- Revision of the Recreational Trails and Facilities Management Plan (RTFMP), in consultation with DBCA and relevant stakeholders by 31 December 2024 (Commitment 17) (Commitment 20), to include the following:
 - A cumulative visual impact assessment for recreational trails with potential impacts
 - Consideration of additional mitigation measures
 - Stakeholder engagement register

Table 9-5: Avoidance and minimisation of potential impacts to social surroundings (amenity)

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Clearing and mining directly impacts and restricts access to conservation and recreational values.	<p>Increased community and stakeholder concern in relation to social licence to operate.</p> <p>Changes to recreation and conservation facilities impacting local economies (eg, hospitality and ecotourism) and quality of life.</p>	<ul style="list-style-type: none"> No clearing or mining of ore in conservation or recreation reserves. Provision of mining avoidance zones for significant areas of recreational value. Establish and maintain mining avoidance zones within the region to prevent direct impacts, which will be clearly marked on construction and mining maps. Where mine pits have been identified close to the Munda Bididi Trail, Alcoa will negotiate the trail realignment with DBCA prior to mining activity that may impact on trail user experience. 	<ul style="list-style-type: none"> Community Consultation - 5 Year Mine Plan and drill plan consultation with, government and neighbours potentially affected by mining operations. Reduce visual impact/visual amenity zone from public infrastructure. Monitor broad sentiment to understand community concerns. Tours and education. Fencing, bunding & signage. Visitor access protocols. Complaints handling and response. Providing interim and temporary agreement to community for ad hoc access Provision of areas open (currently minimal) for recreation such as Marrinup Trail, Langford Park, Waterous Loop. Prioritisation of mining in close proximity to significant recreational areas to facilitate continuity of community land use. If mining proposed within 2 km of sites, then commission noise, dust and visual assessments Amend road alignments to address community and stakeholder expectations in relation to waterway and wetland protection; recreation, landscape protection and public access A Recreational Trails and Facilities Management Plan (RTFMP) will be developed in consultation with DBCA and relevant stakeholders, and will be implemented. The RTFMP commits to: <ul style="list-style-type: none"> Maintain community access within the Larego mine region for critical thoroughfares between towns, communities and recreation opportunities. Minimise direct impacts to recreational trails and facilities within the Larego mine region, which includes investigating options to maintain access, where practicable. Where impacted, rehabilitate and reinstate these facilities where 	<ul style="list-style-type: none"> Prioritisation of mining and rehabilitation in close proximity to significant recreational areas to facilitate continuity of community land use. Adherence to Completion Criteria - land use objectives. 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			practicable, in consultation with DBCA and other key stakeholders. <ul style="list-style-type: none"> ○ Maintain the scenic values and quality of landscape as seen by users of public roads. ○ Maintain public access to the Munda Biddi Trail for the life of mine through realignment to the west of the Larego mine region. ○ Maintain viability of existing and planned forest industry commercial opportunities. ○ Maintain adequate camping amenities. ○ Maintain access and adequacy of day-use areas. ○ Maintain ability for major events to occur. ○ Maintenance of access and use for cultural heritage uses. ○ Maintenance of access for facility and asset management. ○ Maintain water quality in response to new or changed recreational facility use. 		
Noise and vibration impacting upon sensitive receptors	Decrease in amenity values. Decline in social licence to operation. Increase in community concern. Non-compliance with legal and other requirements. Non-compliance with internal standards.	<ul style="list-style-type: none"> • Avoidance of sensitive receptors to minimise noise amenity impacts and low vibration from blast air overpressure 	<ul style="list-style-type: none"> • Neighbours are invited to be notified on blasting timing • Alcoa applies internal noise limits of 110 dB at Dwellingup and the Yamba sub-division in Keysbrook, and 115 dB at all other locations. • The main blast is preceded by a pilot shot which produces lower levels of noise than the main blast. If the pilot blast is above internal pilot noise limits, the main blast is postponed. • Willowdale schedules mining adjacent to neighbouring properties (on western and northern boundaries) during the daytime and/or when atmospheric conditions will minimise the noise levels received by neighbours • DBCA closed Hoffman Mill for public use with a cost-neutral compensation agreement • Noise sensitivity zones will be established. The zones restrict mining activities in more 	<ul style="list-style-type: none"> • 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<p>sensitive areas to manage noise impacts to sensitive receptors</p> <ul style="list-style-type: none"> Noise generated by mining operations is managed to meet the requirements of the Environmental Protection (Noise) Regulations 1997. Alcoa does not mine in areas where the pre-mining noise assessment identifies that noise impact on Noise Sensitive Premises (Highly Sensitive Area) cannot be managed below 35dB LA10. Preliminary noise assessment and noise sensitivity zones incorporated into Long Term Mine Plan. Operational noise is maintained below the noise limits identified in the Environmental Protection (Noise) Regulations 1997 If mining proposed within 2 km of a sensitive receptor, then commission noise assessments. If predicted noise levels at noise-sensitive sites may exceed assigned levels under the Environmental Protection (Noise) Regulations 1997, then prepare and implement a Noise Management Plan in consultation with key stakeholders Noise emissions are managed through regular maintenance (including change out of conveyor rollers and idler cleaning) Near-field noise monitoring Quarterly noise monitoring results from the 371 conveyor are reported in the Environmental Review As a requirement of an EP Act licence amendment in 2020 to transfer the crusher from Orion to Larego, Alcoa undertakes noise validation monitoring and provides a Noise Compliance Report on all mining infrastructure to DWER. Alcoa's noise management system includes live noise modelling at an operation level with fixed and attended noise monitors, predictive modelling, procedures, training and audits. All noise complaints received by Alcoa are investigated and a report is compiled detailing information about the location of mining equipment, the location of neighbouring properties and weather 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<p>conditions at the time of the complaint. Report details and findings are communicated with the complainant.</p> <ul style="list-style-type: none"> Alcoa is implementing an Integrated Noise Management System (INMS) (completion in 2023) which consists of noise management software, fixed noise monitors, and data inputs. Data from multiple sources (e.g., noise monitoring stations, historic and real time weather, mine plan, and equipment and activity location) is utilised and consists of three main modules: <ul style="list-style-type: none"> Long term planning – this module uses historic weather and a range of mine plans to identify potential noise impacts for management. By assessing noise profiles early, the mine plan can be optimised to mitigate noise impacts and strategic decisions can be made. Scheduler – uses forecast weather data, mine and operations plans to assist in predicting noise levels across the operations. Scheduler uses a traffic light system to easily identify mine plans which may result in an exceedance of noise requirements. Planners can change the plan (i.e., change operational locations, or equipment) to develop a mining plan which is unlikely to result in noise exceedances. Execute – uses real time weather, real time noise monitoring data, current operational plan and equipment location to create a real time noise model. The model predicts noise levels at key receptors and provides an early warning system that allows operations to adjust the mining activities to prevent noise exceedances. A blast may not proceed if the predicted impact at a neighbouring property is above the limit identified in the Environmental Protection (Noise) Regulations 1997. Blast noise levels are monitored using portable sound level meters. Blast noise is managed through a module within Alcoa’s Integrated Noise Management tool. The module allows facilitation of detailed blast planning, taking 		

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			into consideration weather forecasts and planned blast parameters to predict potential impacts at receivers. Where this indicates that the 120 dB(L) limits cannot be adhered to, alternative methods of exposing ore will be employed in order to manage noise emissions.		
Clearing visual amenity impacting upon sensitive receptors	Visual amenity impacts on sensitive receptors resulting in a decrease in amenity values	<ul style="list-style-type: none"> Develop mining avoidance zones to prevent direct impacts to screening vegetation within 200m of public roads, where possible. 	<ul style="list-style-type: none"> If mining proposed within 2 km of a sensitive receptor, then commission visual amenity assessments. If mining is predicted to be visible from visually sensitive sites, then prepare and implement a Visual Management Plan in consultation with key stakeholders. The following additional controls are implemented for Logue Brook Dam: <ul style="list-style-type: none"> Visual amenity assessment to be undertaken for any clearing encroachment upon the area. The outcomes will determine any visual amenity buffers required. A clearing elevation buffer was generated based on topographic high points then implementing a 15m down the hillslope. Minimise landscape and visual impacts to recreational facilities and road interfaces with the provision of screening corridors suitable to the area, where possible. Screening corridors are based on existing vegetation density and topography to adequately screen clearing of mine pits, haul roads and other infrastructure. The material and structural finishes for all built form elements will be compatible with surrounding visual environment to assist the built form to blend in with surrounding existing vegetation when viewed from elevated distant viewing locations. Where mine pits, haul roads and other infrastructure are proposed to be located near existing road corridors, rehabilitation will be commenced as soon as practicable. Where mining occurs close to the Munda Bididi Trail, Alcoa will negotiate the trail realignment with DBCA prior to mining activity that may impact on trail user experience. 	<ul style="list-style-type: none"> During rehabilitation of mine pits, contouring of the excavated pits will tie them into the surrounding landform and rehabilitation planting will restore the vegetated character of the area when vegetation reaches suitable coverage. 	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Dust deposition impacting upon sensitive receptors	<p>Decrease in amenity values.</p> <p>Decline in social licence to operation.</p> <p>Increase in community concern.</p>	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> If mining proposed within 2 km of a sensitive receptor, then commission dust assessments. If predicted dust levels at dust-sensitive sites may exceed relevant criteria for dust deposition or 24 hour Ambient Air National Environmental Protection Measure (NEMP), then prepare and implement a Dust Management Plan in consultation with key stakeholders. Refer to Flora and Vegetation Management Plan. 	<ul style="list-style-type: none"> 	Low
Light spill impacting upon sensitive receptors	<p>Decrease in amenity values.</p> <p>Decline in social licence to operation.</p> <p>Increase in community concern.</p>	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Mine planning considers separation distances from sensitive receptors Lighting is positioned sensitively to reduce risk of light spill to sensitive receptors 	<ul style="list-style-type: none"> 	Low
Change to road access and increase in traffic	<p>Increase in community concern.</p>	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Any public road crossing will comply with all relevant standards and specifications as applied by Main Roads WA and other decision makers including relevant local governments. To ensure safety during blasting, visitors to site (including government personnel) are required to access the mine through the main gate so that they can be informed of any proposed blasting activities. If this is not possible, the mine security staff must be notified by telephone. Details regarding access to particular areas must be arranged by contact between the relevant officers and the site manager. The Mines Safety and Inspection Act 1994, Mines Safety and Inspections Regulations 1995, and Alcoa's safety procedures require all persons driving on the mine to obtain a mine driving permit and to comply with mine driving procedures. 	<ul style="list-style-type: none"> 	Low

9.4 Assessment of impacts

Whilst the 24 Month Clearing Schedule does not directly impact upon any recreational areas or associated access, the potential impacts are considered to be high. This accounts for the cumulative impacts of current operations and the potential for community concern. The Huntly and Willowdale mines operate in a landscape which supports numerous recreational, aesthetic, economic and conservation values and community concern is reflective of the associated impacts. A Recreational Trails and Facilities Management Plan has been developed in consultation with DBCA and is provided in Appendix 18. Alcoa is committed to improving transparency and consultation with the community and key stakeholders in future MMP submissions.

The potential noise impacts from the 24 Month Clearing Schedule to amenity are considered to be medium, as similar impacts to current operations are expected. A similar level of mitigation will be undertaken, including implementation of mining avoidance zones and noise sensitivity zones (if required) and operational noise management. Similar impacts from blast noise are expected.

Visual amenities impacts from the 24 Month Clearing Schedule are considered to be medium. Visual impact assessments will be undertaken for any mining within 2 km of sensitive receptors. The 24 Month Clearing Schedule is within current mining regions and if required, a 200 m vegetated screening buffer will be implemented along public access roads.

Low potential traffic, dust and light spill impacts to amenity are expected, with the 24 Month Clearing Schedule occurring within current mine regions.

10 Social Surroundings (Heritage)

10.1 Receiving environment

10.1.1 Baseline surveys

A desktop review was undertaken to identify any historic heritage sites listed on the State Heritage Register within 5 km of the Huntly and Willowdale mine areas, using the DPLH-006 (Heritage Council–WA - State Register) dataset (DPLH 2022c). In addition, a review of the Local Heritage Survey Inventory was undertaken, using the DPLH-008 (Heritage Council–WA - Local Heritage Survey) dataset (DPLH 2022b).

In consultation with Traditional Owners, Alcoa has completed numerous Aboriginal cultural heritage surveys over the area subject to this MMP, as summarised in Table 10-1.

In 2023, Alcoa reviewed its internal Aboriginal cultural heritage due diligence process. This process includes an initial desktop spatial analysis of the Aboriginal Cultural Heritage Inquiry System (ACHIS) and assessing the reports of any previous surveys undertaken by Alcoa over the areas subject to this MMP.

Alcoa Mineral Lease 1SA (ML1SA) is in the Northern Jarrah Forest where ground visibility is limited due to the dense forest canopy. Due to the size of the mining region and lack of visibility, a GIS based Archaeological Predictive Model (APM) was initially developed in 2001 to inform the methodology and approach to archaeological surveys preceding commencement of exploration or mining in ML1SA. The predictive model has been refined and independently peer reviewed a number of times since 2001 to ensure it remains aligned with GIS and archaeological best practice. The most recent independent peer review was completed in April 2023.

Alcoa's second stage of due diligence is the completion of Archaeological site avoidance surveys with Traditional Owners ensuring all locations identified in:

- a. the APM of high archaeological site probability, and
- b. a randomly generated area of low to medium probability archaeological, are surveyed. This allows a continual assessment of the reliability of the predictive model. If requested by Traditional Owner survey participants, additional areas can be added to the survey plan. Ethnographic site avoidance assessments are also completed prior to any ground disturbing activities commencing.

Recognising the importance of water and waterways to Noongar people, Alcoa's survey plans include coverage of all waterway crossings to ensure both archaeological and ethnographic values and any potential impacts are understood.

Archaeological and ethnographic site identification surveys will be undertaken for the 24 Month Clearing Schedule. These surveys will be undertaken prior to clearing activities and to ensure that any Aboriginal cultural heritage places within 100m of the proposed clearing boundary have appropriate management controls identified.

Alcoa has presented the Aboriginal cultural heritage due diligence process to Gnaala Karla Booja Aboriginal Corporation in August 2023; and at this time no issues or concerns have been raised regarding Alcoa's proposed approach, and internal due diligence process.

Prior to the establishment of the Gnaala Karla Booja Aboriginal Corporation, heritage surveys were conducted with representatives nominated by Bilya Noongar Organisation and more recently, via South West Aboriginal Land and Sea Council. Since the establishment of the Gnaala Karla Booja Cultural Advice Committee, all nominations are now sought via that Committee.

Alcoa has entered into secured Noongar Standard Heritage Agreements (NSHAs) over various project areas and works collaboratively with Gnaala Karla Booja regarding surveys where NSHA are not in place.

Alcoa will ensure that all potential Aboriginal Sites under the *Aboriginal Heritage Act 1972* (and any Aboriginal cultural heritage under the ACH Act, if any) identified in the survey reports in Table 10-1, and future surveys, will be submitted to the DPLH via the Heritage Information Submission form or equivalent, following consultation with Gnaala Karla Booja Aboriginal Corporation.

Table 10-1: Aboriginal cultural heritage studies

Year	Author	Study Name
2006	Rapley, S., Hook, F., Hammond, C. & Veitch, B.	The Report of an Aboriginal Archaeological Assessment of the McCoy and Orion Mining Regions, Huntly and Willowdale Mines, Near Dwellingup, South-Western Australia
2009	Hammond, C and McHarg, K.	The Report of an Aboriginal Archaeological Assessment of the Myara Region, near McCoy mine, Karnet, South-Western Australia
2010	Hammond, C. & Doering, J.	The Report of an Aboriginal Archaeological Assessment of the O'Neil Region, near McCoy Mine, Karnet, South-Western Australia.
2016	Archae-aus Pty Ltd	A report on Aboriginal archaeological assessments within the Jarrahdale South and Myara East project areas, Jarrahdale and Myara, WA
2016	Randolph, P.	Ethnographic Survey of the Myara and O'Neil Mining Regions: Focussing on Serpentine River (DIA 3582)
2016	Randolph, P.	Addendum: Ethnographic Survey of the Myara and O'Neil Mining Regions: Focussing on Serpentine River (DIA 3582)
1995	Edwards, K. & Hammond, M.	Report of an Aboriginal Heritage Survey Proposed Alcoa Mining Operations Area, Wagerup (Willowdale North)
2007	Rapley, S., Di Lello, A. and Hook, F.	The Report of and Indigenous Archaeological Assessment – Larego Mining Envelope, near Willowdale, Willowdale, South Western Australia
2022	Archae-aus Pty Ltd.	A Report on an Aboriginal Archaeological Sample Survey of the Larego Project area near Willowdale, Western Australia
2018	Archae-aus Pty Ltd.	A Report on an Aboriginal Archaeological Assessment of an area for the proposed Larego crusher and associated infrastructure, near Willowdale, Western Australia
2018	Archae-aus Pty Ltd.	Addendum to a report on an Aboriginal Archaeological assessment of an area for the proposed Larego Crusher and associated infrastructure near Willowdale, Western Australia.
2023	Archae-aus Pty Ltd.	Report on Aboriginal Archaeological and ethnographic Site Avoidance Heritage Surveys of the O'Neil East Project Area, Darling Scarp, Western Australia (Draft)

10.1.2 Aboriginal Cultural Heritage

The Huntly and Willowdale mine areas are located within the Gnaala Karla Booja region of the South West Native Title Settlement area. The South West Native Title Settlement saw the determination of all Noongar native title claims as areas where native title does not exist, in exchange for permanent recognition of the Noongar people as the Traditional Owners over south Western Australian through the provisions of the Settlement ILUAs which contain a comprehensive benefits package, paid by the State.

The area to which this MMP applies is located within the area identified in those settlement ILUAs as the Gnaala Karla Booja region. Alcoa is committed to undertaking regular and ongoing engagement with Gnaala Karla Booja Aboriginal Corporation in relation to Alcoa's proposed future activities and existing operations. As the Gnaala Karla Booja Aboriginal Corporation has begun to build its capacity, including with the appointment of the CEO in March 2023, Alcoa has commenced formal engagements with Gnaala Karla Booja regarding Alcoa's operations and proposed Mining Management Program. This has included engagements with the Gnaala Karla Booja Board of Directors, Cultural Advice Committee and Executive leadership team with senior Alcoa leadership, operations and environment team members. Engagement has consisted of:

- Alcoa consulted with GKB board of Directors on 4 March 2023 regarding ongoing engagement relating to ongoing operations and future approvals.
- Alcoa consulted with GKB cultural advice Committee on 5 July 2023 regarding MMP approval process.
- Alcoa consulted with GKB Executive Leadership Team on 4 August 2023 regarding MMP approval process and heritage due diligence processes.

10.1.2.1 Aboriginal Cultural Heritage Sites

All identified Aboriginal cultural heritage Places and Sites recorded within the Huntly and Willowdale mine regions are shown in Figure 10-1 and Figure 10-2.

10.1.3 Historic Heritage

There is one place on the State Heritage Register within the Huntly and Willowdale mine regions:

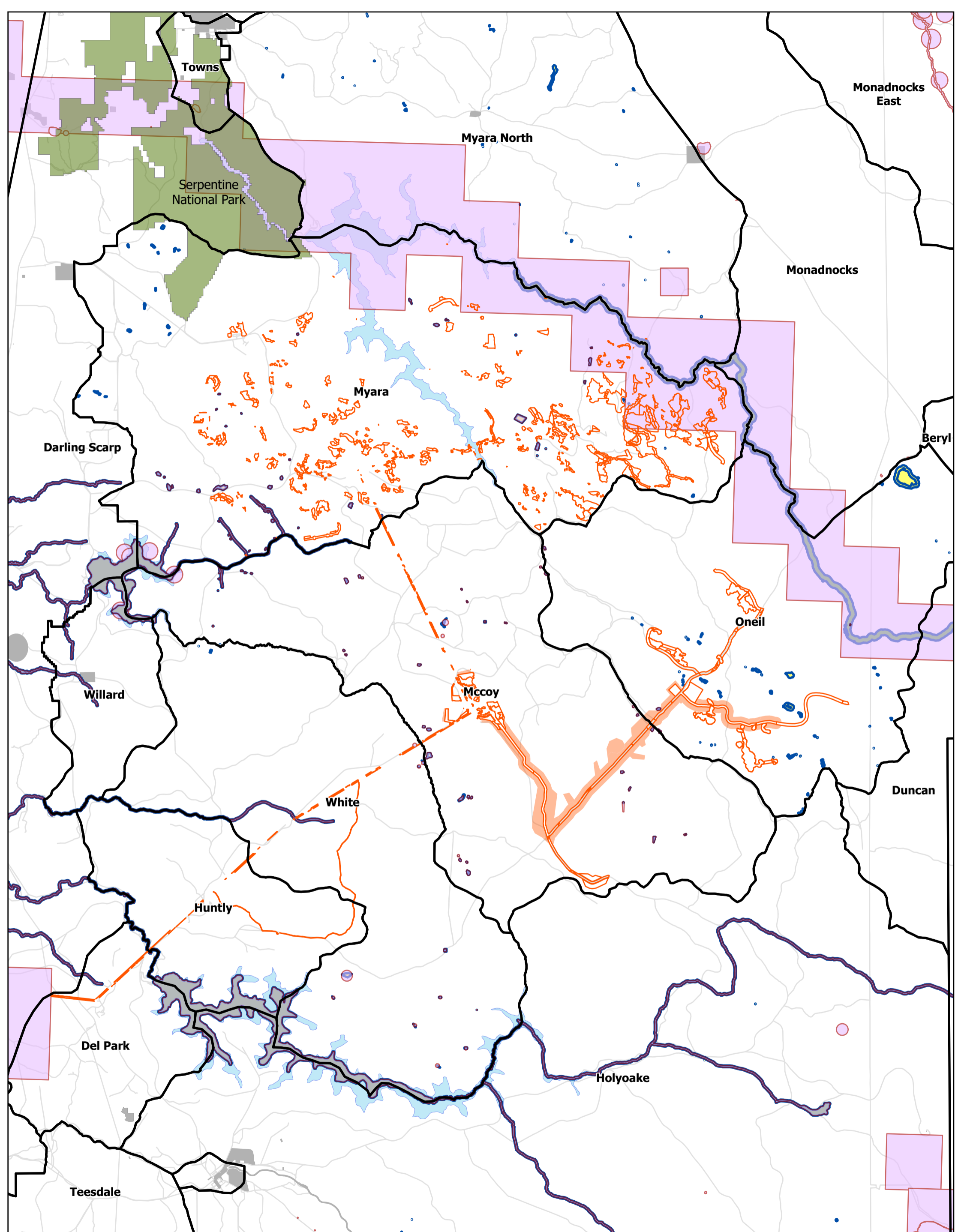
- The Murrinup Prisoner of War Camp which is located in the Del Park region

The analysis indicates that there are four local European heritage sites within the Huntly and Willowdale mine regions:

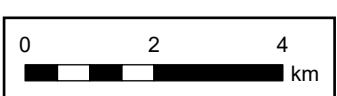
- The Bodhinyana Buddhist Monastery
- Falls Brook Homestead
- Harvey Weir
- Logue Brook Dam

No World Heritage Sites or Commonwealth Heritage Sites occur within 5 km of the Huntly and Willowdale mine areas.

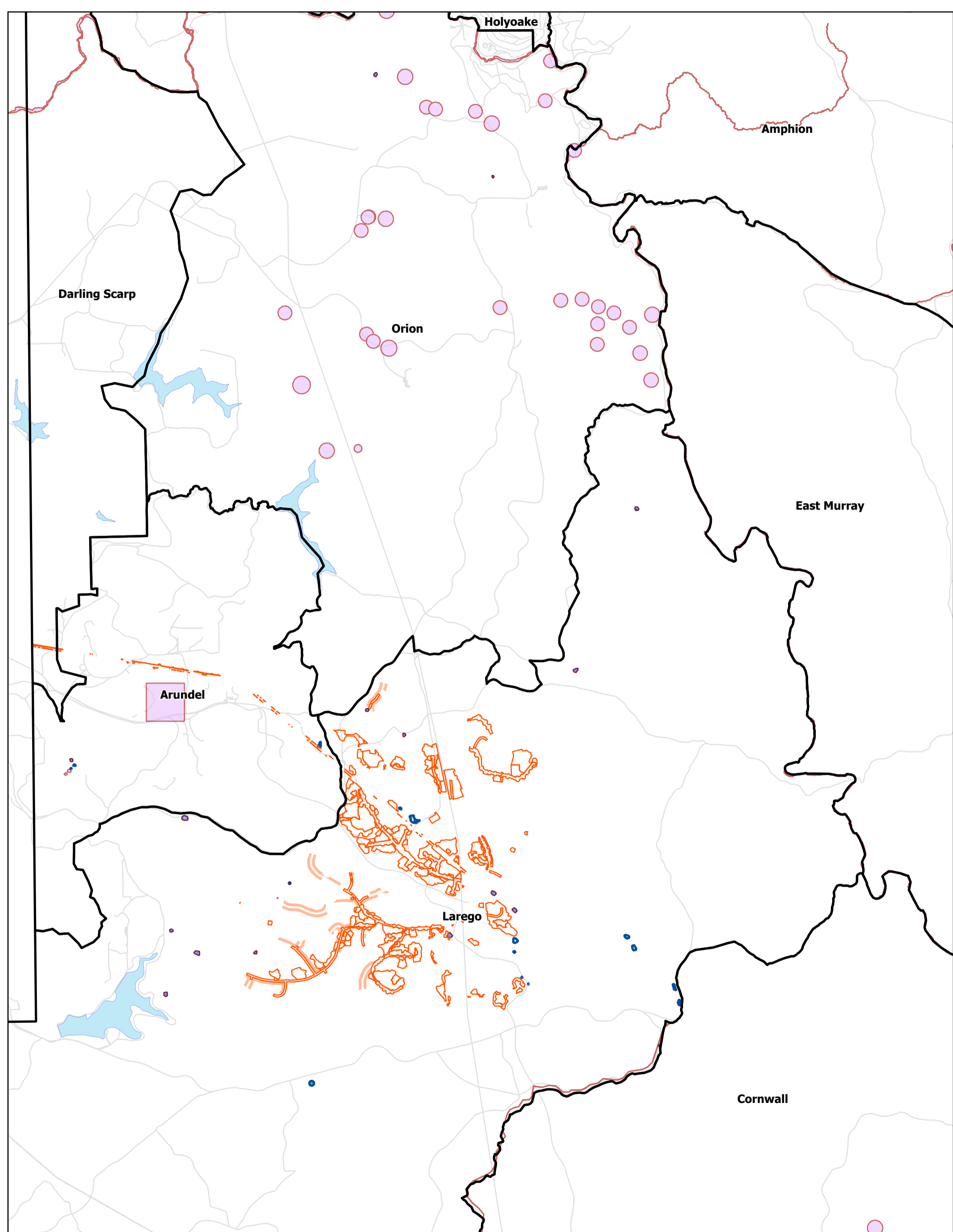
All State and Local European heritage sites are shown in Figure 10-1 and Figure 10-2.



Legend		
24 Month Clearing Schedule	Alcoa Aboriginal Heritage Sites	Mining Regions
Conceptual Clearing Buffer	Cultural Landscape	National Parks
Government Aboriginal Heritage Sites (DPLH-001)	Heritage Site	Major Dams
	Government European Heritage Sites	
	DPLH006	
	DPLH008	

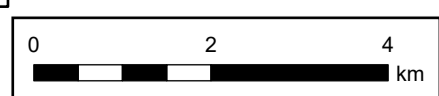


2023 – 2027 Mining and Management Plan	
Figure 8-1: Sensitive receptor locations - Huntly	
Scale: 1:117,352	Date Printed: 1/11/2023



Legend

24 Month Clearing Schedule	Alcoa Aboriginal Heritage Sites	Mining Regions
Conceptual Clearing Buffer	Cultural Landscape	Major Dams
Government Aboriginal Heritage Sites (DPLH-001)	Heritage Site	



2023 – 2027 Mining and Management Plan	
Figure 10-2: Heritage sites and places - Willowdale	
Scale: 1:85,380	Date Printed: 2/11/2023

10.2 Potential Impacts

The following mine activities have the potential to directly or indirectly impact heritage values:

- Clearing of native vegetation
- Construction, mining, refining and operational activities
- Physical presence of infrastructure.

There is the potential for direct and indirect impacts to heritage sites as a result of construction and operation. Direct impacts can occur from clearing and construction. Indirect impacts include stormwater runoff, erosion and sediment from nearby construction areas.

10.2.1 Disturbance to Aboriginal cultural heritage

All Aboriginal cultural heritage located within 100m of the 24 Month Clearing Schedule will be the subject of site identification surveys prior to clearing, to confirm site location and avoidance buffer. The following DPLH Heritage Places and Alcoa Heritage Sites have been identified as being within 100 m of the 24 Month Clearing Schedule:

- Huntly – six Aboriginal cultural heritage sites consisting of five artefact scatters and one site of ethnographic value
- Huntly – one Registered Site (Serpentine River), 17 Lodged Places (consisting of 16 artefacts / scatters and one mythological site) and one Stored data
- Willowdale - six Heritage sites which are artefact scatters
- Willowdale – six Lodged Places which are artefact scatters

All Aboriginal cultural heritage cultural and places identified will be avoided by the 24 Month Clearing Schedule apart from waterways crossings and the installation of the turbidity monitors as detailed below.

The 24 Month Clearing Schedule intersects one known registered Aboriginal cultural heritage site, the Serpentine River (DPLH 3582). The Serpentine River is listed on the AHIS as having a 'closed' status resulting in its boundary being dithered to a series of 1km boxes. Previous ethnographic consultation undertaken by Alcoa with Gnaala Karla Booja Traditional Owners has identified that the ethnographic site boundary relates to a 100m buffer around the Serpentine River. This 100m buffer resulting from the ethnographic consultation has been incorporated into Alcoa's GIS and is used to inform mine planning.

Mining activities are located outside the ethnographic boundary for the Serpentine River, however, Alcoa's 24 Month Clearing Schedule currently references the installation of water quality turbidity monitors within the Serpentine River. Alcoa will undertake further engagement with Gnaala Karla Booja Aboriginal Corporation and DPLH and ensure appropriate approvals (e.g., Section 18 permit) are in place, wherever required, prior to the turbidity monitors being installed.

10.2.2 Disturbance to European heritage sites

European heritage sites comprise the physical remnants of the former timber industry, railway and former POW camps.

The identified local European heritage sites are not within proximity to the 24 Month Clearing Schedule. The sites have been avoided and will not be impacted by the 24 Month Clearing Schedule.

10.3 Mitigation

Alcoa is committed to ensuring understanding of any and all potential impacts to heritage over the areas subject to this MMP. This includes both Aboriginal cultural heritage and European heritage.

A risk-based approach has been taken to align with Alcoa's risk and environmental management processes. The Risk assessment methodology is provided in Appendix 3 . The associated mitigation actions are provided in Table 10-2 as a risk register.

Some key mitigations include:

- Co-designed Cultural Heritage Management Plan with Gnaala Karla Booja Traditional Owners to ensure Aboriginal cultural heritage within ML1SA is appropriately managed. The Cultural Heritage Management Plan for ML1SA will be a live operational document that will be regularly updated and reviewed in line with Alcoa's activities. The Cultural Heritage Management Plan for ML1SA is a contractual document, and not an "ACHMP" for the purposes of the ACH Act. Alcoa is committed to preparing the ML1SA operational CHMP in consultation with Gnaala Karla Booja by 31 December 2024 (Commitment 22).
- Following the completion of the archaeological and ethnographic Aboriginal cultural heritage surveys, any identified Aboriginal cultural heritage is included in Alcoa's GIS system as constraints to enable them to be considered and avoided during exploration and mine planning processes.
- Ensuring all draft Aboriginal ethnographic and archaeological surveys reports are provided to Gnaala Karla Booja Aboriginal Corporation for their review and input to ensure all values are appropriately captured.
- Where avoidance to Aboriginal cultural heritage is not possible, Alcoa will consult with Gnaala Karla Booja Aboriginal Corporation and submit a section 18 application under the *Aboriginal Heritage Act 1972* or other appropriate approvals.
- Aboriginal cultural heritage sites located with 100m of proposed clearing boundaries will have the following additional controls:
 - Site identification surveys to confirm boundaries and appropriate buffer distances
 - heritage demarcation
 - work exclusion zones
 - inclusion of heritage in applicable safety toolbox discussions and job hazard assessments
 - heritage awareness inductions of personnel and contractors

Alcoa remains focussed on opportunities to continue to improve understanding of heritage values (Aboriginal and European) and further obtain data in that regard. Alcoa has identified that the inclusion of heritage survey outcomes (survey extent and sites identified) in FCA submissions would support this aspiration, and this will form part of future FCA submissions from Q2 2024 onwards. Prior to this, heritage survey outcomes can be provided to Mining Operations Group upon request and prior to clearing.

Table 10-2: Avoidance and minimisation of potential impacts to Aboriginal Cultural Heritage

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
Damage or harm to / loss of Aboriginal cultural heritage	<p>Non-compliance with Alcoa’s Aboriginal Cultural Heritage Standard (Global Standard)</p> <p>Impact to unidentified Aboriginal cultural heritage</p>	<ul style="list-style-type: none"> Compliance with Cultural Heritage Mitigation Hierarchy – Avoid, Minimise - based on site avoidance survey outcomes. Site avoidance survey for proposed areas of exploration drilling and other ground disturbing activities. An internal due diligence process to be undertaken as per Alcoa Aboriginal Cultural Heritage Due Diligence Procedure. Exploration – Aboriginal archaeological and ethnographic site avoidance surveys will be undertaken prior to exploration drilling. Avoidance surveys identify any sites within the proposed area so avoidance can occur. 	<ul style="list-style-type: none"> Mine clearance, construction and operations will have Aboriginal archaeological and ethnographic site identification surveys undertaken prior to clearing. Aboriginal cultural heritage survey results will be used to inform mine planning and infrastructure design. Direct and indirect impacts to identified Aboriginal cultural heritage sites will be avoided, where possible. Co-development of Aboriginal Cultural Heritage Management Plan (CHMP) for ML1SA with Gnaala Karla Booja Traditional Owners Compliance with Cultural Heritage Mitigation Hierarchy – Avoid, Minimise - based on site avoidance survey outcomes. Alcoa’s GIS Constraints Layer – which includes Aboriginal cultural heritage survey results, which includes a 10m non-negotiable buffer. Any additional buffer requirements will be decided in consultation with traditional owners. Aboriginal cultural heritage included in the Alcoa One induction training package to all employees and contractors. Specific training for those involved in clearing activities which includes Aboriginal cultural heritage flagging requirements. Prior to any ground disturbing activities, an activity notice as per the Noongar Standard Heritage Agreement (NSHA) will be provided to SWALSC for their review (if required), and to determine if a heritage survey might be required. Where it is agreed with SWALSC that Aboriginal cultural heritage surveys are required, Alcoa will undertake archaeological and ethnographic Aboriginal cultural heritage 	-	Medium

Risk	Description of Impact	Risk Controls			Residual Risk Rating
		Avoid	Minimise	Rehabilitate	
			<p>surveys in consultation with nominated Aboriginal representatives.</p> <ul style="list-style-type: none"> If there is a risk of harm to Aboriginal Cultural Heritage, then an impact assessment and consultation with GKB will be undertaken. A section 18 application under the AH Act will be required. 		
Damage to / loss of European heritage sites	Impact to unidentified European heritage site	-	<ul style="list-style-type: none"> Desktop reviews of European heritage. Mine plan designed to avoid European heritage sites where possible. Consultation with stakeholders prior to disturbance and development of a European Heritage Management Plan will be considered. 	-	Low

10.4 Assessment of impacts

Alcoa is confident that through the implementation of the updated cultural heritage due diligence process, and ongoing engagement with Gnaala Karla Booja Aboriginal Corporation, the potential for impact to Aboriginal cultural heritage is low with the exception of the proposed impact arising from the installation of water quality turbidity monitors within the boundaries of the ethnographic boundary for the Serpentine River (for which a section 18 consent will ultimately be required).

We are committed to ensuring both Aboriginal archaeological and ethnographic site identification surveys are completed for all sites and places identified within 100m of the proposed clearing boundary. The co-development of the Cultural Heritage Management Plan for ML1SA will ensure we have a strong understanding of the required management measures and appropriate mechanisms to continue engagement with Gnaala Karla Booja Traditional Owners regarding Alcoa's current and future operations.

We are committed to working with Gnaala Karla Booja Traditional Owners regarding the potential impact arising from the proposed installation of water quality turbidity monitors within the boundaries of the ethnographic boundary for the Serpentine River. Alcoa will seek to obtain their consent for the proposed activity and impact prior to seeking the required government approval (e.g., Section 18 permit, which will be the subject of a section 18 notice once the ACH Act has been repealed).

Based on the findings of surveys and consultation, Alcoa will seek to implement avoidance, minimisation and management measures to ensure no risk of harm to Aboriginal cultural heritage outside of any statutory impact approvals under the ACH Act or the AHA.

No impacts to local or State European heritage will occur, with the risk of impacts considered to be low.

11 Summary of GIS Dataset

Name	Area	Description	File Name
Drilling Approval Plan (DAP)	All	Areas Previously approved and Subject to Approval for Exploration activities	Drilling_approval_plan_230906
24 months clearing	Huntly	Spatial representation of 24 months of Clearing	Huntly_24MonthClearing_231107
	Willowdale		Willowdale_24MonthClearing_231107
5 Year Mine Plan	Huntly	Spatial representation of 5 Year Mine Plan	Huntly_5YearClearing_231107
	Willowdale		Willowdale_5YearClearing_231107
10 Year Mine Plan	Huntly	Spatial representation of 10 Year Mine Plan (conceptual clearing and ore shells for year 6 – 10). Huntly is not included.	Huntly_10YearMinePlan_230906
	Willowdale		Willowdale_10YearMinePlan_230906
Rehabilitation Plan	Huntly	Spatial representation of indicative Rehabilitation Plan	Huntly_rehab_plan_231107
	Willowdale		Willowdale_rehab_plan_230906
Historic data – Open areas	All	Shapefile of areas previously cleared by Alcoa and not rehabilitated	Open_Areas_230906

Name	Area	Description	File Name
Historic data – Rehabilitation areas	All	Shapefile of areas previously cleared by Alcoa and rehabilitated	Rehabilitation_230906
FCA endorsed	All	Shapefile of areas previously endorsed through an FCA, but not cleared	FCA_Endorsed_231107
FCA endorsed	All	Shapefile of areas previously endorsed through an FCA, but not cleared which are proposed to be revoked	FCA_Endorsed_Revoke_231107
Ecological Survey	All	Shapefiles of vegetation mapping with fauna and SRE habitat	VegetationFaunaHab_230906
Groundwater bores	All	Groundwater bores locations (proposed and current)	Groundwater_Bores_230906
Surface water monitoring	All	Surface water turbidity locations (proposed and current)	Turbidity_Locations_230906
Heritage Data	All	Shapefiles of heritage surveys and	HeritageSurveys_230906 HeritageSites_230906

Name	Area	Description	File Name
		Alcoa heritage sites and places	

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Appendix 1 – Drilling Approval Plan

Appendix 2 – Drilling Plan per Tenure

Appendix 3 – Risk Assessment Methodology

Appendix 4 – Current Approach to Rehabilitation, Monitoring and Area Certification

Appendix 5 – Long Term Fauna Monitoring Program

Appendix 6 – Rehabilitation Peer Review

Appendix 7 – Stakeholder Engagement Register

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
LOCAL GOVERNMENT AUTHORITIES					
Shire of Harvey	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for a meeting has been received.	
Shire of Waroona	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	Request for meeting received.	Meeting organised for 12 June 2023.
	12-Jun-23	Meeting	Meeting with Shire CEO and President.	Willowdale draft five year mine plan and enhanced 23-27 5YMP map presented and discussed. No specific feedback or questions received.	
Shire of Murray	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.		
	8-Jun-23	Meeting	As part of schedule of pre-organised quarterly briefings with the Shire, information was shared with the Shire and Council on the mine plan and environmental management .	Broad range of topics discussed including the MMPLG process.	Follow up meeting set up with Shire President and CEO to further discuss the MMP.
	26-Jul-23	Meeting	Information was shared on the mine plan and environmental management and the component explained.	Discussed: Proximity of future mining. Protection of Lane Pool Reserve. Avoiding or mitigating impacts to tracks and trails. Seek to continue meaningful consultation with Alcoa on operational changes and enhancements.	All matters discussed were addressed.
Shire of Serpentine Jarrahdale	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.		
	7-Aug-23	Briefing to Council	As part of schedule of pre-organised quarterly briefings with Shire, information was shared on the mine plan and environmental management.	Questions focussed on Alcoa's operations along Kingsbury West.	Confirmed activity to the north west of current operations is not in the plan.
LOCAL STATE AND FEDERAL MEMBERS OF PARLIAMENT					
Hugh Jones MLA Member for Darling Range	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	Request for meeting received.	
	26-Jun-23	Face to face	Information shared on mine plan and environmental management.	Current and future operational topics discussed: No issues raised. Request for a tour of Alcoa's operations.	A tour was organised and held on 23 August 2023. Attendees included Mr Hugh Jones, Harrison Swinbourne (Admin) and Chris Fowler (office research analyst).
Robyn Clarke MLA Member for Murray-Wellington	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	
Hon. Donald Punch MLA Member for Bunbury	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	
Hon. Jackie Jarvis MLC Member for South West	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	
Ms Jodie Hanns MLA Member for Collie-Preston	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
Hon Sally Talbot MLC Member for South West	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	
Hon Steve Thomas MLC Member for South West	6-Jun-23	Email	Letter of invitation to meet and consult on the 2023-2027 MMP.	No request for consultation.	
Hon Andrew Hastie MP Member for Canning	6-Jun-23	Email	Email offering consultation on the WDL enhanced 23-27 5YMP.	No request for consultation.	
Hon Nola Marino, MP Member for Forrest	6-Jun-23	Email	Email offering consultation on the WDL enhanced 23-27 5YMP.	No request for consultation.	
Shane Love MLA Leader of the Opposition	28-Aug-23	Face to face	Meeting to introduce Matt Reed and discuss issues.	Current status of MMP.	
David Honey MLA Shadow Minister for State Development	25-Aug-23	Face to face	Meeting to introduce Matt Reed and discuss issues.	Current status of MMP.	
Hon Simone McGurk MLA Minister for Water	11-Oct-23	Face to face	Meeting to introduce Matt Reed and discuss issues.	Current status of MMP.	
Hon David Michael MLA Minister for Ports	18-Sep-23	Face to face	Meeting to introduce Matt Reed and discuss issues.	Current status of MMP.	
Stephen Price MLA Member for Forrestfield	25-Oct-23	Face to face	Meeting to introduce Alcoa's GA team and discuss issues.	Current status of MMP.	
Hon Roger Cook Premier of WA Hon Reece Whitby MLA Minister for Environment, Hon Simone McGurk MLA Minister for Water	21-Aug-23	Face to face	Meeting to discuss current issues.	Current status of MMP.	
Hon Bill Johnston MLA Minister for Mines and Petroleum, Energy	21-Aug-23	Face to face	Meeting to discuss current issues.	Current status of MMP.	
Hon Rita Saffioti Deputy Premier of WA	22-Aug-23	Face to face	Meeting to discuss current issues.	Current status of MMP.	
WA STATE DEPARTMENTS AND AGENCIES, INCLUDING DECISION MAKING AUTHORITIES					
Mine Management Program Liaison Group: - Department of Jobs, Tourism, Science and Innovation (Chair) - Department of Water and Environmental Regulation - Department of Mines,	18-May- 23	Face to face	In depth discussion of MMP.	Water source protection. Biodiversity. Aboriginal Cultural Heritage.	
	10-Sep-23	Face to face	In depth discussion of MMP.	Water source protection. Biodiversity. Aboriginal Cultural Heritage.	

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
Industry Regulation and Safety - Department of Planning, Lands and Heritage - Department of Biodiversity, Conservation and Attractions - Water Corporation	9-Oct-23	Face to face	In depth discussion of MMP.	Water source protection. Biodiversity. Aboriginal Cultural Heritage.	
	12-Jul-23	Face to face	In depth discussion of MMP.	Water source protection. Biodiversity. Aboriginal Cultural Heritage.	
Office of the Premier	8-Apr-23	Face to face	General issues discussion.	Status of MMP.	
	25-May-23	Face to face	General issues discussion.	Status of MMP.	
	16-Aug-23	Face to face	Preparatory meeting for Premier's meeting with Alcoa.	Status of MMP.	
Department of Jobs, Tourism, Science and Innovation	7-Aug-23	Face to face	Monthly JTSI/Alcoa meeting.	Status of MMP.	
	9-Aug-23	Face to face	Meeting to discuss MMPLG meeting.		
	29-Aug-23	Face to face	Introduction of Matt Reed to DDG.	Status of MMP.	
	4-Oct-23	Face to face	Introduction of Matt Reed to DG.		
Department of Water and Environmental Regulation	4-Oct-23	Face to face	Introduction of Matt Reed to DG.		
Water Corporation (Regional contact for Huntly Mine)	23-Jun-23	Email	Invitation to consult on 2023-2027 MMP.	No request for meeting received.	
Water Corporation	26-Sep-23	Phone call	Status of MMP.		
	6-Oct-23	Face to face			
Department of Justice (Karnet Prison Farm)	6-Jun-23	Letter	Invitation to consult on 2023-2027 MMP.	No request for meeting received.	
Department of Biodiversity, Conservation and Attractions	23-Aug-23	Phone call	Overview of EPA assessment process and revised Willowdale mine plan discussed, due to impacts to Munda Biddi Trail.	Understanding of impacts and expected timeframe is required to inform any future trail changes.	Alcoa to provide details of mine plan and timing and undertake further consultation with DBCA on potential realignment.
Department of Planning, Lands and Heritage	25-Aug-23	Teams meeting	Meeting to discuss Aboriginal Cultural Heritage.	Places not reported correctly.	Alcoa to investigate and amend.
Department of Mines, Industry Regulation and Safety	19-Sep-23	Face to face	Introduction of Matt Reed to DDG.	Status of MMP.	
INTEREST GROUPS					

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
Munda Biddi Trail Foundation	11-Aug-23	Face to face	Information shared on mine plan and environmental management. This included where future mining would interact with a section of the MBT north of Logue Brook Dam.	MMP map was shared the potential disturbance area discuss MBTF noted they would need to "ground truth" the area MBTF also seeking to understand any further impact to the west to ensure Alcoa looks at this area holistically as part of its long terms planning.	BB Committed to arranging an internal meeting with key stakeholders to better understand the potential conflicts with the Munda Biddi Trail within WDL mining.
	22-Aug-23	Email	Email update sent following meeting on 11 August 2023.	Update to MBTF on internal meeting to discuss points raised in meeting on 11 August 2023.	Alcoa confirmed it would: Develop a broader view of mining activities/track impacts for next 20 yrs Organise to present this to the MBTF Board and Executive Team.
	11-Oct-23	Face to face	Follow up discussion on MMP.	MBTF seeking to have a long term holistic plan of Alcoa's future operations and the anticipated interactions with the Trail.	Alcoa confirmed a shared committment to look to the medium to long term to ensure that any potential realignments can be managed with a broader view of what may be on the radar in 5–20-year trajectory.
Alcoa Wagerup/Willowdale Community Consultative Network	Apr-23	Bi-monthly CCN meetings	April CCN meeting included discussion on delays/timing variability in mining approval and the MMPLG process.	No specific issues raised.	
COMMUNITIES AND LANDOWNERS					
Huntly Mine Neighbours (North Dandalup, Keysbrook, Yamba and surrounds)	6-Jun-23	Letters	Approximately 90 letters to private landowners in the vicinity of Huntly mine were sent on 6 June 2023 offering an opportunity to meet and consult on the MMP. Letter includes an offer to landowners to have a personal tour of Huntly mine.	8 requests from landowners to consult were received.	
	4-Jul-23	Face to Face	Information shared on mine plan and environmental management.	General discussion on the current and future operations with a specific interest in current noise issues (blast and operations).	Alcoa provided advice on how to report noise concerns through Alcoa's 24/7 report line.
	7-Jul-23	Telephone call	Information shared on mine plan and environmental management.	Discussed blast and operation noise impacts and monitoring equipment nearby.	A follow up site visit was organised.
	19-Jul-23	Face to face	Information shared on mine plan and environmental management.	Discussed impacts to dam and creek levels in the area.	Discussed the matters raised. Alcoa maintains ongoing engagement with the landowner.
	20-Jul-23	Face to face	Information shared on mine plan and environmental management.	Blast and operation noise was raised by landowner.	Alcoa provided advice on how to report noise concerns through Alcoa's 24/7 report line.
	20-Jul-23	Face to face	Information shared on mine plan and environmental management.	Discussed the low water levels on the property and sought to understand the cause of this.	Alcoa organised for a hydrologist to visit to property. Hydrologist met with landowners and discussed their concerns and answered questions . No further follow up was requested.
	31-Jul-23	Face to face	Information shared on mine plan and environmental management.	No issues raised.	

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
	14-Aug-23	Face to face	Information shared on mine plan and environmental management.	Dust present at the property near home due to mining activity in area.	Discussed dust issues, including the sand mine that operates across the road which could also be contributing to the dust. Information was provided on how to report dust exceedances to Alcoa Alcoa has organised for landowners to tour operations.
Waroona-Harvey community	8-Jun-23	Letters	Approximately 90 letters to private landowners in the vicinity of Willowdale mine were sent on 8 June 2023 offering an opportunity to meet and consult on the EMMP. Letter includes an offer to landowners to have a personal tour of Willowdale mine.	Two (2) conversations were held with landowners.	
	1-Jul-23	Face to face	The landowner has land on Scarp Road, directly east of Yarloop, and shares a boundary with an Alcoa-owned bush block to the west.	Proximity of future mining to landowner's property, in particular what noise and dust impacts might be. Landowner acknowledged that they do not currently hear Alcoa's operations. Sought to understand the mining process and potential impacts on water sources (springs and streams) and in Logue Brook.	Alcoa addressed all points raised. An action taken to provide the Willowdale mine map when approved.
	8-Aug-23	Telephone call	Landowner located on Black Rock Road near Logue Brook Dam.	Seeking assurance on the extent of Alcoa's mine plans.	Follow up email by CRA acknowledging feedback. Action taken to provide the Willowdale mine map when approved.
TRADITIONAL OWNERS					
	5-Jul-23	Meeting	Presentation included: <ul style="list-style-type: none"> - overview of the MMP and the assessment/approvals process, including the role of the MMPLG. - Alcoa is transitioning its approvals for new mining areas to be approved under the Environmental Protection Act. - A revised/updated MMP is prepared and submitted each year. -Alcoa will consult with GKB as part of the annual updating of the MMP. 	GKB indicated they wanted to work with Alcoa and have meaningful consultation on Alcoa's future plans.	Alcoa reiterated its commitment to engage with GKB and would ensure it had the appropriate experts to attend meetings.
	27-Jul-23	Letter	Request to meet and discuss the MMP.		Meeting subsequently confirmed for 4 August 2023.
	4-Aug-23	Meeting	Overview of MMP approval process and draft 2023 MMP clearing schedule Sharing of MMP map to facilitate discussion.	GKB indicated their support to work closely with Alcoa, and sought further information on: <ul style="list-style-type: none"> - Exploration approach (including types of equipment used). - Pre mining approach to identify constraints such as heritage and environmental. - Forest Clearing Advice - how it is approved within the MMPLG process GKB asked all business decisions to go through the Corporation, the CAC is for consultation only.	Alcoa reiterated its alignment with wanting to work with GKB. Questions raised were responded to in the meeting. Alcoa committed to organising a tour of its operations for the Board and CAC members. Alcoa would like to set up an appropriate forum to engage with GKB on its annual MMP.

Stakeholder	Date	Type of consultation	Overview	Topics raised	Alcoa's response
	27-Sep-23	Bus Tour	Bus tour of Alcoa's operations and rehabilitation.	Positive event, provided opportunities for further understanding and discussion about Alcoa's operations and areas of interest and importance to GKB.	
	Pending	Letter	Confirm 2023-2027 MMP to be submitted shortly. Thanked GKB for their participation in the consultation. Open invite to contact Alcoa with questions or if follow up presentations are required. A copy of the MMP map was attached to the letter.		
BUSINESS AND INDUSTRY					
	6-Jun-23	Email	Invitation to consult on 2023-2027 MMP.	Stakeholder requested to meet.	
Business owner located near Huntly Mine	27-Jul-23	Meeting	Information on the MMP was shared.	Overview of MMP. Discussed proximity of Alcoa's operations to the local business, in particular noise impacts (blasting) and visual amenity.	Alcoa confirmed: It would continue to include business owner in MMP consultation. It had prioritised the completion of nearby mining and would then commence rehabilitation.

Appendix 8 – Flora and Vegetation Reports

Appendix 9 – Flora and Vegetation Management Plan

Appendix 10 – Flora Likelihood of Occurrence Assessment

Appendix 11 – Fauna Likelihood of Occurrence Assessment

Appendix 12 – Fauna Management Plan

Appendix 13 – Water Reports

Appendix 14 – Big Brook Crossing Supporting Documents

Appendix 15 – Water Resources Management Plan

Appendix 16 – WA Mining and Haul Road Drainage Design Manual

Appendix 17 – ‘Wittwer 8’ Example Application of the WA Mining and Haul Road Drainage Design Manual

Appendix 18 – Recreational Trails and Facilities Management Plan

Appendix 19 – Groundwater Monitoring Data
