NORTHERN STAR
RESOURCES LTD

BUNDARRA WORKS APPROVAL APPLICATION

SUPPORTING ATTACHMENTS

Version	1.0
Date	June 2025
Site Name	Bundarra
Tenements	M 37/350, M 37/513
Tenement Holder	Northern Star (SR Mining) Pty Ltd
Mining Centre	Thunderbox Operations

[redacted]

SUMMARY OF ATTACHMENTS

Attachment	Included	Response
Attachment 1A: Proof of occupier status	Yes	[redacted]
Attachment 1B: ASIC company extract	Yes	[redacted]
Attachment 1C: Authorisation to act as a representative of the occupier	Yes	[redacted]
Attachment 2: Premises map/s	Yes	Premises maps provided for project location, premises boundary and proposed activities.
Attachment 3A: Environmental commissioning plan	Yes	No environmental commissioning phase required – basic commissioning checks to be undertaken during time limited operations.
Attachment 3B: Proposed activities	Yes	Detailed description of proposed activities provided for: Category 5 – Processing or beneficiation of metallic or non-metallic ore (b) tailings from metallic or non-metallic ore are reprocessed Category 6 – Mine dewatering Category 12 – Screening etc. of material Category 89 – Putrescible landfill site
Attachment 3C: Map of area proposed to be cleared (only applicable if clearing is proposed)	No	Not applicable – no clearing proposed under this application.
Attachment 3D: Additional information for clearing assessment	No	Not applicable – no clearing proposed under this application.
Attachment 4: Marine surveys (only applicable if marine surveys included in application)	No	Not applicable – no marine environments.
Attachment 5: Other approvals and consultation documentation	Yes	Summary of other approvals and stakeholder consultation attached.
Attachment 6A: Emissions and discharges	Yes	Potential emissions and discharges and associated risk pathways as well as proposed operational controls are detailed.
Attachment 6B: Waste acceptance	No	Not applicable.
Attachment 7: Siting and location	Yes	Detailed information including site specific baseline studies provided as Appendices.
Attachment 8: Additional information submitted	Yes	Attachment 8 – paste plant general arrangement.
Attachment 9: Category-specific checklist(s)	No	Not applicable.
Attachment 10: Proposed fee calculation	Yes	Attached.
Attachment 11: Request for exemption from publication	No	Not required – no sensitive information.

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TERMS USED

Acronym / Abbreviation	Definition
BC Act	*Biodiversity Conservation Act 2016*
DBCA	Department of Biodiversity, Conservation and Attractions
DEMIRS	Department of Energy, Mines, Industry Regulation and Safety
DWER	Department of Water and Environmental Regulation
EC	Electrical conductivity
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ha	hectare
LOM	Life of mine
MCP	Mine Closure Plan
MP	Mining Proposal
Northern Star	Northern Star Resources Ltd
PEC	Priority Ecological Community
ROM pad	Run-of-mine pad
SMART	Specific, measurable, achievable, relevant, and time-bound.
SWL	Standing water level
TDS	Total dissolved solids
TEC	Threatened Ecological Community
tpa	tonnes per annum
WRL	Waste rock landform (formerly waste rock dump)

1 Proof of Occupier Status (Attachment 1A)

Bundarra is a gold mine comprised of five tenements which are owned and operated by Northern Star (SR Mining) Pty Ltd, a wholly owned subsidiary of Northern Star Resources Ltd (Northern Star) under multiple holding companies. The Environment Online entity under which this application is submitted, Northern Star (Bundarra) Pty Ltd, directly owns Northern Star (SR Mining) Pty Ltd. The proposed prescribed premises boundary is located within two of these tenements as outlined in Table 1-1 below. Tenement summary extracts are also provided.

Table 1-1: Bundarra Tenements

Site Details		
Premises Name	Bundarra	
Tenement Details	Northern Star (SR Mining) Pty Ltd	M 37/350
		M 37/513
Proponent Details		
Company Name	Northern Star (Bundarra) Pty Ltd	
ACN	092 832 892	
Address	Level 4, 500 Hay Street, Subiaco WA 6008	
Postal Address	PO Box 2008, Subiaco WA 6904	
Key Contact Representative	[redacted]	

22 June 2022

[redacted]

Department of Water and Environmental Regulation
Prime House, 8 Davidson Terrace
Joondalup WA 6027

[redacted]

LETTER OF AUTHORITY IN REGARD TO APPROVAL APPLICATIONS

Please be advised that individuals holding the following positions are authorised to sign each of the following approval applications on behalf of Northern Star Resources Ltd and its subsidiaries:

Position

- Site Senior Executive/General Manager – Carosue Dam Operations
- Site Senior Executive/General Manager – KCGM
- Site Senior Executive/General Manager – Kalgoorlie Operations
- Site Senior Executive/General Manager – Jundee Operations
- Site Senior Executive/General Manager – Thunderbox Operations
- Site Senior Executive/General Manager – Bronzewing Operations

Approval application

- Application for: Clearing Permit (Area Permit or Purpose Permit) / Amendment to a clearing permit / Surrender a clearing permit / Notificaton of change of land ownership
- Application form: Works Approval / Licence / Renewal / Amendment / Registration / Surrender works approval or licence / Transfer works approval or licence or Notify new occupier of registered premises
- Application for a water licence under section 26D of the *Rights in Water and Irrigation Act 1914*
- Application for a 5C licence to take groundwater
- Application for a section 11/17/21A permit to interfere with bed and banks
- Annual Audit Compliance Report
- Annual Environmental Report
- Annual and Triennial Groundwater Reviews

Executed by **Northern Star Resources Limited (ABN 43 092 832 892)** on its own behalf and on behalf of its wholly-owned subsidiaries, in accordance with section 127 of the *Corporations Act 2001* (Cth):

[redacted]

4 Premises Maps (Attachment 2)

4.1 Proposal Location

Bundarra is located approximately 60 km north of Leonora and 60 km southeast of Leinster in the northeastern Goldfields region of Western Australia. Northern Star's Thunderbox Operations (Thunderbox) is located approximately 20 km northwest, with Bundarra forming a satellite operation to Thunderbox. Tenement M 37/513 is intersected by the Goldfields Highway which provides access to Bundarra. Both tenements are located within the Shire of Leonora, with the regional location shown of Bundarra shown in Figure 1.

4.2 Prescribed Premises

There is no existing prescribed premises located at Bundarra. The proposed premises boundary is shown in Figure 2, with coordinates of the boundary provided vertices detailed in Table 4-1 below (described clockwise from northwest). The boundary has been designed to be as small as practicable around the proposed activities.

Table 4-1: Prescribed Premises Coordinates

ID	Tenement	Coordinates (GDA 2020 MGA Zone 51)	
		Easting (m)	Northing (m)
1	M 37/350	319,600	6,863,000
2	M 37/513	320,100	6,863,000
3	M 37/513	320,100	6,862,850
4	M 37/513	321,750	6,862,950
5	M 37/513	321,300	6,863,250
6	M 37/513	321,050	6,864,100
7	M 37/513	321,350	6,864,100
8	M 37/513	321,400	6,863,950
9	M 37/513	322,050	6,863,950
10	M 37/513	322,300	6,863,150
11	M 37/513	321,900	6,862,850
12	M 37/513	320,100	6,862,750
13	M 37/513	320,100	6,862,500
14	M 37/350	319,600	6,862,500

4.3 Proposed Activities

The locations of proposed activities within the prescribed premises boundary are shown in Figure 3.

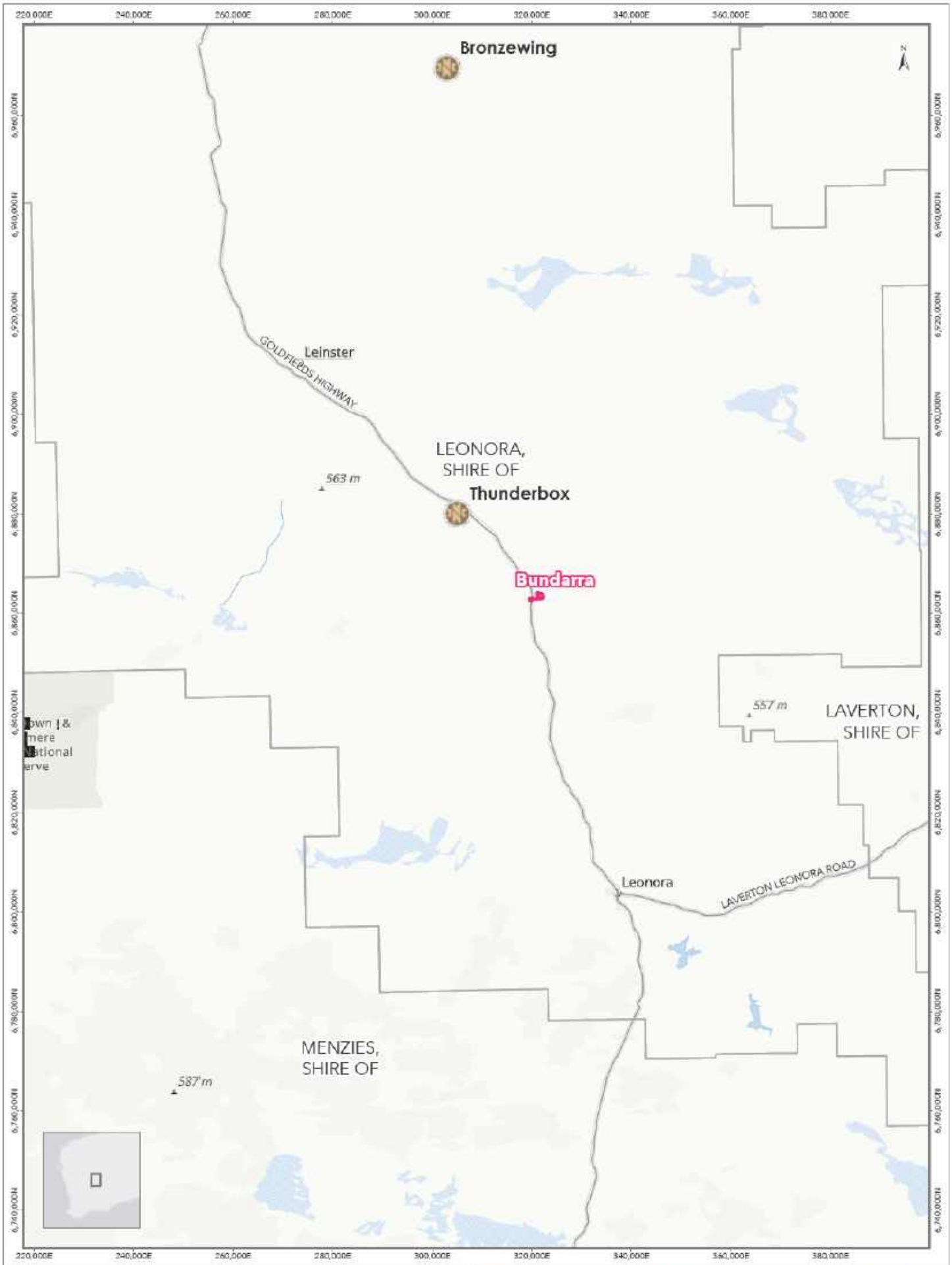

Figure 1: Regional Location

Bundarra Works Approval Application Supporting Attachments

Northern Star Mine Site

Principal Road

Prescribed Premises Boundary

Local Government Boundaries

Date: 19/05/2025 | Author: dmantini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:1,000,000 |

0 20 40km

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Figure 2: Proposed Prescribed Premises

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements

Prescribed Premises Boundary

Date: 19/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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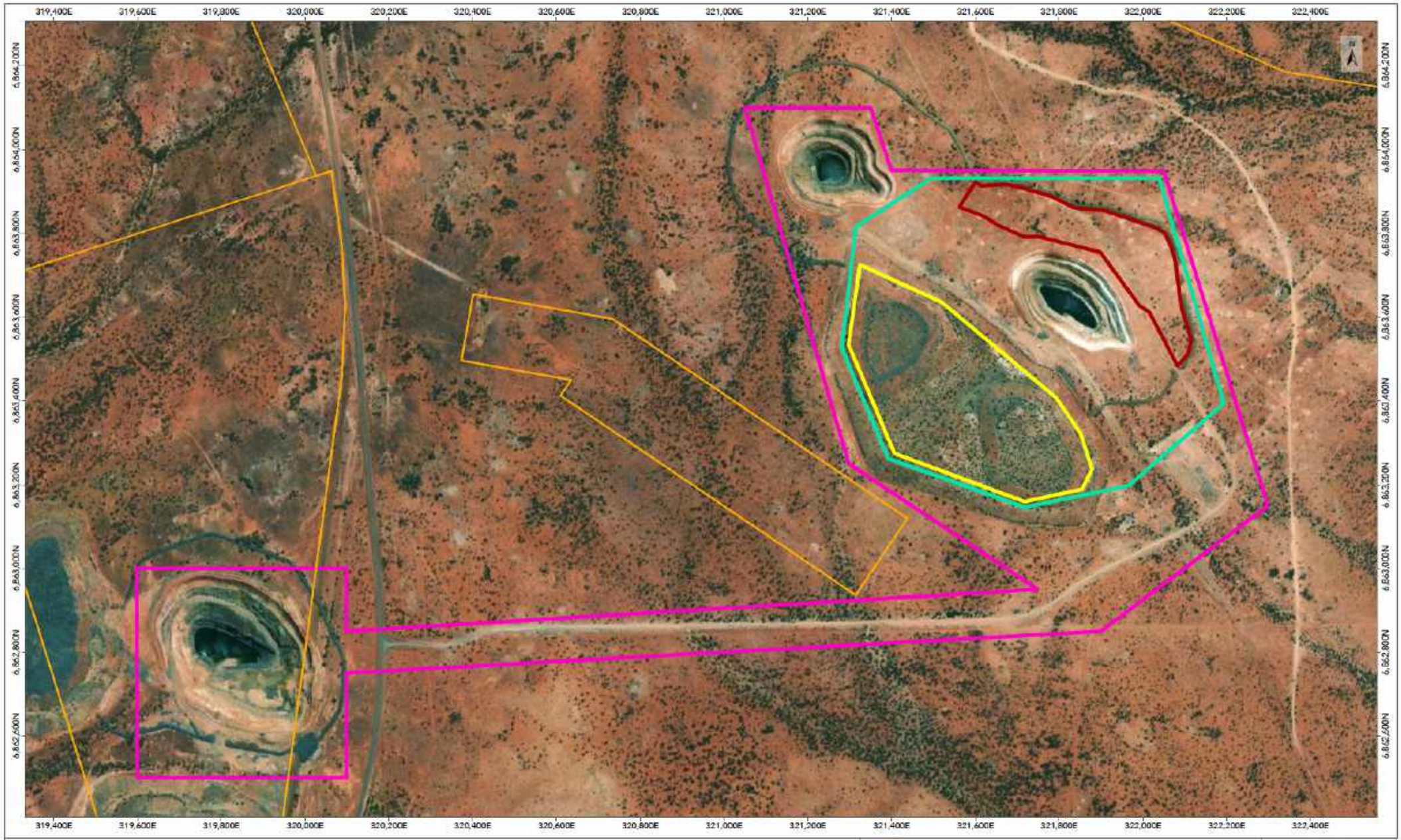

Figure 3a: Proposed Activities

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements
Prescribed Premises Boundary
Crushing and Screening Plant
Landfill Cells
Paste Plant & Tailings Stockpiles

Date: 19/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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Figure 3b: Proposed Activities

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements
Prescribed Premises Boundary
Open Pit
Dewatering Pipelines
Abstraction / Discharge Point
Transfer Point

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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5 Environmental Commissioning Plan (Attachment 3A)

In accordance with the Guideline: Industry Regulation Guide to Licensing (DWER 2019) there is no environmental commissioning phase required to validate environmental performance relative to predicted performance. All proposed activities are low risk and controls conditioned under the Works Approval are considered effective to mitigate risks during time limited operations (TLO).

Basic commissioning checks associated with construction activities are summarised in Table 5-1 below, demonstrating that these checks can be conducted in a short time frame during TLO.

Table 5-1: Basic Commissioning Checks

Infrastructure	Indicative Test Period	Environmental Checklist
Mobile Crushing and Screening Plant	1 hour (each mobilisation)	◤ Observe visual dust generation. ◤ Check for any hydrocarbon leaks.
Dewatering Infrastructure	1 week	◤ Confirm V-drain has been excavated and pipeline fully contained within. ◤ Inspect pipeline for leaks and rectify any issues identified. ◤ Check water storage tanks for leaks and rectify any issues identified. ◤ Check flow meters are installed and functioning correctly.
Landfill	1 hour	◤ Ensure earthen bunds are installed to three faces of landfill cell.
Paste Plant and Tailings Stockpiles	~2 weeks (or first rainfall event)	◤ Confirm surface water runoff is contained within plant / stockpile area boundary following rainfall event. ◤ Confirm tailings stockpiles are not causing dust liftoff during high wind event.

5.1 Time Limited Operations

A proposed period of 180 days TLO is requested for each item of infrastructure to allow for staggered construction and commissioning, and sufficient time to apply for a licence and potential licence amendment(s):

- Crushing and Screening Plant
- Dewatering Infrastructure
- Landfill
- Paste Plant

6 Proposed Activities (Attachment 3B)

6.1 Proposal Overview

Northern Star is applying for a Works Approval pursuant to Section 54 the *Environmental Protection Act 1986* (EP Act) for Schedule 1 Categories 5, 6, 12 and 89 to support mining activities at Bundarra. Bundarra includes two mining areas: Celtic and Wonder, located on opposite sides of the Goldfields Highway. Celtic is comprised of one open pit (Celtic Pit) and two waste rock landforms (WRL) and was first mined in 2000 by Pacmin. Wonder is comprised of two open pits (Wonder North and West Pits) and one WRL and was first mined by Sons of Gwalia in 2001.

Mining activities at Bundarra ceased in 2003, and Bundarra was placed in care and maintenance for 20 years until Northern Star recommenced underground mining of Wonder North Pit in late 2023. All ore mined at Bundarra is hauled by road trains via Goldfields Highway to Thunderbox for processing, with tailings disposed within the existing tailings storage facilities (TSF) at Thunderbox, operated under licence L7815/2001/12. Bundarra currently has a 10-year life of mine (LOM) based upon known gold reserves.

6.1.1 Proposed Activities

Four categories as defined in Schedule 1 of the *Environmental Protection Regulations 1987* are sought in this Works Approval application. Prescribed premises categories and capacities sought under this Works Approval application are summarised in Table 6-1 below. Design capacity has been calculated based on tonnes per annum (tpa) throughput assuming utilisation for 24 hours per day, 365 days per year.

Table 6-1: Proposed Category Outputs

Schedule 1 Category	Infrastructure	Prescribed Premises Trigger	Design Capacity (tpa)	Proposed Output (tpa)
Category 5: Processing or beneficiation of metallic or non-metallic ore (b) tailings from metallic or non-metallic ore are reprocessed	Paste Plant and Tailings Stockpiles	50 000 tonnes or more per year	1,400,000	584,000
Category 6: Mine dewatering	Dewatering Infrastructure	50 000 tonnes or more per year	3,468,960	840,000
Category 12: Screening etc. of material	Mobile Crushing and Screening Plant	50 000 tonnes or more per year	4,380,000	150,000
Category 89: Putrescible landfill site	Landfill	More than 20 but less than 5 000 tonnes per year	480	240

6.2 Category 5 - Processing or Beneficiation of Metallic or Non-Metallic Ore

Northern Star propose to construct and operate a dry tailings paste plant on M 37/513 to generate paste fill for backfilling of underground voids (stopes). Paste will be generated from blending of reclaimed tailings, cement and water within a mixing tank, and will be fed directly underground via bore hole to open stopes. Paste fill enables for higher recovery of ore than open stope mining as pillars are not required for ground support and can be extracted, also enabling tailings to be reused for a beneficial purpose in a low-risk environment.

Dry tailings will be reclaimed (excavated) from Thunderbox TSF and transported by road train to Bundarra. Whilst tailings are considered dry, they contain sufficient residual moisture (approximately 15%) to prevent dusting during loading, unloading and transportation. Notwithstanding, tailings will be fully covered during transport to further minimise the potential for dust lift-off and spillages. Northern Star are currently hauling ore via this route and will back-transport tailings resulting in no increases to trucking movements on the Goldfields Highway.

Upon arrival at Bundarra, tailings will be unloaded in a designated stockpile area adjacent to the paste plant which will be surrounded by earthen bunds on external perimeters (excluding road train egress points) and graded internally to contain surface water runoff. The stockpile area will be constructed of a compacted clay layer over crushed aggregate to ensure separation between tailings and in-situ soils. Tailings will be stockpiled to a maximum of 3 m height in windrows (from side tipper unloading).

6.2.1 Paste Plant Infrastructure

The proposed dry tailings paste plant is of a prefabricated modular design, enabling quick installation and relatively minimal commissioning requirements. A concrete pad will firstly be constructed to allow for modular infrastructure to be bolted into place. The maximum throughput is 100 m^3/ hour, but the estimated productivity is likely to average between 800 -1,000 m^3/day as it will not be operated continuously.

The paste plant has a simple configuration broadly comprised of the following items of infrastructure:

- **Hopper** - front end loader fed with a capacity of 10 m^3 with constant feed rate onto conveyor.
- **Conveyor** - rubber lined incline conveyor with discharge chute directly into mixer.
- **Cement silo** - 240 tonne silo fed via compressed air driven pneumatic transfer and fitted with dust filter and overfill protection.
- **Water tank** - 25,000 L water storage tank to contain mine dewater from Wonder Underground for paste blending.
- **Mixer** - single shaft continuous mixer which blends tailings, cement and water into paste.
- **Bore hole** - bore hole located over concrete sump driven by two centrifugal pumps which transfers paste directly underground to open stopes.
- **Control system** - central control system with operator interface with appropriate fault messages and automated shut down processes

An indicative layout of the paste plant is shown below in Plate 6-1 below, which is an existing paste plant with the same configuration which will be utilised at Bundarra.

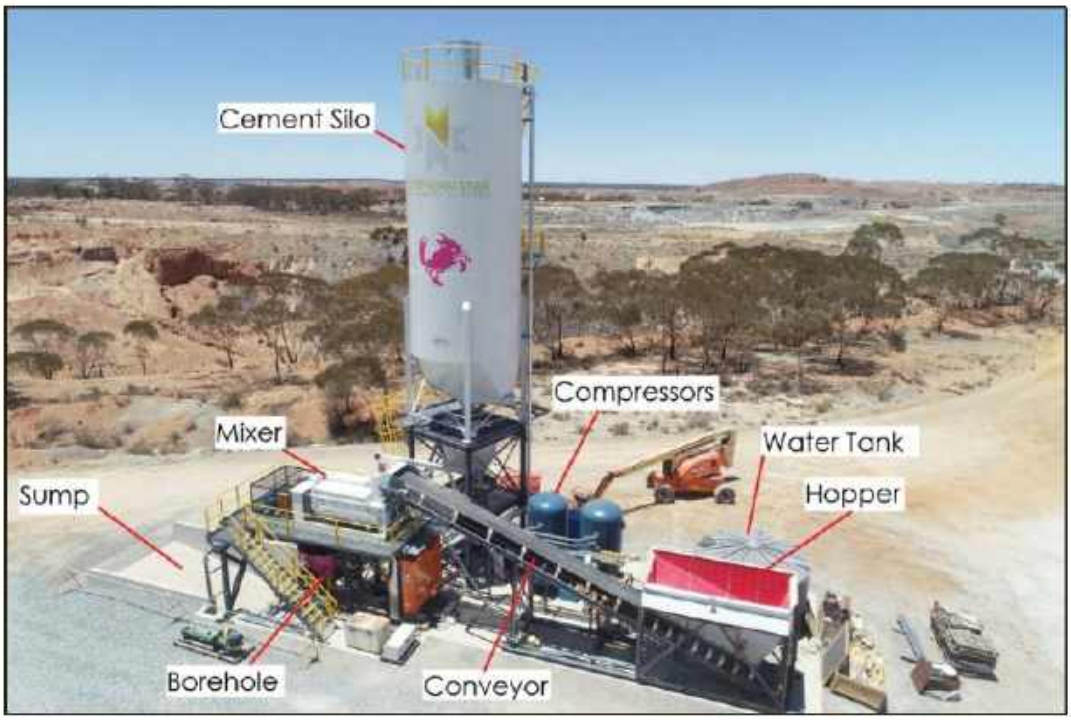

Plate 6-1: Paste Plant Indicative Layout

6.3 Category 6 - Mine Dewatering

Northern Star propose to dewater underground mine workings throughout the anticipated 10-year LOM of Bundarra. Groundwater will be drawdown and maintained below the active mining elevation to facilitate dry mining conditions. Based on peak modelled dewatering rates with contingency for varying hydraulic conductivity, a total allocation of 840,000 kL (tpa) is expected to be sufficient for maximum possible annual dewatering requirements across the LOM. Average annual dewatering requirements are expected to be much lower at approximately 289,000 kL per annum.

Groundwater will be pumped from underground sumps to a pit lake in the base of Wonder North Pit, where it will then be pumped to a series of fully contained surface holding tanks. Water from the holding tanks will be recycled underground to support drilling and mining activities or utilised on the surface in the paste plant or for dust suppression activities. A pump and standpipe are sited adjacent to the surface water tanks to allow for filling of watercarts. There are no surface water holding ponds (turkeys' nests) associated with this proposal.

Surplus dewater from Wonder North Pit will be discharge firstly to Wonder West Pit. Given the proximity of these two pits (approximately 350 m), it is possible that dewater will re-enter underground workings during the LOM although hydraulic conductivity is generally low. A new pipeline is proposed to connect Wonder North Pit to Celtic Pit (approximately 2.8 km away) for any water balance exceeding the capacity of Wonder West Pit over the LOM. It is noted that these pits were previously connected via a pipeline and an existing culvert is in place beneath the Goldfields Highway.

A basic water balance has been prepared using average dewatering requirements assuming no dewater is recycled for paste blending, underground mining or dust suppression activities, as outlined in Table 6-2 below. Pit volumes are based upon survey pick in April 2025. The water balance demonstrates that the capacity of both pits is sufficient for dewatering requirements over the 10-year LOM under conservative assumptions.

Table 6-2: Dewatering Water Balance (April 2025)

Parameter	Celtic Pit	Wonder West Pit
Total pit volume (m^3)	4,113,761	1,248,961
Total pit volume with 5 m freeboard (m^3)	3,670,721	1,103,129
Current remaining volume with 5 m freeboard (m^3)	3,601,187	942,193
% Fill capacity remaining	98.1	85.4
Estimated annual water loss (m^3) (evaporation - rainfall)*	85,200	34,000
Estimated net inflows (m^3)	203,800	255,000
Capacity (years)	**18.0**	**3.7**

*Estimated based on maximum pit lake areas, 0.7 pan factor for open water body, 0.69 salinity factor.

6.3.1 Dewatering Infrastructure

Dewatering infrastructure including pipelines and pumps will be installed between Wonder North Pit and Celtic Pits to facilitate water transport. Pipelines of nominal 110 - 160 mm diameter high density polyethylene (HPDE) with control valves will be installed to direct flow. Pipelines will be installed with applicable AS/NZS standards and be predominantly sited within existing disturbed areas adjacent to access roads. All new pipelines will be constructed within v-drains of sufficient capacity to contain spills for a period equal to the time between routine inspections, and form part of the monitored network of saline pipelines operated across Thunderbox. Dewatering infrastructure broadly includes:

- **Pumps** - pumps installed across pipeline to direct water between transfer and discharge points.
- **Water storage tanks** - fully enclosed surface water tanks located adjacent to standpipes.
- **Standpipes** - two standpipes to fill watercarts for dust suppression purposes.
- **Shutdown valves** - installed at appropriate intervals to allow for isolation of sections of dewatering pipelines for maintenance and in response to leaks or spills.

- **Air-release valves** – installed at appropriate intervals to allow for release of air in pipeline to reduce risks of rupture.
- **Flow meters** – fitted to measure pit abstraction / discharge volumes.
- **Scout pits** – installed where required (i.e. low points) to provide additional capacity for spills if v-drain not sufficient.

A general concept of the Bundarra dewatering infrastructure is shown in Plate 6-2 below.

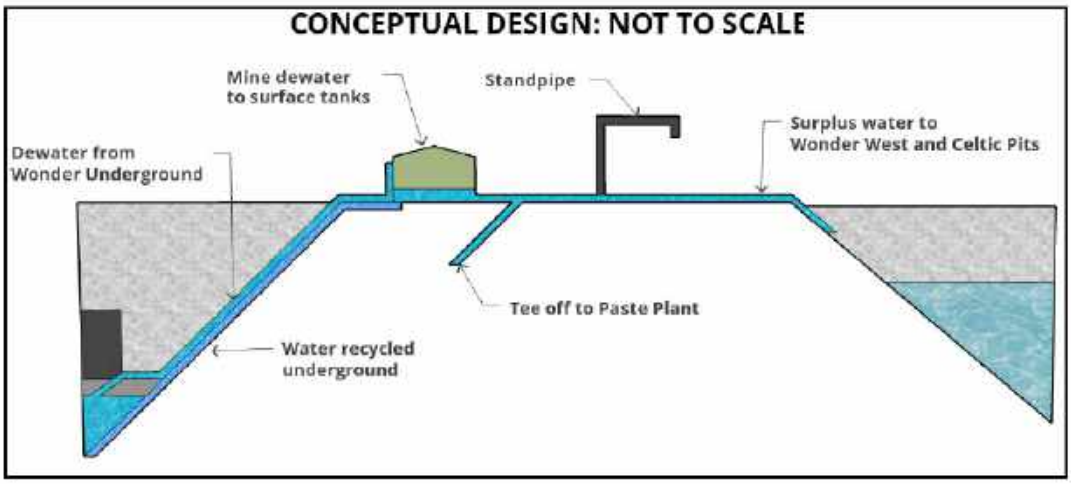

Plate 6-2: Indicative Bundarra Dewatering Process

6.4 Category 12 - Screening etc. of Material

Northern Star propose to operate mobile crushing and screening plant on a campaign basis to generate construction material to support continued development of Bundarra. The crushing and screening unit will be mobilised to site and deployed to process stockpiled inert waste rock materials, which are proposed to be reused within Bundarra boundary for road base, stemming, hardstand and cemented aggregate fill. No crushed and screened materials will be transported offsite.

A nominal 100,000 tonnes per year maximum throughput has been assigned to be crushed and screened, however the actual throughput is likely to vary due to the campaign nature of activities. The mobile crushing and screening plant will be moved throughout the designated crushing and screening area depending on locations of stockpiled materials to process.

Stockpiled waste rock material will be fed via front end loader or excavator into a hopper, with rock materials crushed by a jaw crusher and fed via conveyor to an adjacent screening unit. Crushed materials will go through a secondary impact crusher before going through a vibrating screen, separating material into various apertures ranging from approximately 5 mm to 300 mm.

6.4.1 Crushing & Screening Infrastructure

The specific mobile crushing and screening plant used will be dependent on contractor availability, however, will have the same general configuration and environmental controls regardless of model. The mobile plant will arrive as separate components which will be assembled on site. It is anticipated that the maximum throughput achieved for any model of crushing and screening plant would be 500 tonnes per hour. The general component of mobile crushing and screening plant include:

- **Hopper** – waste rock is fed via front end loader or excavator into the hopper where it drops into the jaw crusher.
- **Jaw crusher** – this is the first stage of crushing in which rock is compressed between two jaws (one stationary one moving) to reduce size.
- **Cone crusher** – this is the secondary stage of crushing which rock enters a crushing chamber driven by eccentric motion pulverising rock to reduce size.

- **Vibrating screen** – shakes to separate crushed aggregate into different apertures which are then conveyed to separate stockpiles.
- **Conveyors** – rubber lined incline conveyors which transport crushed rock between crushing and screening plant and into screened stockpiles.

Supporting the crushing and screening plant will be site-based watercarts which will be used at an on required basis to wet down stockpiles and supress dust. An indicative mobile crushing and screening plant is shown in Plate 6-3 which shows a typical arrangement (not necessarily indicative of selected plant).

Plate 6-3: Indicative Mobile Crushing and Screening Plant

6.5 Category 89 - Putrescible Landfill Site

An unlined Class II putrescible landfill is proposed to be constructed on tenement M 37/513 to dispose site generated waste throughout the LOM. The landfill will be constructed within Wonder waste rock landform (WRL) and operated in accordance with the *Environmental Protection (Rural Landfill) Regulations 2002* (fencing will be excluded as the site is surrounded by an existing abandonment bund which prevents livestock entry).

The landfill will consist of a series of cells up to approximately 3 meters deep by 3 meters wide and up to 20 meters in length (180 m^3). All waste materials generated during construction and ongoing operations will be collected, transported, stored and disposed of in the site landfill, except recyclable waste (scrap metal, poly pipe, copper cabling etc.) which may be stockpiled and recycled in campaigns.

Pursuant to the Landfill Waste Classification and Waste Definitions 1996 (as amended 2019) the waste types sought to be disposed of include:

- **Inert waste type 1** – non-organic waste primarily leftover materials and demolition waste.
- **Inert waste type 2** – used tyres which are not able to be refurbished or economically recycled.
- **Putrescible waste** – non-hazardous organic waste generated from offices, crib areas, workshops etc.
- **Contaminated solid waste meeting acceptance criteria for Class II landfills** – contaminated soils from spills onsite which have been tested and are confirmed to be within the threshold for Class II landfill disposal.

It is expected that approximately 240 tonnes of waste (2 cells) will be disposed of per year for the LOM, however an allowance of up to 480 tonnes (4 cells) has been made in the event of future construction activities generating higher waste volumes. Following completion of each cell it will be capped with waste rock material and eventually will become part of the rehabilitated landform at mine closure.

7 Other Approvals & Engagement (Attachment 5)

Northern Star is aware of its obligation to seek approvals and comply with requirements under various Federal and State Legislation in addition to securing this Works Approval. At the time of preparing this document environmental legislation applicable to this application has been summarised in Table 7-1 below.

Table 7-1: Environmental Approvals Summary

Legislation / Regulation	Environmental Aspect(s)	Approval Status
Aboriginal Heritage Act 1972	Aboriginal heritage sites	Section 18 consent was sought under previous ownership to disturb registered Aboriginal Sites located within M 37/350 and M 37/513 to facilitate development of Celtic and Wonder. No disturbance to Aboriginal Sites will occur as part of the proposed activities.
Biodiversity Conservation Act 2016 (BC Act)	Threatened flora, fauna and ecological communities	No Threatened flora, fauna or ecological communities within the prescribed premises boundary – no Section 40 approval is required under BC Act.
Contaminated Sites Act 2003 (CS Act)	Soil resources	No classification under the CS Act exists over Bundarra – no reclassification or other considerations.
Dangerous Goods Safety Act 2004	Storage of dangerous goods	No dangerous goods will be stored at the paste plant - diesel generators will be refuelled by mobile service trucks.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Matters of national environmental significance	No matters of national environmental significance applicable – no referral required under EPBC Act.
Environmental Protection Act 1986 (Part IV)	Matters of state environmental significance	Not a 'significant proposal' – no triggers for referral under Section 38 of the EP Act.
Environmental Protection (Controlled Waste) Regulations 2004	Controlled waste transport	Tailings characterisation progressing to determine if controlled waste regulations applicable when transporting tailings from Thunderbox to Bundarra.
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Native vegetation clearing	The majority of Bundarra had been cleared for previous mining campaigns, any minor clearing is facilitated under exemption of 10 ha per tenement per year.
Environmental Protection (Noise) Regulations 1997 (Noise Regulations)	Social surroundings	Construction noise management plan not required – no nearby sensitive receptors.
Health Act 1911	Human health	An approved septic system with leach drains is in place and approved (below 20 m^3 / day Category 85 trigger).
Mining Act 1978	Biodiversity Water resources Land and soils Closure and rehabilitation	Mining activities at Bundarra are approved under existing Mining Proposal and Mine Closure Plans. A revised Mining Proposal will be submitted to reflect the proposed activities.
Native Title Act 1993	Land access	All tenements within the proposed prescribed premises are granted. Northern Star are in progress of negotiating an agreement with Native Title holders across Thunderbox.
Rights in Water and Irrigation Act 1914 (RIWI Act)	Groundwater resources	GWL 170438(5) covers Bundarra tenements M 37/350 and M 37/513 with an allocation of 250,000 kL annual abstraction which is currently sufficient. This will be amended prior to increasing dewatering requirements. No dewatering bores are required as abstraction occurs from underground and pit sumps.

7.1 Stakeholder Engagement

Stakeholder engagement has been ongoing throughout the life of the project commencing with previous owners of Bundarra. Northern Star has a dedicated Social Performance team to enhance stakeholder outcomes across the business. Northen Star's stakeholder engagement strategy is informed by the principles outlined below.

- **Communication** - Communication must be open, accessible, clearly defined, two-way and appropriate.
- **Transparency** - The process and outcomes of community and stakeholder engagement should, wherever possible, be made open and transparent, agreed upon and documented.
- **Collaboration** - A co-operative and collaborative approach to seek mutually beneficial outcomes is considered key to effective engagement.
- **Inclusiveness** - Inclusiveness involves identifying and involving communities and stakeholders early and throughout the process, in an appropriate manner.
- **Integrity** - Community and stakeholder engagement should establish and foster mutual trust and respect

Key stakeholders to Bundarra and adopted engagement strategies for each party are summarised in Table 7-2, noting that this is subject to change as the project develops over time.

Table 7-2: Stakeholder Engagement Strategy

Group	Key Stakeholder	Engagement	Timing
Local Government	Shire of Leonora	Notification of proposed mining activities.	Completed September 2023.
		Project updates or changes to mining activities	Ongoing as required.
Native Title (Darlot)	Watarra Aboriginal Corporation RNTBC	Notification of proposed exploration activities at Bundarra through heritage survey requests.	Completed September 2023.
		Organising heritage surveys for any new disturbances.	New heritage survey over Bundarra completed April 2025 – report pending.
		Project updates or changes to mining activities	Ongoing as required.
Pastoralist	Tarmoola Station	Notification of proposed mining activities at Bundarra.	Completed April 2023.
		Project updates or changes to mining activities	Ongoing as required.
	Weebo Station	Notification of proposed mining activities at Bundarra.	Completed April 2023.
		Project updates or changes to mining activities	Ongoing as required.
State Government	DEMIRS	Provision of updated Mining Proposal for proposed activities.	To be submitted (expected June 2025).
	Main Roads WA	Notification of proposed tailings haulage on Goldfields Highway and reutilisation of culvert under Goldfields Highway and installation of dewatering pipeline.	To be completed prior to commencement of activities.

7.2 Stakeholder Engagement Register

Northern Star utilise INX InForm as a Stakeholder Engagement Register (SER). The purpose of this SER is to document consultation activities undertaken with all stakeholder groups and individuals, including any comments or concerns raised and follow up actions. The SER is a live database and will continue to document all consultation through the LOM.

8 Emissions & Discharges (Attachment 6A)

Emissions and discharges and associated potential risk pathways and proposed controls during construction and TLO are summarised in Table 8-1 below. The proposed controls during TLO will be continued during operations following granting of a licence.

Table 8-1: Emissions & Discharges

Activity	Potential Emissions / Discharge	Potential Risk Pathways	Proposed Controls
Construction			
Construction of paste plant Excavation of landfill cells	◤ Dust ◤ Noise ◤ Hydrocarbon spills	◤ Operation of mobile plant (excavators, cranes etc.). ◤ Operation of handheld tools (i.e. rattle gun).	◤ Utilisation of watercart for dust suppression as required. ◤ Limiting construction activities during periods of excessive winds. ◤ Monitoring for spills and provision of spill kit equipment and training
Time Limited Operations			
Operation of landfill	◤ Contaminated runoff ◤ Leachate ◤ Odour ◤ Windblown waste	◤ Surface water runoff interacting with exposed waste. ◤ Vertical seepage of leachate into groundwater. ◤ Exposed waste for excessive periods.	◤ Sited within WRL with significant separation to groundwater. ◤ Constructed and operated in accordance with Rural Landfill Regulations (applicable controls).
Operation of mobile crushing and screening plant	◤ Dust ◤ Noise ◤ Hydrocarbon spills	◤ Dust liftoff during loading and crushing / screening. ◤ Noise from operations. ◤ Hydrocarbon spills during refuelling etc.	◤ Water carts available to proactively wet down stockpiles. ◤ Visual dust monitoring and cessation during excessive winds if required. ◤ Spill kits available on service trucks.
Operation of paste plant	◤ Contaminated runoff ◤ Dust (tailings) ◤ Noise ◤ Paste spills	◤ Dust liftoff from tailings stockpiles and during tipping into hopper. ◤ Operation of diesel generator and air compressors. ◤ Surface water runoff interacting with tailings stockpiles.	◤ Sited within existing abandonment bund and largely cleared area. ◤ Earthen bund around tailings stockpiles and graded internally. ◤ Paste borehole located within concrete sump. ◤ Visual monitoring of dust liftoff from tailings stockpiles and wetting down if required.
Transport of mine dewater via pipeline	◤ Noise ◤ Hydrocarbon spills ◤ Saline water spills	◤ Operation of pumps via diesel generator. ◤ Pipeline leak or rupture releasing water into environment.	◤ Daily inspection of pipeline when in use to confirm visual integrity. ◤ Secondary containment for spills (v-drains, scour pits where required). ◤ Shutdown valves, air release vales and flow meters installed. ◤ Spill kits available on service trucks.
Discharge of mine dewater into receiving pit	◤ Saline water spills ◤ Groundwater mounding	◤ Overtopping of pit into surrounding environment. ◤ Saturation of plant root zone.	◤ Maintaining 5 m pit operating freeboard. ◤ Monthly survey monitoring of pit water volume.

9 Siting & Location (Attachment 7)

9.1 Sensitive Land Uses

The environmental protection authority (EPA) defines sensitive land uses as "land uses considered to be potentially sensitive to emissions from industry and infrastructure include residential developments, hospitals, hotels, motels, hostels, caravan parks, schools, nursing homes, childcare facilities, shopping centres, playgrounds, and some public buildings". In accordance with this definition the nearest sensitive land use to the proposed prescribed premises is the accommodation village located at Jaguar Mine Site approximately 4 km southwest. This mine site is currently in care & maintenance (since 2023) however is the nearest potential residential receptor.

Separation distances between industrial and sensitive land uses are outlined by the EPA (2005) and summarised in Table 9-1 below, demonstrating that the minimum separation distances are well exceeded.

Table 9-1: Separation Distances

Activity	Description	Minimum Separation Distance	Separation Distance Achieved
Concrete batching plant*	Concrete is made (batched)	300 – 500 m	4000 m
Mine dewatering	Water extracted and discharged to allow mining of ore	Case by case	
Screening works	Screening or sieving of sand, rocks, chemicals and minerals	500 m	
Waste disposal - putrescible landfill site	Site accepting inert, putrescible, contaminated solid waste	500 m (and internal buffer of 35 m from premises boundary)	

*Most similar activity to paste plant.

9.2 Baseline Environmental Studies

Baseline environmental studies have been completed across Bundarra to understand environmental values and risks associated with proposed activities. A summary of considerations for the environmental risk assessment has been provided within each following subsection. All environmental studies have been provided as Appendices and are summarised in Table 9-2 below.

Table 9-2: Baseline Environmental Studies

Environmental Aspect	Study Type	Author / Reference	Appendix
Waste Rock	Materials Characterisation Study	Botanica (2023)	Appendix A
Biodiversity	Reconnaissance Flora / Vegetation & Basic Fauna Assessment	Botanica (2022)	Appendix B
Hydrology	Surface Water Assessment	Rockwater (2023a)	Appendix C
	Hydrogeological Assessment	Rockwater (2023b)	Appendix D

9.3 Climate

The WA Goldfields region has an arid to semi-arid climate with average annual rainfall decreasing from about 250 mm in the south-west to 200 mm in the north-east. The area experiences hot summers and mild winters with cold nights. Rainfall varies widely between years and droughts are common; remnants of tropical cyclones occasionally bring heavy summer rain and can cause localised flooding. The area is transitional between desert summer and winter dominated rainfall and desert: non-seasonal bioclimatic (Beard, 1990).

Data sourced from Leonora weather station (Site 012046) managed by the Bureau of Meteorology (BoM) located approximately 80 km southeast of Thunderbox shows a mean annual rainfall of 236.7 mm,

however this is highly variable ranging from 57.8 mm to 552.2 mm between 1898 to 2020 (BoM 2025). Long term monthly average temperature and rainfall for Leonora weather station are shown in Plate 9-1 demonstrating rainfall is concentrated towards the first six months of the year.

Mean annual evaporation is approximately 10 times higher than mean annual rainfall, with evaporation highest in the summer months (December to February), but still exceeding monthly rainfall every month of the year. Annual pan evaporation across Australia is shown in Plate 9-2 with Bundarra located near the 2,800 mm gradient between Kalgoorlie-Boulder and Wiluna.

Wind roses are available for the Leonora Weather Station from data collected between 1957 to 2010. Prevailing winds are expected to be predominantly easterly in the morning (9 am), with afternoon winds (3 pm) more variable depending on season, and are shown in Plate 9-3. Wind is influenced by a wide range of factors, notably large-scale pressure patterns, time of the day, temperature and local terrain.

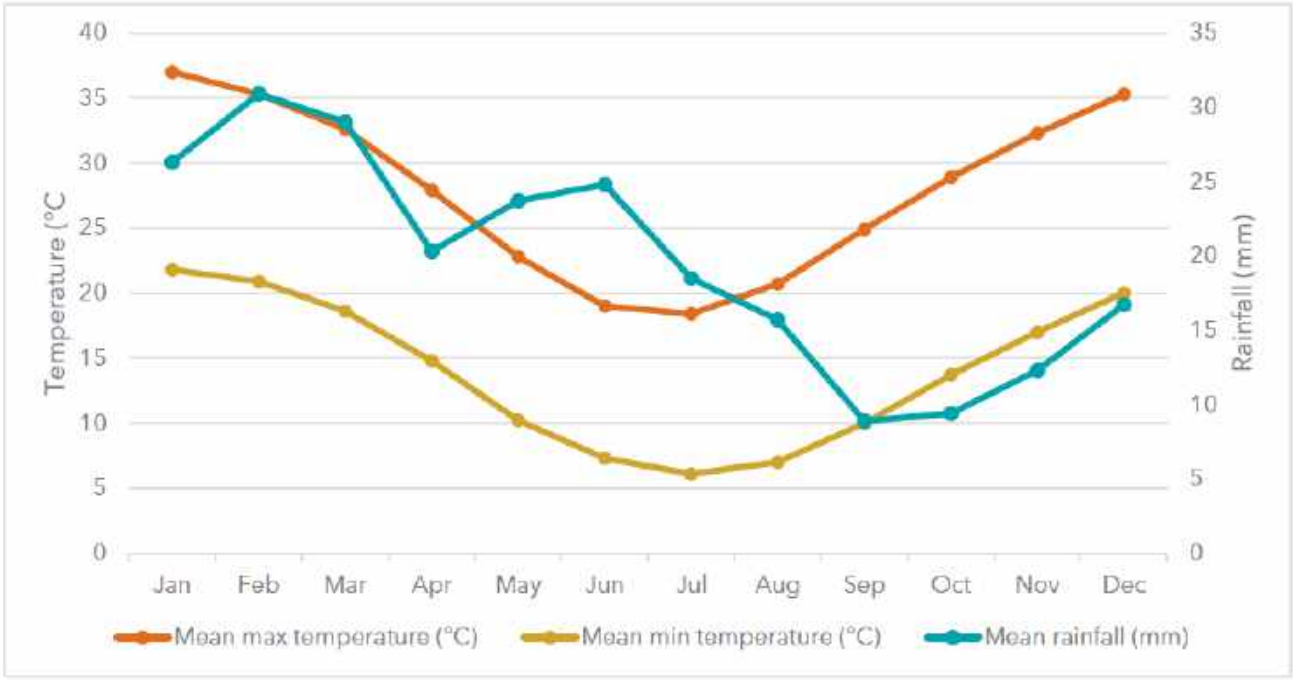

Plate 9-1: Leonora Climate Statistics 1949 - 2020 (BoM Station 012046)

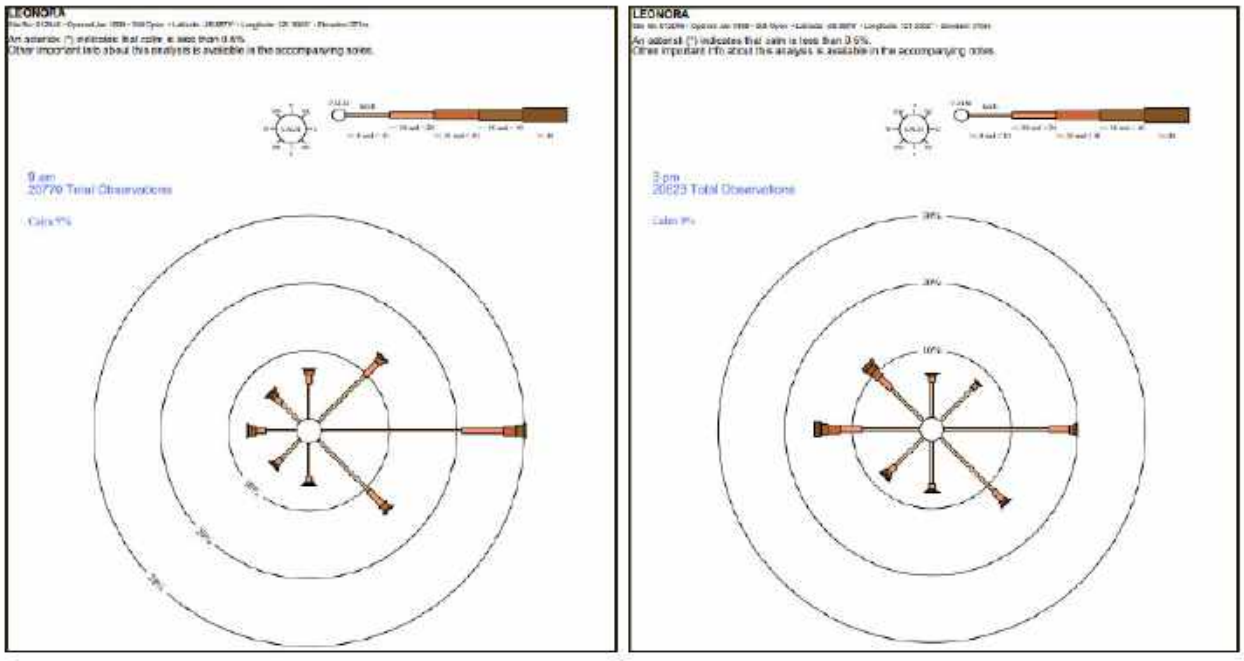

Plate 9-2: Leonora Wind Roses 1957 - 2014 (BoM Station #012046)

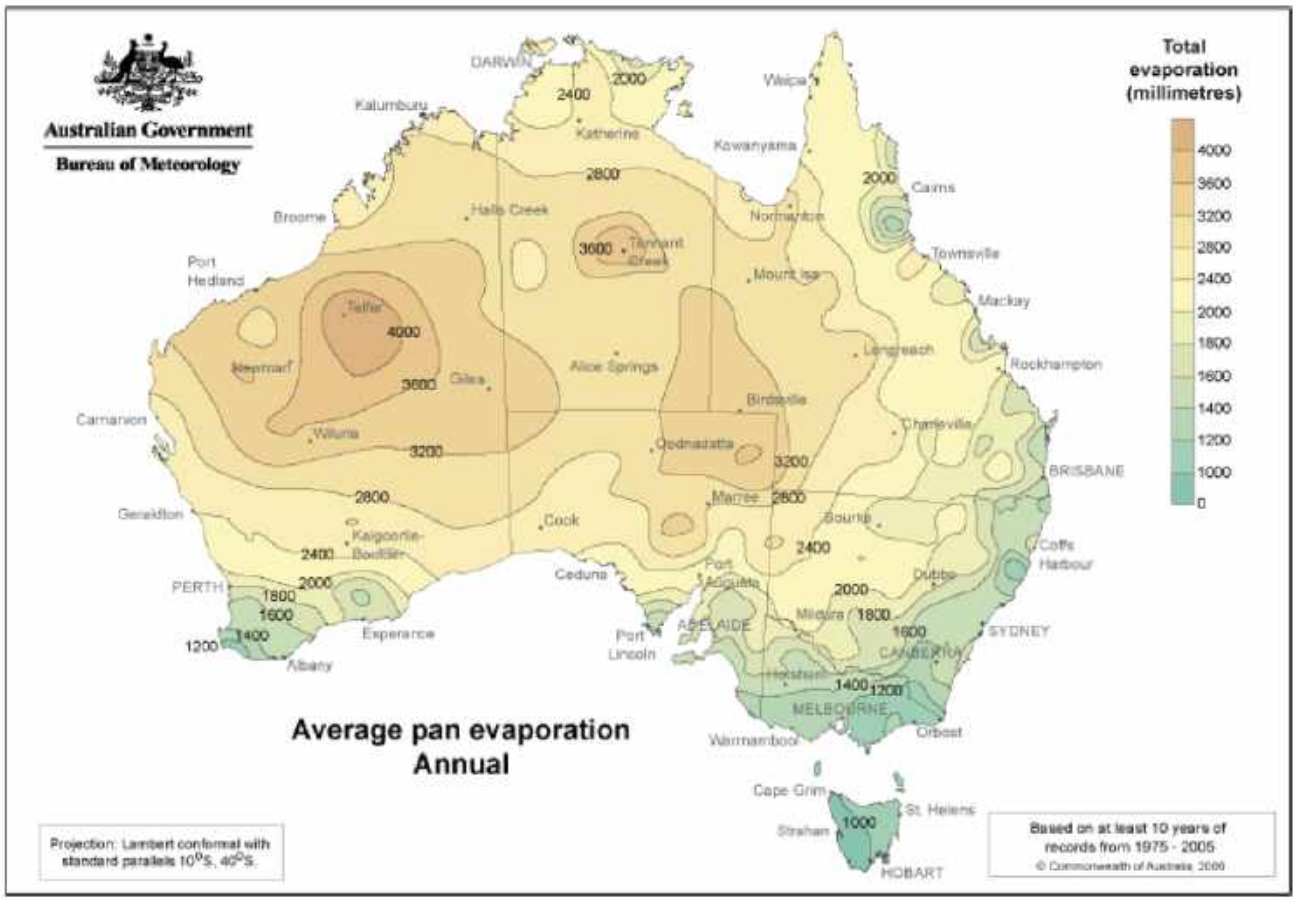

Plate 9-3: Average Pan Evaporation (BoM 2025)

Flooding risk at Bundarra has been estimated from rainfall intensity-frequency-duration design rainfall data provided by BoM for the local coordinates. The probability of a particular rainfall depth for a specified duration being equalled or exceeded in any 1-year period can be expressed as a percentage (the Annual Exceedance Probability or AEP). AEP rainfall events for Bundarra have been summarised in Table 9-3 below, demonstrating that the 'worst case' flood event (1% AEP 72 hours) is just under 200 mm.

Table 9-3: AEP Rainfall Events

Duration	Rainfall (mm)			
	50% AEP	20% AEP	10% AEP	1% AEP
1 hour	13.9	22.1	28.6	55.4
24 hours	37.0	58.3	74.4	136
48 hours	42.9	68.4	88.0	165
72 hours	45.2	72.9	94.4	182

9.4 Landscape

9.4.1 Bioregion

The Interim Biogeographic Regionalisation of Australia divides Australia into 89 bioregions based on major biological, geographical and geological attributes. These bioregions are subdivided into 419 subregions as part of a refinement of the framework (Thackway & Cressdell 1995). Bundarra occurs within the Eastern Murchison subregion of the Murchison bioregion which is characterised as Mulga low woodlands, often rich in ephemerals, on outcrop and fine-textured Quaternary alluvial and eluvial surfaces mantling granitic and greenstone strata of the northern part of the Yilgarn Craton (Thackway & Cressdell 1995). The Eastern Murchison subregion and proposed clearing footprint is located within the 'extensive land use zone' which is an expansive tract of native vegetation with low fragmentation.

9.4.2 Land Uses

The dominant land uses in the Shire of Leonora include pastoral leases, unallocated crown reserves, mining leases, conservation reserves and Aboriginal communities. The Goldfields Highway traverses the centre of Bundarra with tenement conditions restricting excavation approaching the highway reserve. An abandoned Aboriginal community known as Corringie is located approximately 1.7 km northwest of the proposed premises boundary.

Bundarra is located on both Tarmoola (N049945) and Weebo (N049440) pastoral stations. Tarmoola Station homestead is located approximately 41 km south and Weebo Station homestead is located approximately 38 km north. Stock route (R 17398) interacts with the eastern side of M 37/513 with consent to mine granted for activities not restricting the use of the reserve. Mining activities occur alongside pastoral activities, and Northern Star engages regularly with pastoral leaseholders.

There are no ecologically sensitive areas (ESAs) located within the proposed premises boundary. The nearest ESA is associated with Wanjarri Nature Reserve which is located 105 km northwest of Bundarra. Surrounding land uses are shown in Figure 4.

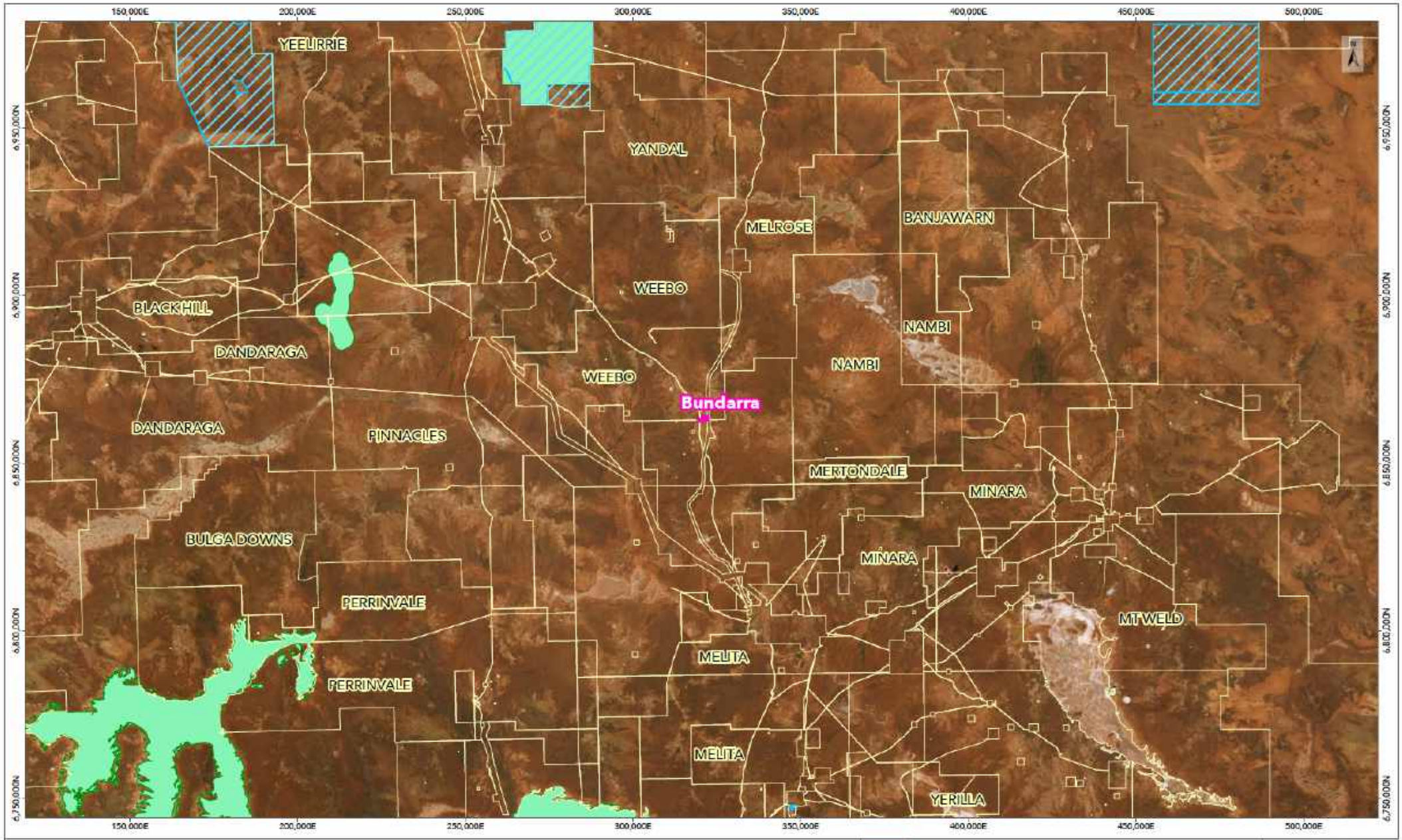

Figure 4: Surrounding Land Uses

Bundarra Works Approval Application Supporting Attachments

Prescribed Premises Boundary

Environmentally Sensitive Areas (DWER-046)

Pastoral Stations (DPLH-083)

Legislated Lands and Waters (DBCA-011)

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:1,500,000 |

0 30 60km

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9.4.3 Regional Soils

The East Murchison subregion is characterised as having internal drainage with soils that are typically shallow earthy loam overlaying red-brown hardpan, shallow stony loams on hills and red sand on sand plains (Beard, 1990). Regional soils mapping shows Bundarra occurs across three soil systems as detailed in Table 9-4 and shown in Figure 5. Wonder North and West Pits are predominantly located in the Gransal System whilst Celtic Pit is located across the Hamilton and Nubev systems. These soil systems are widespread and not associated with notable topographic landforms.

Table 9-4: Soil Landscape Systems

System Name	Description
Gransal	Stony plains and low rises based on granite supporting mainly halophytic low shrublands.
Hamilton	Hardpan plains, stony plains and incised drainage lines supporting mulga tall shrublands.
Nubev	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands.

9.4.4 Soil Characterisation

Limited soil materials from Celtic and Wonder were characterised as part of the original mining proposal submissions. Soils and subsoils from 0 – 2 m depth were collected and analysed for a range of physiochemical parameters including pH, electrical conductivity (EC), cation exchange capacity (CEC), total dissolved solids (TDS) and metals. All surface soils were classified as 'desirable' for rehabilitation and were recommended for collection and storage for use on outer surfaces of landforms. No soils characterisation was undertaken as part of the Wonder Underground mining proposal as no new disturbance was required, and accordingly no topsoils were stripped. Topsoils are stockpiled away from mining activities and will not be impacted by the proposed activities.

Figure 5: Soil Landscape Systems

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements
Prescribed Premises Boundary
Gransal System
Hamilton System
Nubev System

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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9.5 Geology

Within the greater Bundarra region, the Archaean stratigraphic succession is dominated in the east by mafic granitoids on the western edge of the Bundarra Batholith, which host numerous partially assimilated Archaean greenstone rafts. The mafic granitoids intrude basalts and gabbros, and felsic volcanics. The felsic sequence which is part of the Teutonic Bore belt overlies the older mafic sequence on the western side. Bundarra is moderately-to-strongly weathered with the base of complete oxidation extending to maximum depths of 70m. All existing pits are deeper than this and extend into fresh rock material.

9.5.1 Waste Characterisation

In 2023, 62 samples were selected from eight drill holes to represent the five waste lithologies from the proposed Wonder Underground mine as detailed in Table 9-5 below. Samples were assessed for salinity, acid generation potential and metalliferous enrichment. All waste samples were fresh rock and therefore no stability assessment was required given the minimal risk of erosion.

Table 9-5: Wonder Underground Waste Sampling

Lithology	Volume (m^3)	Tonnes	%	# Samples
Andesite	19,499	52,453	2.04	4
Basalt	69,702	186,342	7.25	14
Lamprophyre	31,365	85,940	3.34	7
Tonalite	805,844	2,175,318	84.62	31
Vein	26,503	70,763	2.75	6
Total	**952,913**	**2,570,816**	**100**	**62**

The results of the 2023 waste characterisation determined that all samples across lithologies were assessed as low acid mine drainage (AMD) risk waste types with no specific handling requirements. AMD status was determined based upon Total S (%), net acid generation (NAG) pH and net acid production potential (NAPP), with all lithologies categorised as not acid forming (NAF) as outlined in Table 9-6 below.

Table 9-6: Wonder Underground AMD Status

Lithology	Total S %	NAG pH	(-ve) NAPP	AMD Status
AMD Criteria	> 0.2	< 4.5	> 0	PAF
Andesite	0.01 - 0.10	7.4 - 8.1	28.7 - 229.1	NAF
Basalt	<0.01 - 0.22	6.5 - 8.4	5.6 - 94.6	NAF
Lamprophyre	<0.01 - 0.68	7.4 - 9.0	18.0 - 250.0	NAF
Tonalite	<0.01 - 0.42	6.8 - 8.7	8.5 - 72.8	NAF
Vein (ore)	<0.01 - 0.77	5.9 - 8.2	0 - 64.6	NAF

Asbestiform minerals may be constituents of mafic and ultramafic rocks (i.e. magnesium enriched) and include six different varieties (Chrysolite, Amosite, Crocidolite, Anthophyllite, Actinolite, Tremolite) across the Serpentine and Amphibole mineral groups. Mine waste from Wonder Underground is predominantly Tonalite which is felsic and is not predisposed to containing asbestiform minerals. There are no ultramafic rocks present which have higher risk of containing asbestiform minerals. Basalt is a mafic rock which may contain amphiboles, however based upon drilling of Wonder North and Wonder West Pits no fibrous minerals have been logged in any basalt samples, and fibrous risk is considered very low.

Overall, waste rock lithologies are considered geochemically benign and crushing and screening of waste rock is unlikely to present any adverse environmental or health risks.

9.6 Biodiversity

9.6.1 Biological Surveys

Biological surveys were undertaken to support the original approvals of Celtic and Wonder approximately 25 years ago. A more recent survey undertaken by Botanica Consulting was commissioned by Northern Star over all of Bundarra and some surrounding tenure in 2022. This included both a reconnaissance flora and vegetation assessment and basic fauna assessment.

9.6.2 Regional Vegetation

Vegetation within the Bundarra is mapped as regional vegetation association Laverton 28 – Low woodland, open low woodland or sparse woodland. This association is largely intact with over 98% of pre-European vegetation remaining according to the 2018 Statewide Vegetation Statistics (DBCA 2019). Pre-European vegetation extent is summarised in Table 9-7 below and shown in Figure 6.

Table 9-7: Pre-European Vegetation Extent

Association	Pre-European area (ha)	Current extent (ha)	Extent remaining (%)	DBCA managed (ha)	DBCA managed (%)
Murchison Bioregion	28,120,586	28,044,823	99.73	2,185,987	7.77
Beard Vegetation Association - State					
Laverton 28	133,739.72	131,531.31	98.35	-	-
Beard Vegetation Association - Local					
Laverton 28	126,344.70	124,136.29	98.25	--	

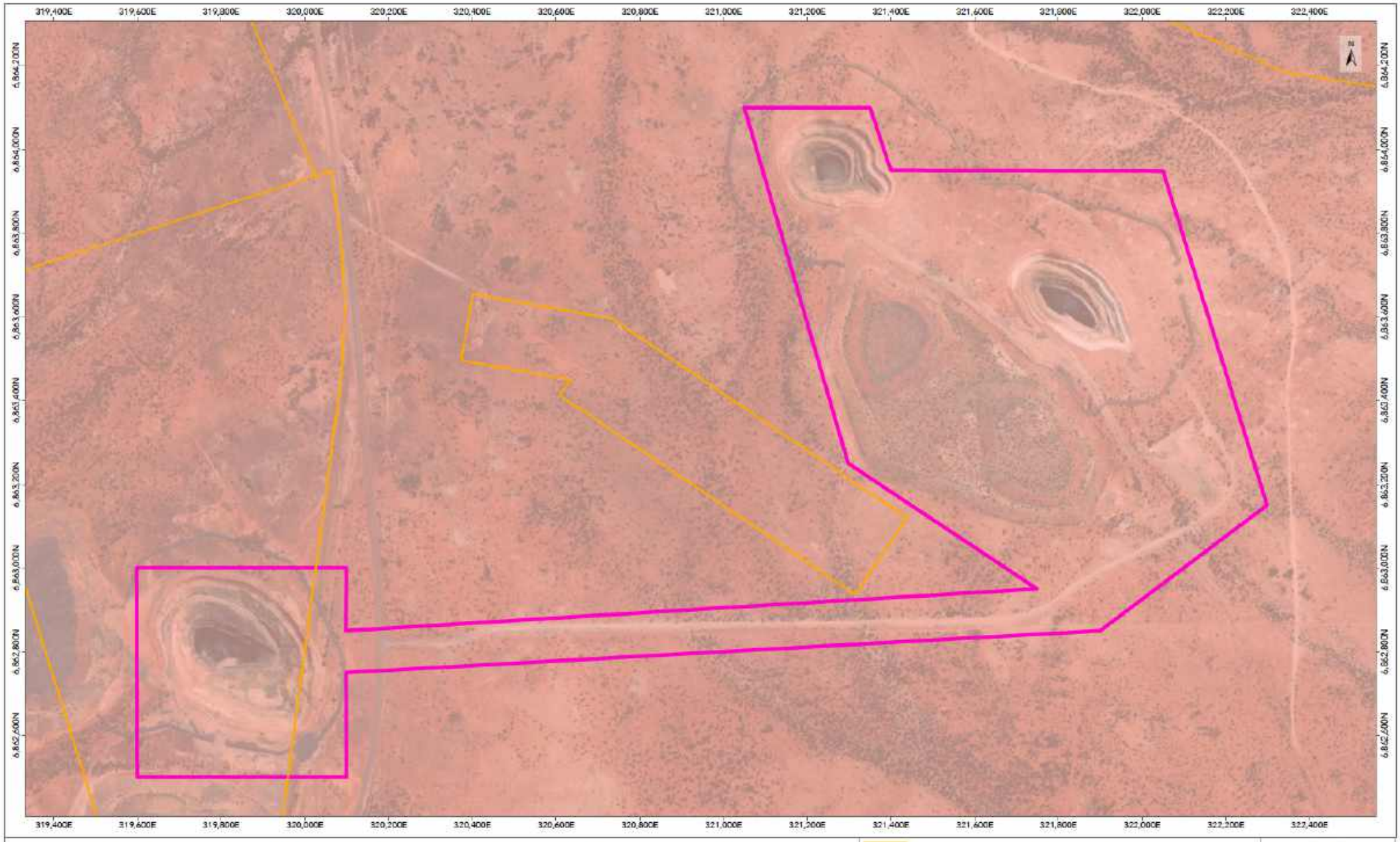

Figure 6: Pre-European Vegetation

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements

Prescribed Premises Boundary

Laverton 28

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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9.6.2.1 Vegetation Communities

Vegetation communities were identified and described using quadrats to take representative samples of different vegetation present. Eight vegetation communities were recorded within Bundarra survey area (Botanica 2022). A summary of mapped vegetation communities is provided in Table 9-8 below. The proposed prescribed premises boundary is mostly situated within existing cleared land but also contains vegetation communities OD-AFW1 and RP-AFW1 (both *Acacia* woodland variants), which were most widespread across the broader survey area.

None of these vegetation communities are analogous to threatened ecological communities (TEC) or priority ecological community (PEC) (Botanica 2022). The nearest PEC is located 35 km northeast of Bundarra, the Nambi calcrete groundwater assemblage type on Carey palaeodrainage on Nambi Station. According to the Atlas of Groundwater Dependent Ecosystems database (BoM, 2022b) there are no known or potential aquatic or terrestrial groundwater dependent ecosystems located within Bundarra.

Table 9-8: Vegetation Communities

Vegetation Code	Description
B-AFW1	Low woodland of *Acacia caesaneura / A. incurvaneura* over mid open shrubland of *Dodonaea adenophora* and low shrubland of *Ptilotus obovatus* on breakaway.
B-MWS1	Mid open mallee woodland of *Eucalyptus carnei* over mid open shrubland of *Scaevola spinescens* and low open samphire shrubland of *Tecticornia indica subsp. bidens* on breakaway.
OD-AFW1	Low open woodland of *Acacia aptaneura* over tall open shrubland of *Acacia tetragonophylla* in open depression.
OD-EW1	Mid open woodland of *Eucalyptus camaldulensis* over tall open shrubland of *Hakea recurva subsp. recurva* in open depression.
OD-MWS1	Mid open mallee woodland of *Eucalyptus lucasii* over low open woodland of *Acacia aptaneura* and tall open shrubland of *Acacia tetragonophylla* in open depression.
RP-AFW1	Low woodland of *Acacia quadrimarginea* over low shrubland of *Eremophila forrestii subsp. forrestii* and low open tussock grassland of *Aristida contorta* on rocky-plain.
RP-AOW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Cratystylis subspinescens / Maireana sedifolia* on quartz-rocky plain.
RS-AFW1	Low woodland of *Acacia incurvaneura* over low open chenopod shrubland of *Maireana triptera* on rocky hillslope.

9.6.2.2 Vegetation Condition

Vegetation condition across the broader Bundarra area was mapped by Botanica as cleared to very good, as detailed in Table 9-9 below. Most vegetation in the broader area was in very good condition despite previous mining and exploration activities occurring within Bundarra, demonstrating resilience to environmental threats. The proposed prescribed premises is sited within predominantly cleared areas as shown in Figure 8, with a small portion of good vegetation.

Table 9-9: Vegetation Condition

Vegetation Condition	Survey Area (ha)	% of Survey Area
Very Good	349	13
Good	2,131	81
Cleared	167	6
Total	**2,647**	**100**

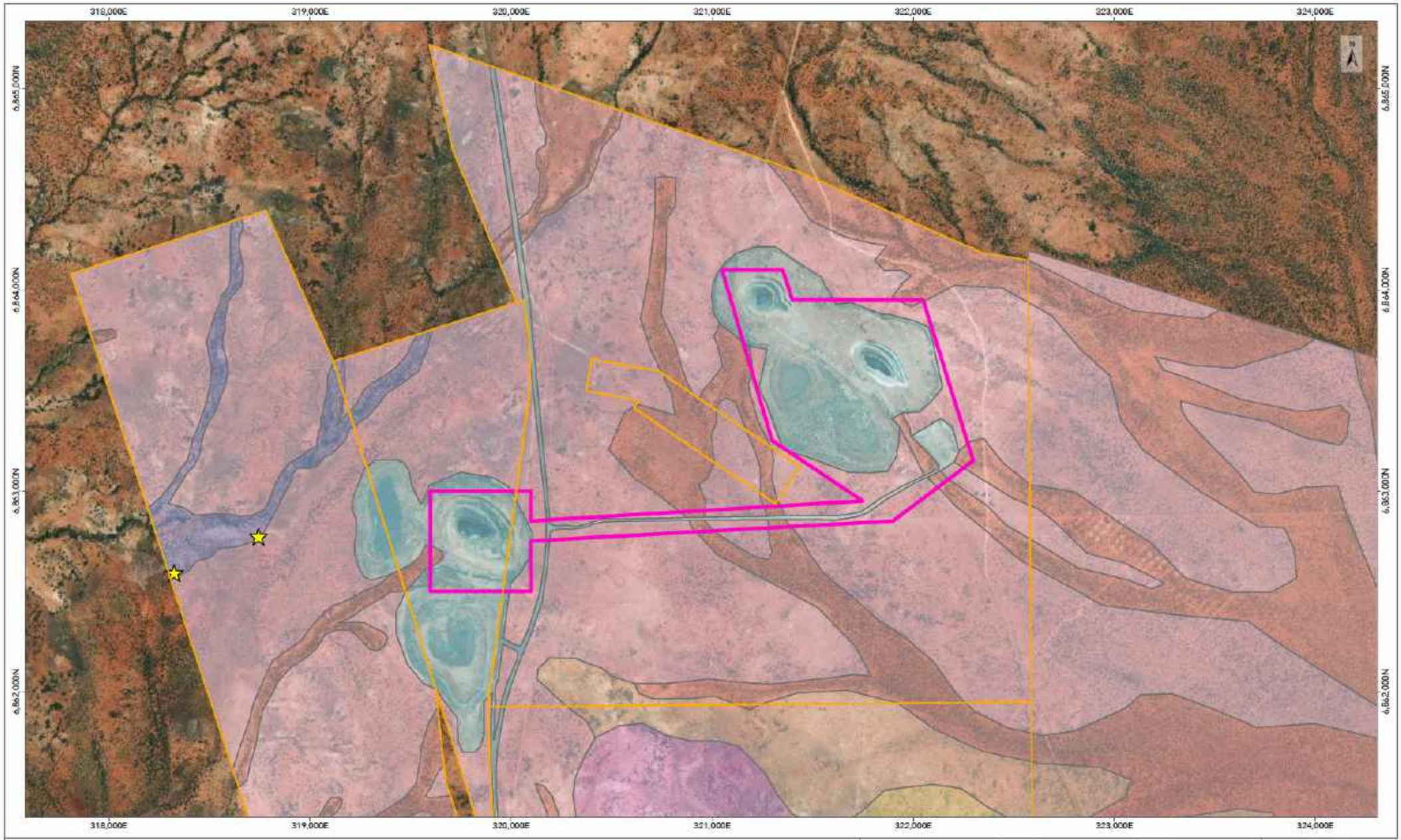

Figure 7: Vegetation Communities

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Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:25,000 |

0 0.5 1km

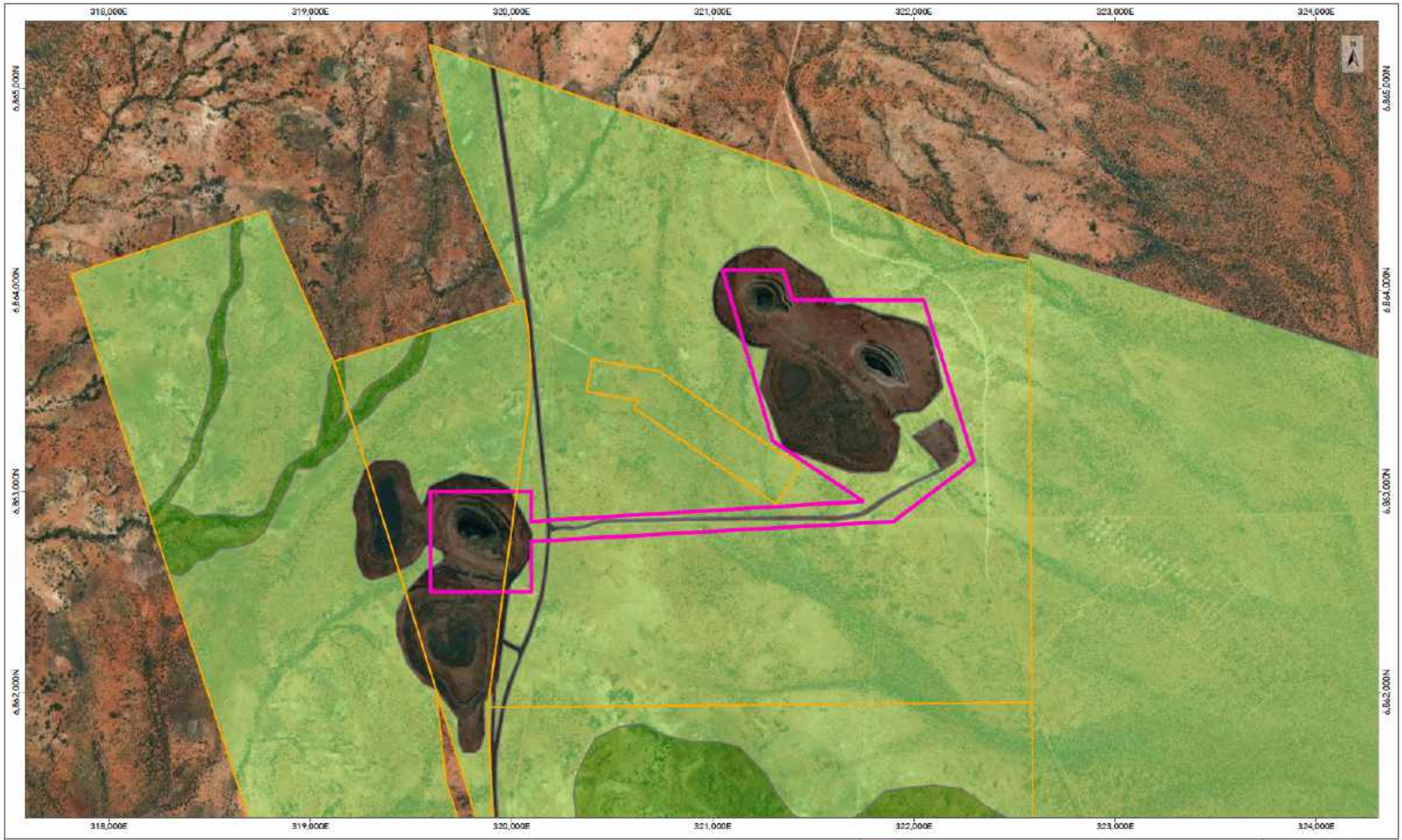

Figure 8: Vegetation Condition

Bundarra Works Approval Application Supporting Attachments

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:25,000 |

9.6.3 Flora

82 flora taxa were recorded in the Bundarra survey area, representing 26 families and 45 genera, the most common of which being *Acacia*, *Eremophila* and *Marieana*. Three introduced flora were recorded (Paddy Melon, Wild Sage and Buffel Grass), of which none were listed as a Declared Plant Pest or Weed of National Significance (Botanica 2022).

9.6.3.1 Significant Flora

Based upon desktop searches with a 40 km radius, 12 flora taxa of conservation significance were identified in the vicinity of the Bundarra survey area (Botanica 2022). Of these 12, one was listed as Threatened under the BC Act, four were listed as Priority (P) 1, five were listed as P3 and two were listed as P4. Of these species, *Hemigenia exilis* (P4) was found within the during the field survey. A total of 15 plants were recorded in an area in the western extent of M 37/638, which has been excluded from the proposed premises boundary and will not be impacted by proposed activities.

9.6.4 Fauna

Based upon desktop searches of the Bundarra survey area, 210 species of vertebrate fauna had the potential to occur of which nine species were recorded during the field assessment (Botanica 2022). Three of these species were mammals, five were birds and one was a reptile. Two introduced fauna species were observed, rabbit and cattle.

Based upon desktop searches, eight conservation significant terrestrial fauna were found as being previously identified within the regional area (Botanica 2022). No conservation significant fauna species were found within the field survey, and a significant fauna assessment following the survey is summarised in Table 9-10 below. In summary, no significant fauna are considered likely to utilise the prescribed premises area.

Table 9-10: Significant Fauna Assessment

P = Priority, VU = Vulnerable, MI = Migratory, OS = Other Species. Accurate as of November 2024

Species Name	Common Name	Conservation Status			Revised Assessment	Likelihood
		BC Act	EPBC Act	DBCA Priority		
Dasyurus geoffroii	Chuditch	VU	VU	-	No known records within 130 km of the survey area. Considered to be locally extinct. Suitable habitat unlikely to be present.	Unlikely
Falco hypoleucos	Grey Falcon	-	VU	-	Nearest known record located approximately 80 km southeast of the survey area (recorded in 1996). Potential for individuals to occur aerially over the survey area however generally uncommon and suitable breeding habitat unlikely.	Unlikely
Falco peregrinus	Peregrine Falcon	OS	-	-	Previously recorded approximately 30 km south-east of the survey area (recorded in 1978). Potential for individuals to occur aerially over the survey area however suitable breeding habitat unlikely to be present.	Unlikely
Leipoa ocellata	Malleefowl	VU	VU	-	Previously recorded approximately 30 km north-west of the survey area. Habitat largely unsuitable due to low density, and no evidence of Malleefowl in survey area.	Possible
Macrotis lagotis	Greater Bilby	VU	VU	-	Previously recorded approximately 20 km west of the survey area (recorded in 1981). Considered to be locally extinct. Suitable habitat unlikely to be present.	Unlikely

Species Name	Common Name	Conservation Status			Revised Assessment	Likelihood
		BC Act	EPBC Act	DBCA Priority		
Polytelis alexandrae	Princess Parrot	-	VU	P4	Previously recorded approximately 115 km north-west of the survey area (recorded in 1964). Suitable habitat unlikely to be present.	Unlikely
Migratory birds (various species)		MI	MI	-	No suitable habitat (wetlands) present within the survey area.	Would not occur

9.6.4.1 *Fauna Habitat*

Five fauna habitat types were mapped within the broader Bundarra survey area, as detailed in Table 9-11 below and shown in Figure 9 (Botanica 2022). Broad habitat values observed included shelter, foraging and food sources, however these values varied across vegetation associations. The breakaway vegetation was identified as potentially locally significant habitat due to potential refuge it provides for fauna (Botanica 2022), this habitat type has been excluded from the proposed prescribed premises boundary and will not be impacted by proposed activities.

Table 9-11: Fauna Habitats

Habitat Type	Habitat Description	Habitat Values	Example Image
Breakaway: Acacia / Mallee Woodland (10.4%)	Mulga / Mallee Woodland over low mixed shrubland on breakaway	◤ Ground not suited to burrowing species. ◤ Potential refuge for small fauna under rocks / with breakaway crevices. ◤ Low diversity vegetation strata. ◤ Low vegetation density and leaf litter.	
Drainage Line: Acacia / Mallee Woodland (21.5%)	Mulga / Mallee Woodland over low mixed shrubland in ephemeral drainage line	◤ Ground well suited to burrowing species. ◤ Moderate diversity vegetation strata supporting avifauna assemblage. ◤ Moderate vegetation density and leaf litter. ◤ Potential freshwater source during floods.	

Habitat Type	Habitat Description	Habitat Values	Example Image
Drainage Line: Eucalypt Woodland (0.3%)	River Red Gum Woodland over low mixed shrubland in ephemeral drainage lime	◤ Ground well suited to burrowing species. ◤ Moderate diversity vegetation strata supporting avifauna assemblage. ◤ Moderate vegetation density and leaf litter ◤ Potential freshwater source during floods.	
Rocky Hillslope: Acacia Woodland (1.4%)	Mulga Woodland over low open bluebush shrubland on rocky hillslope	◤ Ground not particularly suited to burrowing species. ◤ Potential refuge for small fauna under rocks ◤ Low diversity vegetation strata ◤ Low vegetation density and leaf litter	

Habitat Type	Habitat Description	Habitat Values	Example Image
Rocky Plain: Acacia Woodland (60.2%)	Mulga / Acacia Woodland over mixed Chenopod shrubland and tussock grassland on rocky plain	◤ Ground not particularly suited to burrowing species. ◤ Low diversity vegetation strata ◤ Low vegetation density and leaf litter.	

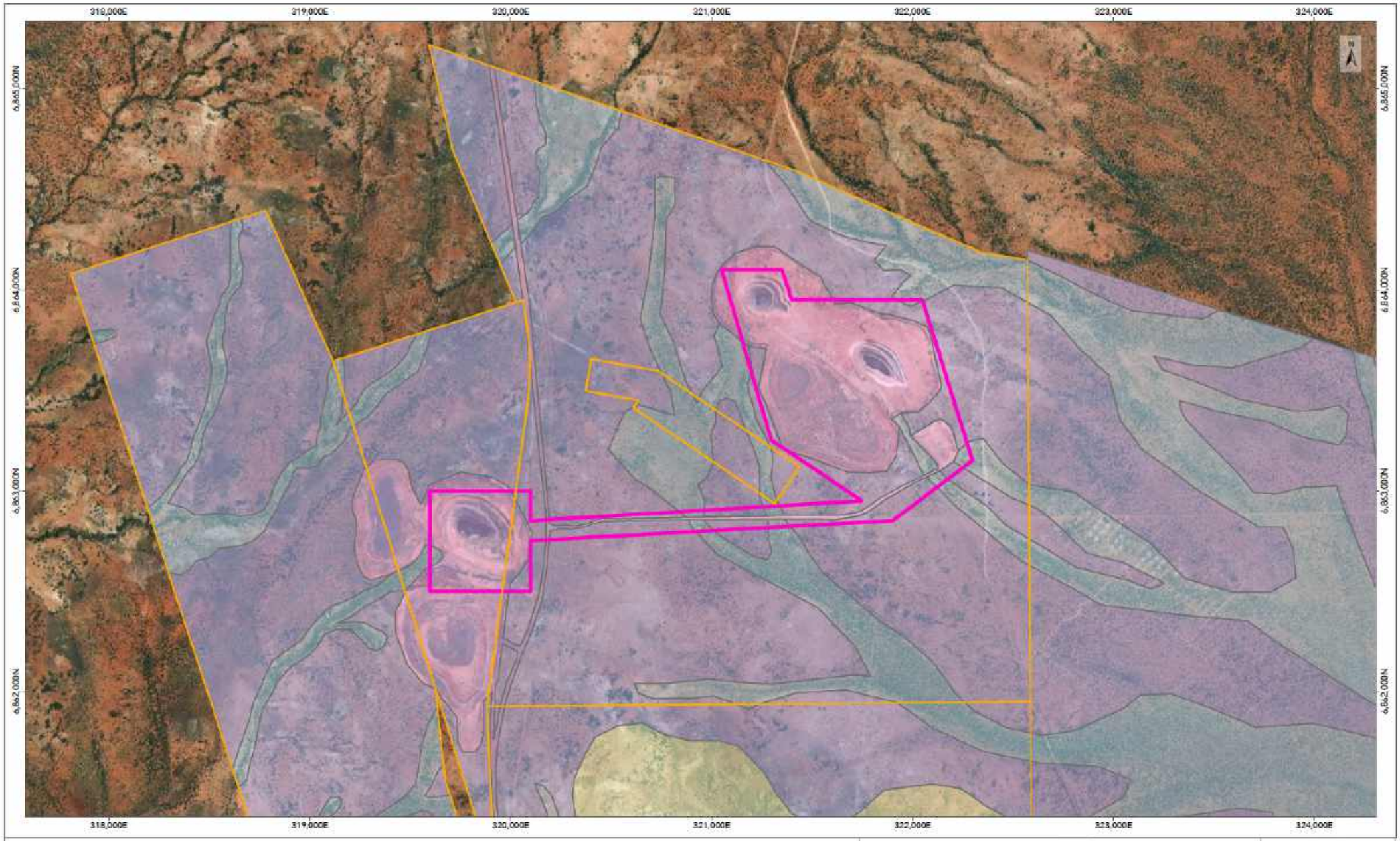

Figure 9: Habitat Types

Bundarra Works Approval Application Supporting Attachments

Date: 20/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:25,000 |

9.7 Hydrology

9.7.1 Surface Water

Bundarra is located within the Raeside-Ponton regional catchment area. The region is defined by ephemeral drainage lines which internally drain towards playa lake systems following large rainfall events and associated paleodrainage systems (Cowan, 2001). There are no permanent or semi-permanent surface water bodies within the regional vicinity of Bundarra. Surface water ponding following high rainfall events temporarily concentrates around drainage lines before evaporating.

Bundarra sits across several local catchment areas (i.e. Celtic and Wonder are within separate catchments). Drainage flows to the west and southwest adjacent to Celtic, and to the southeast adjacent to Wonder, with downstream surface flows ultimately reporting to Lake Raeside. An ephemeral watercourse traverses the proposed prescribed premises across the access road between Goldfields Highway and Wonder North Pit as shown in Figure 10. Proposed activities excluding the dewatering pipeline between Celtic and Wonder North Pit are located well away from this drainage line and will not impact on downstream receptors.

9.7.1.1 Flood Risk Management

A surface water assessment was undertaken for Wonder by Rockwater (2023a) prior to commencement of underground mining. This assessment looked at the site topography, local catchment boundaries and predicted rainfall events to determine flooding risk to mine infrastructure.

Mining infrastructure at Wonder is located within an existing abandonment bund which prevents inflow from surrounding ephemeral drainage lines. Surface drainage is diverted around this abandonment bund. A 1:100-year flood event is predicted to have a maximum depth of 0.39 m which will not exceed the abandonment bund height (1.5 m) (Rockwater 2023a). This abandonment bund also acts to protect surrounding vegetation from the proposed activities and will ensure that tailings stockpiles are protected from stormwater runoff.

Figure 10: Surface Water Features

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements

Prescribed Premises Boundary

Watercourses (Geodata Topo 250K)

Date: 19/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:50,000 |

0 1 2km

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9.7.2 Groundwater

Bundarra is located within the Raeside subarea (fractured rock) of the Goldfields Groundwater Area pursuant to the RIWI Act, and accordingly groundwater licenses are required to abstract groundwater. The nearest public drinking water source area known as Leonora Water Reserve is located approximately 37 km south of Bundarra and will not be impacted by proposed activities.

Groundwater in the North-Eastern Goldfields occurs throughout the region within sparse fractures in basement rocks, within the weathering profile, and in alluvial sediments. The regional water table is sub-parallel to the topography, below which is a saturated zone with a lower limit ranging from 30 to 100 m depending on underlying geology (Johnson et al. 1999). Groundwater recharge occurs from major, but infrequent, rainfall events, mainly on drainage divides, and locally at site specific intake areas such as drainage lines or sand plains and dune fields. Groundwater recharge is a very small proportion of rainfall (less than 1%) (Johnson et al. 1999).

The region generally has low permeability; however, weathered zones and fractures within the basement rocks can offer greater permeability and the presence of locally significant groundwater volumes. Shallow alluvial cover and deeper palaeochannels overlying the basement rocks are recognised as locally important aquifers (Allen, 1994).

9.7.2.1 Local Groundwater

Local groundwater conditions of Wonder were characterised by Rockwater (2023) to inform underground mining activities. Prior to underground mining activities, both Wonder West and Wonder North Pits formed groundwater lakes with groundwater levels were between 32 to 37 m below ground level. Based on the recorded water intersections in drillholes and experience at other sites, there is likely to be little permeability below 220 m depth, and consequently highest flow rates are expected to be in the first two years of mining (Rockwater 2023). Hydraulic conductivity is expected to be low, at maximum 1.7 cm / day (Rockwater 2023).

Groundwater conditions of Bundarra pits are summarised in Table 9-12 below, as reported in the triennial groundwater licence report for GWL 170438 (Saprolite 2024). Water quality from all pits is slightly alkaline, and brackish (Wonder North and West Pits) to saline (Celtic Pit). Compared to the ANZECC 2000 Livestock drinking water guideline, Wonder North Pit (abstraction pit) only slightly exceeded the TDS and Sulphate guideline values. All other parameters were below guideline values, indicating that water quality is unlikely to present significant environmental risks. Water quality in Wonder North Pit is roughly equivalent to Wonder West Pit, and of better quality than Celtic Pit, and therefore there are no hydrological risks associated with discharging into these pits.

Table 9-12: Pit Groundwater Quality

Parameter	Units	Celtic Pit (June 2024)	Wonder North Pit (April 2023)	Wonder West Pit (June 2024)	ANZECC 2000 (Livestock)
pH	-	8.12	8.31	8.10	6.5 – 8.5
EC	µS / cm	27,500	11,900	10,400	-
TDS	mg / L	**21,300**	**6,970**	**6,440**	4,000
Sulphate (SO_4)	mg / L	-	**1,200**	903	1,000
Calcium (Ca)	mg / L	-	152	185	1,000
Aluminium (Al)	mg / L	-	0.54	<0.01	5
Arsenic (As)	mg / L	-	0.003	0.002	0.5
Cadmium (Cd)	mg / L	-	<0.001	<0.001	0.01
Colbalt (Co)	mg / L	-	0.002	<0.001	1
Chromium (Cr)	mg / L	-	0.003	<0.001	1
Copper (Cu)	mg / L	-	0.002	0.002	1
Nickel (Ni)	mg / L	-	0.004	0.003	1
Lead (Pb)	mg / L	-	<0.001	<0.001	0.1
Selenium (Se)	mg / L	-	<0.01	<0.01	0.02
Zinc (Zn)	mg / L	-	0.009	0.009	20

9.7.2.2 *Dewatering*

A simple groundwater model was constructed by Rockwater (2023b) of the Wonder area to estimate dewatering flows during planned underground mining operations. The model included a sensitivity analysis where hydraulic conductivity and specific yield assumptions were halved (low flow) and doubled (high flow). The results of the model are summarised in Table 9-13 below, indicating dewatering requirements are likely to be a conservative maximum 839,500 kL in the second year of mining (or 26.5 L / s).

Table 9-13: Estimated Dewatering Rates

Year of Mining	Estimated Dewatering (kL/annum)		
	Low Flow	Medium Flow	High Flow
1	248,200	448,950	824,900
2	211,700	427,050	839,500
3	164,250	324,850	627,800
4 – 10	116,800	233,600	459,900

Groundwater-level drawdowns from dewatering are expected to extend about 1 km from underground workings. There are no known groundwater dependent ecosystems that could be affected by the dewatering; and the nearest pastoral bore (Bundarra Homestead bore), 2.4 km north-west of Wonder North Pit, is very unlikely to be impacted. The final mine void will be a permanent groundwater sink. Water in the pit lake will gradually increase in salinity, but there will be no seepage from the pit lake into the surrounding groundwater.

9.8 Heritage

9.8.1 Native Title

Bundarra is located within Darlot Native Title Determination (WCD2022/002) which was determined on 05/07/2022. Watarra Aboriginal Corporation is the Registered Native Title Body Corporate (RNTBC) responsible for managing the Determination. Northern Star are currently in negotiations with Watarra Aboriginal Corporation RNTBC for a land use agreement over Thunderbox tenements. Notwithstanding, all planned new land disturbances are referred for prior heritage surveys and clearance to ensure Aboriginal Heritage is protected.

9.8.2 Aboriginal Heritage

A review of the Aboriginal Cultural Heritage Inquiry System (ACHIS) in May 2025 identified four registered and 20 lodged Aboriginal Sites interacting with tenements M 37/350 and M 37/513 as outlined in Table 9-14 and shown in Figure 11. Not all sites are located within the proposed prescribed premises boundary, and that some of these sites have large buffers shown on ACHIS to protect the specific site locations. Section 18 approval was utilised by previous proponents of Celtic and Wonder to impact all of these registered sites, as well as lodged site 22448.

Table 9-14: Aboriginal Heritage Sites

Place Status	Site ID	Name	Place Type	Tenement(s)
Registered	15968	Leonora NW 02	Artefacts / Scatter	M 37/350
	15969	Leonora NW 03	Creation / Dreaming Narrative; Other	M 37/350, M 37/513
	15970	Leonora NW 04	Ritual / Ceremonial; Water Source	M 37/350, M 37/513
	18622	Willow Tree Camp	Camp; Historical	M 37/513
Lodged	15967	Leonora NW 01	Artefacts / Scatter	M 37/350
	18213	Celtic Medicine	Other	M 37/350
	18626	Cultural camping site	Camp; Water Source	M 37/350
	22445	Willow Swamp	Landscape / Seascape Feature; Water Source	M 37/513
	22448	Wonder North Campsite 2	Camp; Historical	M 37/513

Place Status	Site ID	Name	Place Type	Tenement(s)
	22451	Rock Outcrop and Men's Place	Ritual / Ceremonial; Landscape / Seascape Feature	M 37/350
	22696	Wilsons Patch Isolated Artefact	Artefacts / Scatter	M 37/513
	22697	Wilson's Patch Artefact Scatter	Artefacts / Scatter	M 37/513
	22698	Wilson's Patch Rockshelter	Artefacts / Scatter; Rock Shelter	M 37/513
	22950	Celtic Mound	Landscape / Seascape Feature	M 37/350
	22951	Celtic Thicket	Landscape / Seascape Feature	M 37/350
	22954	Bush Medicine	Landscape / Seascape Feature; Plant Resource	M 37/350
	22957	Wigdon Area	Landscape / Seascape Feature	M 37/513
	22958	Granite Pillars and Waltilti Willow Swamp	Traditional Structure; Landscape / Seascape Feature; Water Source	M 37/513
	22959	Rock Holes and Nintiranyi	Traditional Structure; Landscape / Seascape Feature	M 37/513
	22960	Mulga Thicket	Landscape / Seascape Feature	M 37/350,
	22961	Celtic Mixed Trees	Landscape / Seascape Feature	M 37/513
	24482	Bundarra Yargurli	Artefacts / Scatter; Birthplace; Camp; Ritual / Ceremonial; Historical; Meeting Place; Landscape / Seascape Feature; Water Source	M 37/513
	38909	Ngununtha #2	Artefacts / Scatter; Hunting Place; Water Source	M 37/513
	38918	SAR10-02 Rock Holes Camp Site	Water Source	M 37/513

9.8.2.1 Heritage Surveys

Northern Star undertake heritage surveys with relevant Traditional Owner groups over areas planned to be impacted by mining activities to ensure that any potential heritage sites are identified and protected with appropriate measures. Northern Star understands its obligations under the *Aboriginal Heritage Act 1972* and will ensure that no Aboriginal Sites are impacted by mining activities. A heritage survey over Bundarra was completed with Traditional Owners in April 2025 – the survey report is pending however no new disturbances will occur prior to heritage clearance. Northern Star utilise a disturbance permit form procedure to ensure that no disturbance is conducted without first ensuring that the land is heritage cleared, and that all necessary government approvals have been obtained.

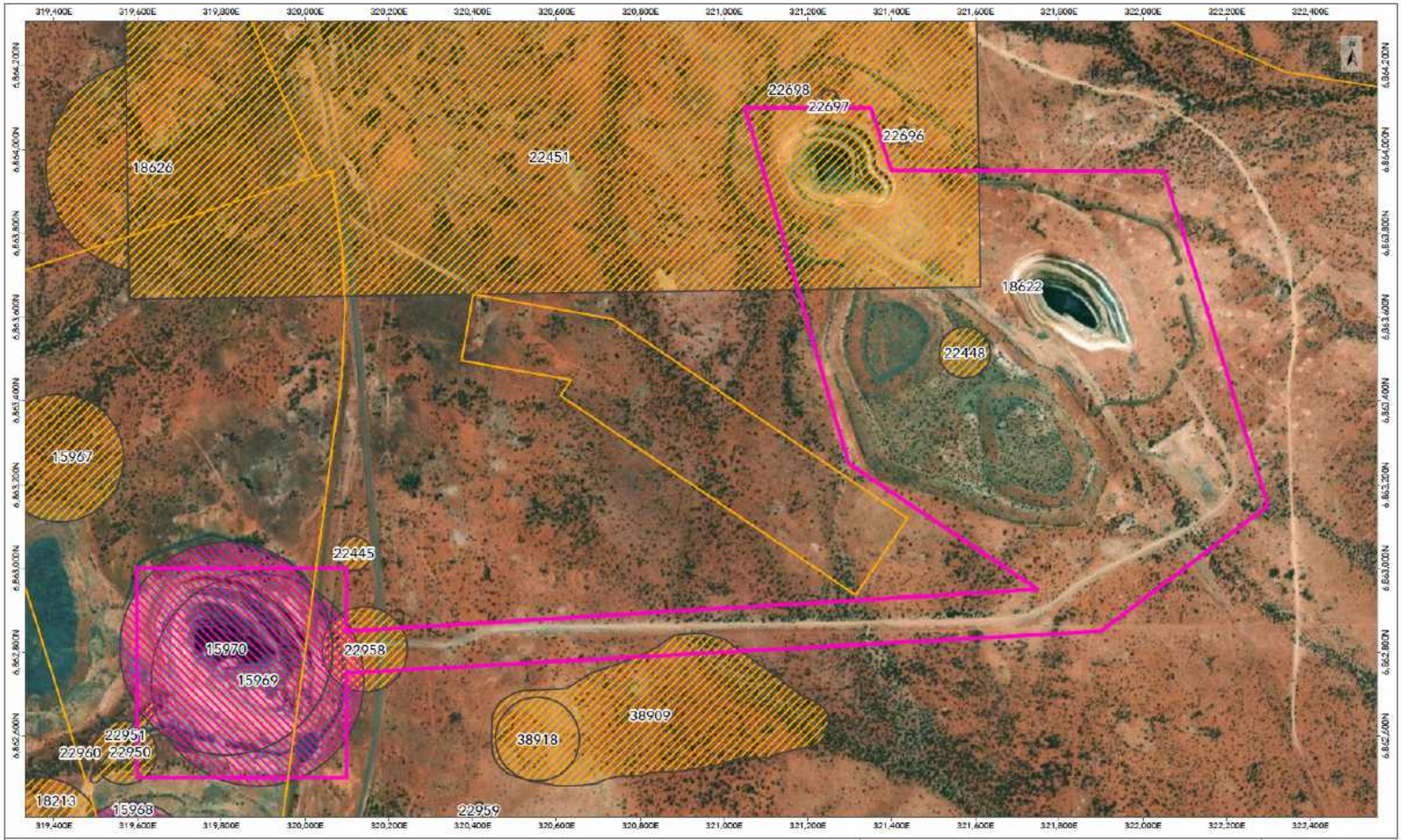

Figure 11: Aboriginal Heritage Sites

Bundarra Works Approval Application Supporting Attachments

Northern Star Tenements
Prescribed Premises Boundary
Aboriginal Cultural Heritage - Register (DPLH-099)
Aboriginal Cultural Heritage - Lodged (DPLH-100)

Date: 19/05/2025 | Author: dmartini | Coordinate System: GDA 1994 MGA Zone 51 | Scale: 1:12,000 |

0 0.25 0.5km

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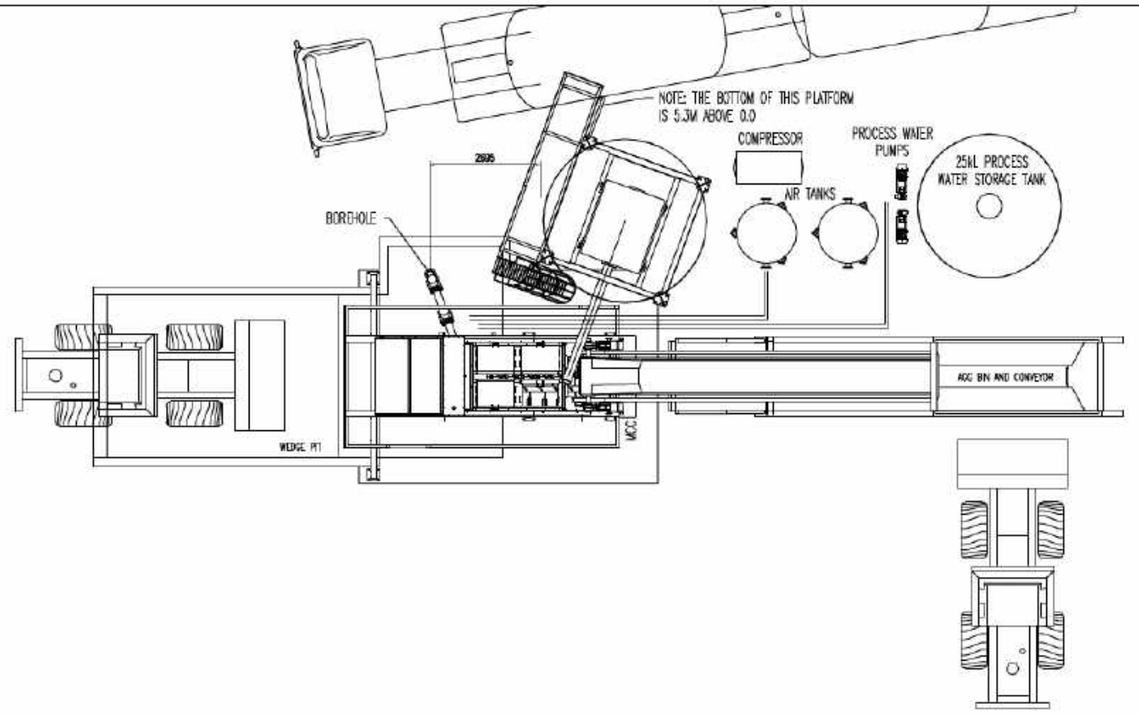
9.9 Environmental Sensitive Receptors Summary

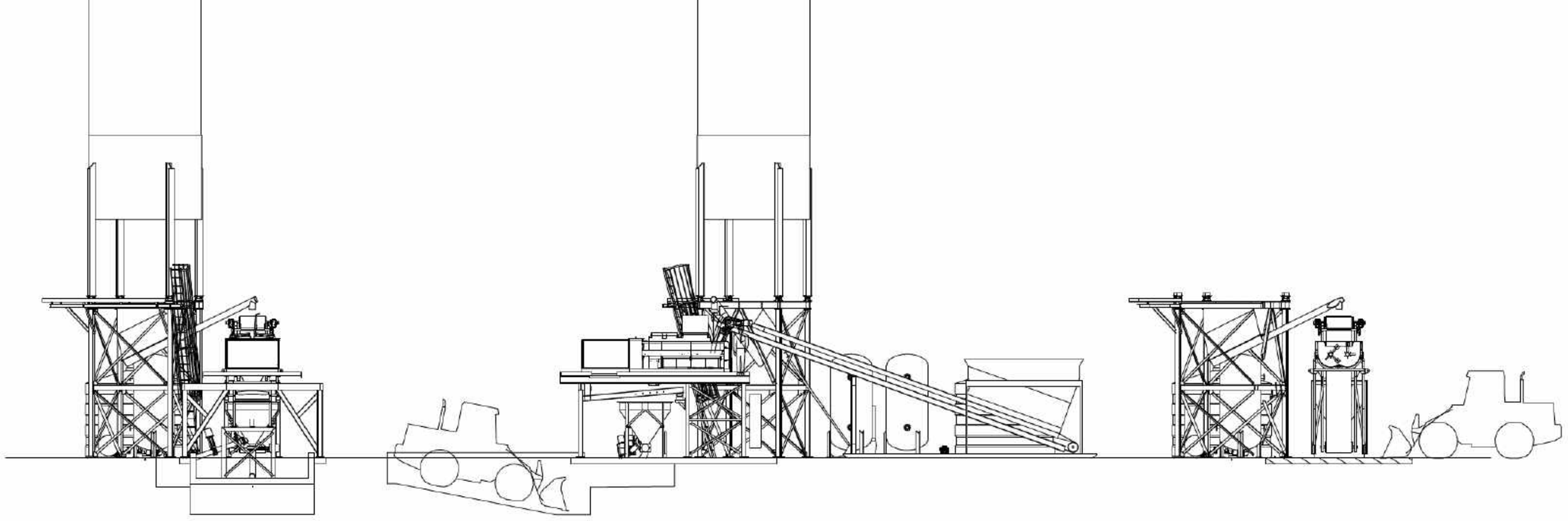
Distances and directions to nearest environmentally sensitive receptors from the proposed prescribed premises boundary have been reviewed and summarised in Table 9-15.

Table 9-15: Environmentally Sensitive Receptors

Type	Description	Distance and Direction	Proposed Controls	Data Source(s)
Environmentally Sensitive Areas	No ESAs are located within or near Bundarra.	105 km northwest	N/A – significant separation.	DWER-046
Threatened Ecological Communities	No TECs are located within or near Bundarra.	105 km northwest	N/A – significant separation.	DWER-038 Botanica (2022)
Threatened and / or Priority fauna	No Threatened or Priority fauna within prescribed premises boundary.	2,000 m north (database record 91,496 – migratory bird)	N/A – no threatened or priority fauna likely within proposed prescribed premises.	DBCA-037 Botanica (2022)
Threatened and / or Priority flora	Priority species *Hemigenia exilis* (P4) is located within Bundarra tenements but not within the proposed prescribed premises.	850 m west	Prescribed premises boundary has been restricted to exclude priority flora locations.	DBCA-036 Botanica (2022)
Aboriginal and other heritage sites	Multiple registered and lodged sites interact with the proposed prescribed premises tenements.	0 m	Heritage surveys occur prior to any new planned disturbance – heritage survey report for Bundarra is pending.	ACHIS 2025 Internal records
Public drinking water source areas	Leonora Water Reserve is the nearest proclaimed public drinking water source area.	37 km south	N/A – significant separation.	DWER-033
Rivers, lakes, oceans, and other bodies of surface water, etc.	Ephemeral watercourses reporting to Sullivan Creek traverse the proposed prescribed premises boundary.	0 m	Paste plant and tailings stockpiles located within existing abandonment bund away from drainage lines. Pipelines located within v-drain and controls to prevent spills.	GEODATA TOPO 250K Rockwater (2023a)
Acid sulphate soils	Bundarra is mapped as having "extremely low probability of occurrence" in the Atlas of Australian Acid Sulphate Soils.	21 km northwest to nearest high probability area.	N/A – significant separation.	CSIRO 2011
Other	Goldfields Highway	0 m* (premises intersects Goldfields Highway).	Dust generating activities (crushing and screening, paste plant) have been restricted to >1 km from Goldfields Highway and are screened by Wonder WRL to the west.	-

10 Paste Plant General Arrangement (Attachment 8)





CMQ Engineering Pty Ltd.
Manufacturing Concrete Batching-Conveying-Materials Handling Equipment
157-161 COBALT STREET, CAROLE PARK 4300. BRISBANE.
TELEPHONE (07) 3879 3288 FAX (07) 3879 3375

- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED
- PROJECTION IS THIRD ANGLE

No.	REVISION	DRAWN	DATE	No.	REVISION	DRAWN	DATE

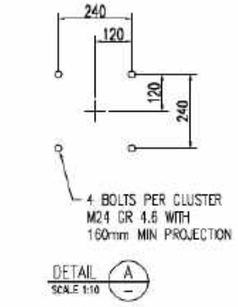
SCALE	1:75	
DRAWN	S.G.D.	28-08-23
CHECKED	-	-
DESIGNED	-	-
APPROVED	-	-

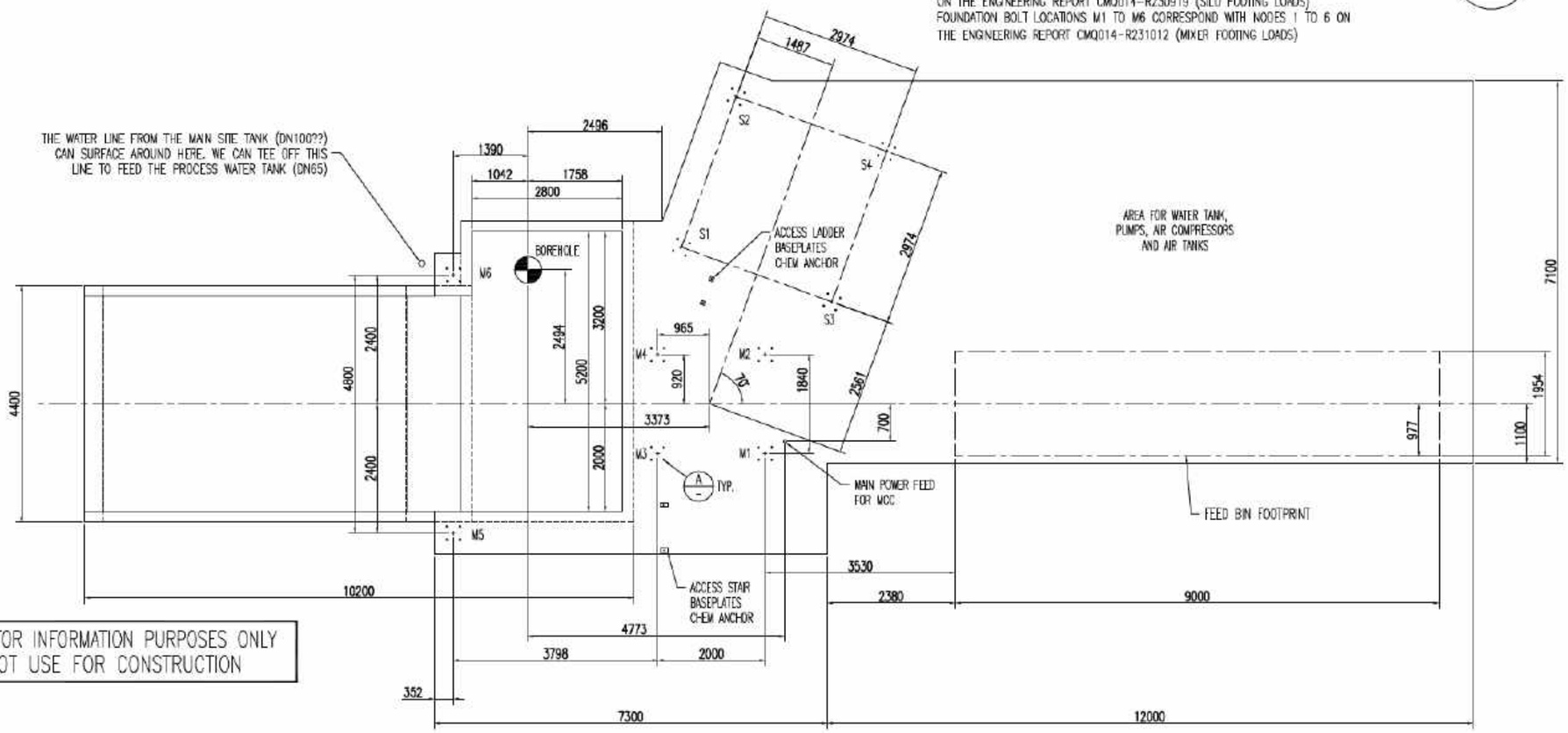
CMQ Engineering Pty Ltd.

NORTHERN STAR RESOURCES PASTE PLANT
PRELIMINARY PLANT LAYOUT

DRAWING No. A1
2792-0000
PRINT DATE:

NOTE: FOUNDATION BOLT LOCATIONS S1 TO S4 CORRESPOND WITH NODES 1 TO 4 ON THE ENGINEERING REPORT CMQ014-R230919 (SILO FOOTING LOADS)
FOUNDATION BOLT LOCATIONS M1 TO M6 CORRESPOND WITH NODES 1 TO 6 ON THE ENGINEERING REPORT CMQ014-R231012 (MIXER FOOTING LOADS)





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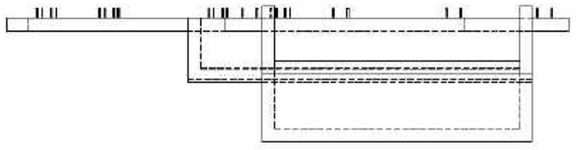

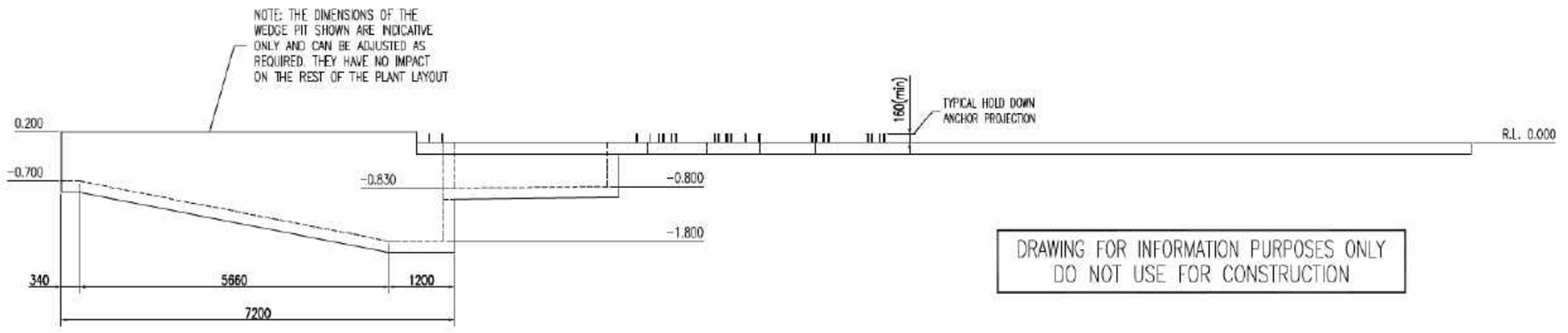

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0 1 2 3 4 5m

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- PROJECTION IS THIRD ANGLE

No.	REVISION	DRAWN	DATE	No.	REVISION	DRAWN	DATE

SCALE	1:50	
DRAWN	S.G.D.	23-10-23
CHECKED	-	-
DESIGNED	-	-
APPROVED	-	-

CMQ Engineering Pty Ltd.

NORTHERN STAR RESOURCES PASTE PLANT
PRELIMINARY CIVILS LAYOUT

DRAWING No. A1
2792-0100
PRINT DATE:

12 References

Allen, A. D. (1994) Hydrogeology. Pages 36-58 in K. M. W. Howes, (Ed.). An inventory and condition survey of rangelands in the north-eastern Goldfields, Western Australia. Department of Agriculture, Perth Western Australia.

Astron (2015). Bundarra Project - Geochemistry Review. Unpublished memorandum prepared for Northern Star Resources Ltd, June 2015.

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

Botanica Consulting (Botanica 2022). Bundarra Project Reconnaissance Flora/ Vegetation & Basic Fauna Assessment. Unpublished report prepared for Northern Star Resources Ltd, July 2022.

Botanica Consulting (Botanica 2023). Wonder UG Gold Project Materials Characterisation Report 2023. Unpublished report prepared for Northern Star Resources Ltd, May 2023.

Bureau of Meteorology (BoM 2024). Climate statistics for Australian locations - Leonora. http://www.bom.gov.au/climate/averages/tables/cw_012046_All.shtml (accessed 16 December 2024)

Department of Energy, Mines, Industry Regulation and Safety (DEMIRS 2024). Guidelines for preparing Mining Development and Closure Proposals.

Department of Planning, Lands and Heritage (DPLH 2024). Aboriginal Cultural Heritage Inquiry System. Department of Planning, Lands and Heritage. https://espatial.dplh.wa.gov.au/ACHIS/index.html?viewer=ACHIS (accessed 16 December 2024)

Department of Water and Environmental Regulation (DWER 2017). Guideline Risk assessments Part V, Division 3, Environmental Protection Act 1986. (Plain English version, December 2020).

Environmental Protection Authority (EPA 2005). Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986). Separation Distances between Industrial and Sensitive Land Uses No. 3 June 2005.

Government of Western Australia (DBCA 2019). 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth.

MineGeoTech (2023). Wonder UG Preliminary Geotechnical Review. Unpublished report prepared for Northern Star Resources Ltd, May 2023.

Rockwater (2023a). Wonder Gold Project Surface Water Assessment. Unpublished report prepared for Northern Star Resources Ltd, May 2023.

Rockwater (2023b). Wonder Gold Project Hydrogeological Assessment. Unpublished report prepared for Northern Star Resources Ltd, May 2023.

Thackway, R. & Cressdell, I, D. (1995). An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0. Australian Nature Conservation Agency, Canberra.

13 Appendices

APPENDIX A – WONDER UNDERGROUND MATERIALS CHARACTERISATION STUDY

WONDER UG GOLD PROJECT

Materials Characterisation Report 2023

Prepared for Norther Star Resources Ltd
May 2023

Prepared by
BOTANICA CONSULTING
33 Brewer St PERTH WA 6000 | 0419 916 034

Document Information

Prepared for: Northern Star Resources Ltd

Tenement: **ML37/513, ML37/514, ML37/350, ML37/488.**

Project Name: Wonder UG Gold Project

Job Reference: Materials Characterisation Report 2023

Job Number: 2023/010

Date: 28th May 2023

Version: DRAFT

Disclaimer

Quality Assurance

An internal quality review process has been implemented to each project task undertaken by BC. Each document and its contents is carefully reviewed by core members of the Consultancy team and signed off at Director Level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Contents

Figures

Tables

1 INTRODUCTION

1.1 Project Background

Botanica Consulting was commissioned by Northern Star Resources to undertake an assessment of soil and waste rock at the Wonder Gold Deposit, to inform a Mining Proposal for the proposed UG mining of Wonder. In 2019, Northern Star acquired ASX-listed Bligh Resources Limited. Bligh's Bundarra project is located less than 30km south of Thunderbox Operations and adjacent to the sealed Goldfields Highway. The Bundarra project consists of five mining leases and six prospecting licences that host four known gold deposits including the Wonder gold deposit. The project area has previously been referred to as the Celtic Gold Mine.

This materials characterisation focuses on the Wonder North Deposit. There are two existing open pits (Wonder North, and Wonder West) and one existing waste rock landform at Wonder North. The material characterised is collected from holes drilled to define resources to be accessed via a proposed underground mine located beneath the Wonder north and west pits.

1.2 Location

The project area is located in North-eastern Goldfields of Western Australia, within the Shire of Leonora (Figure 2-1). It lies approximately 70 km north of the town of Leonora, and 270 km north of the regional hub of Kalgoorlie-Boulder. It is situated midway between Lake Carey, and Lake Raeside, several large salt lakes in the region, and is about 50km from each. The nearest residential area is Leonora (~65 km to the south), and Leinster (~70 km to the north west).

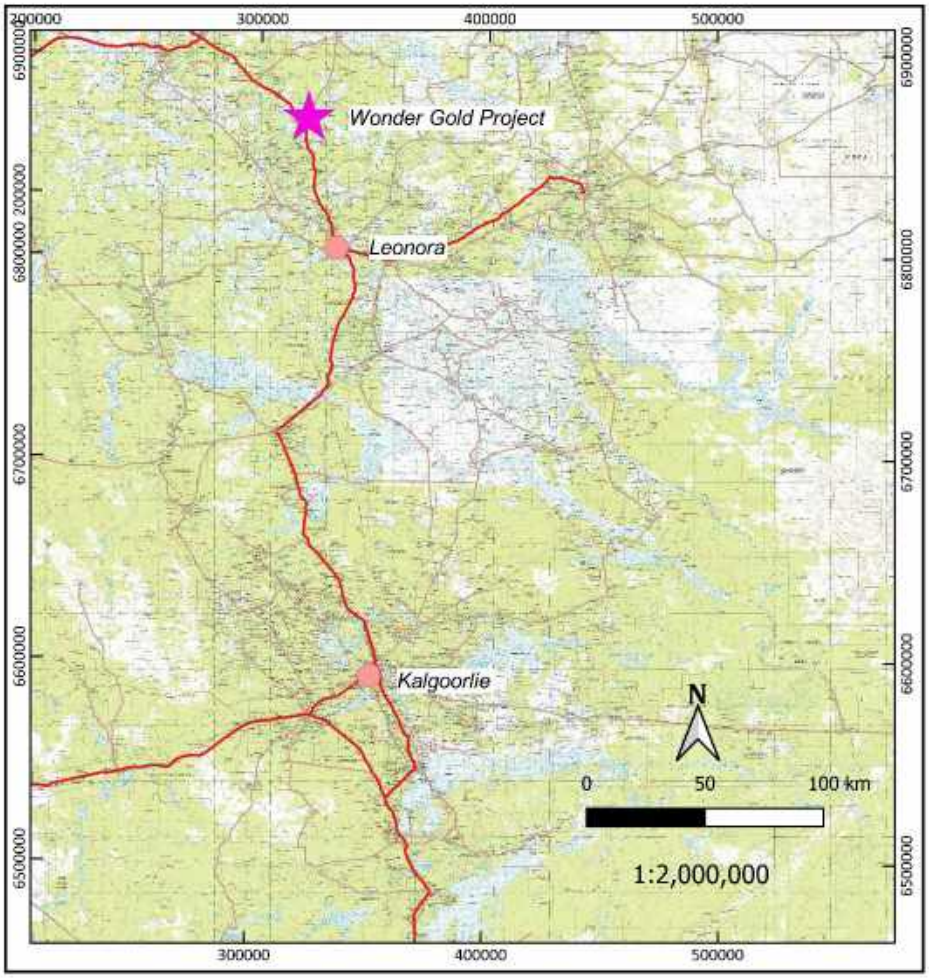

Figure 1-1: Location of Wonder Project

1.3 Climate

The climate of the East Murchison IBRA subregion is described as arid with mainly winter rainfall (Cowan, 2001). The nearest Bureau of Meteorology (BoM) weather station is in Leonora Aero (#012305), located 70 km north of the Project.

The yearly average maximum and minimum temperatures are 36.8 °C in January, and 22°C in July respectively; for data recorded from 1991 to 2022. The mean annual rainfall for Leonora is about 290mm, however rainfall varies considerably from year to year. The mean monthly rainfall ranges from 52.5mm in February to 8.3mm in September. The highest recorded monthly rainfall in this time period was 284mm in February 1995, and the highest daily rainfall was 109.2mm in January 2014. The annual mean days of rain exceeding 25mm is 1.5 days.

The mean annual evaporation of around 3000mm significantly exceeds the mean annual rainfall (BoM, 2006). Single point Design Rainfall analysis for the Project (Longitude 121.181, Latitude -28.343) indicates that a rainfall amount of 181 mm in 72 hours can be expected to be equalled or exceeded on average once every 100 years (BoM, 2016).

1.4 Geology

The regional geology of the Yilgarn Craton is characterised by relatively narrow greenstone belts separated by expanses of granitoid rocks. The Wonder deposit lies within the Kurnalpi Terrane in the western portion of the Yilgarn Craton. To the west, it is separated from the Kalgoorlie Terrane by the Ockerburry Shear Zone. The Project area itself is located at the south end of the Yandal greenstone belt, where the Ockerburry shear intersects the Perseverance Fault and Agnew – Wiluna Greenstone Belt (Porter Geo Database).

Locally, an Archean volcanic succession is dominated by granitoids intruding basalts, gabbros and felsic volcanics along the western edge of the Celtic Batholith. Within the Project tenements there are multiple mafic roof pendants/xenoliths within the fractionated granite batholith. The intrusive is highly variable in composition, with individual phases occurring as irregular intercalations over a broad zone that forms the transitional margin of the batholith. The bases of the roof pendants show evidence of oxidation by late-stage metasomatic fluids from the granite (NSR Memo).

1.4.1 Deposit Geology

Wonder North is hosted within a package of coarse grained tonalite intruded by both diorite porphyry and lamprophyric dykes, with mafic rafts and xenoliths seen in the footwall. Mineralisation at Wonder North can be characterised as a shear hosted gold deposit as it is associated with the west-northwest striking Wonder Shear Zone.

The Wonder Shear Zone has developed in successive phases resulting in re-activated vein development, with different vein types within and proximal to the main shear zone. These vein types include brecciated, laminated and extensional tension veins with gold mineralisation closely associated with pyrite. High grade mineralisation is thought to be controlled by the interaction of the shear zone with the mafic/intermediate intrusives within the tonalite.

A gradational alteration assemblage is observed related to proximity to the ore. Hematite alteration is located distally from the main ore zone, whilst biotite-chlorite alteration is observed closer to the main ore zone with sericite replacement of chlorite occurring proximal to the main shear zone. The Wonder North Shear Zone zone is characterised by quartz-albite-sericite-pyrite alteration, with high grade mineralisation associated with smokey, laminated quartz veins primarily situated within the footwall.

The main waste material lithology types expected to comprise waste in the proposed Wonder UG are:

- Tonalite
- Lamprophyre (intrusive biotite rich dolerite)
- Andesite (a biotite-feldspar diorite)

- Basalt/dolerite with minor xenoliths

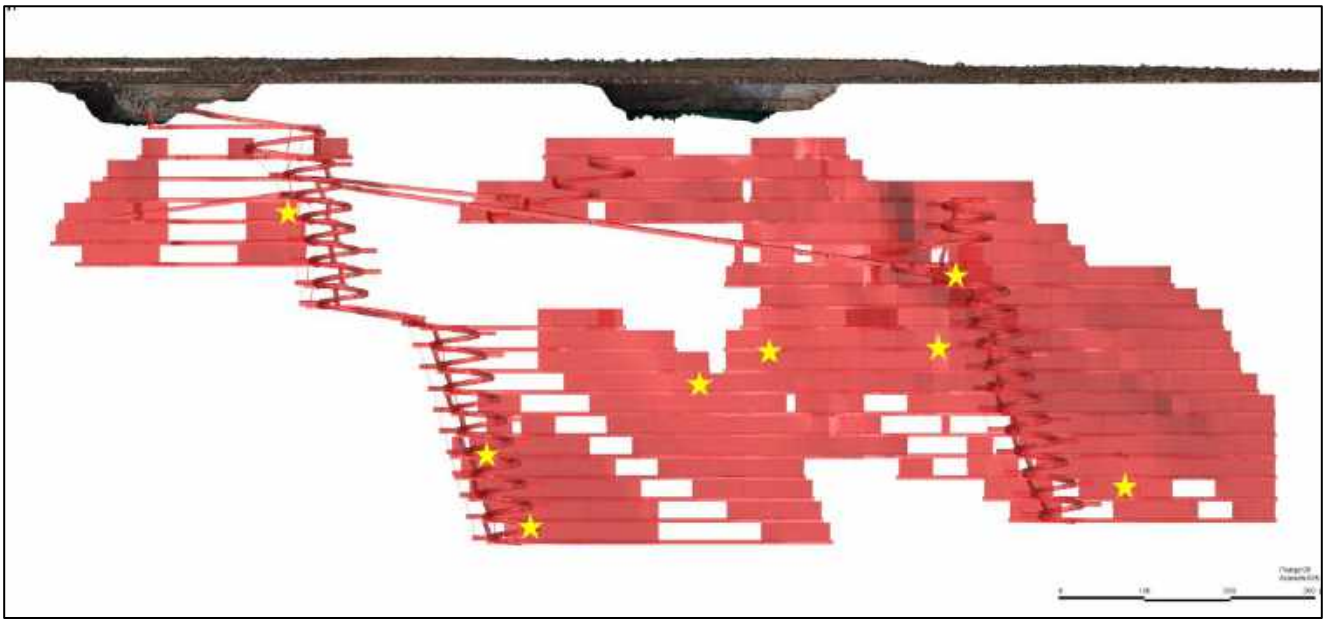

Figure 1-2: Drillholes selected for waste characterisation against the optimised UG shell drilled between July 2022 and January 2023

2 METHODOLOGY

2.1 Sampling

63 samples have been selected to represent the expected waste lithologies within the fresh rock material in the proposed UG design. The number of samples and volume selections that have been supplied is based on the DMP requirements in the 2016 "*Draft Guidance – Materials Characterisation Baseline requirements for Mining Proposals*". Samples collected are predominantly within the FY22 3000 UG optimisation, however some selections sit outside the shell in order to gather a cross section of fresh granitoid material. Sample numbers and waste material proportions and types are shown in Table 2-1.

Table 2-1: Waste Material Proportions of Various Lithologies Expected and Sample Numbers

Lithology	Volume	Tonnes	% of Waste	No of samples
Lamprophyre	31,365	85 940	3	7
Basalt	8,681	23 266	1	4
Tonalite	805,844	2 175 318	85	30*
Andesite	19,499	52 453	2	4
Mafic Unit	61,021	163 076	6	10
Unknown	2	5	0	0
Vein	26,503	70 763	3	7
Total	**952,916**	**2 570 820**	**100**	**62**

Table 2-2: Details of Sampled Drillholes

Hole ID	Tenement	Easting (m)	Northing (m)	RL	Depth
WNRD1033B	M37/513	322242.5	6863718	501.3	621.75
WNRD1085	M37/513	322161.3	6863651	502.224	469
WNRD1115	M37/513	322382.4	6863633	500.18	550
WNRD1152	M37/513	321800.8	6864025	502.8	520.2
WNRD1153	M37/513	321910.3	6864020	504.663	630
WWRD011	M37/513	321460.3	6863979	505.477	272.98
WNRD1131A	M37/513	322031.2	6863781	503.8	457.35
WNRD1051	M37/513	322020.4	6863844	503.8	453.96

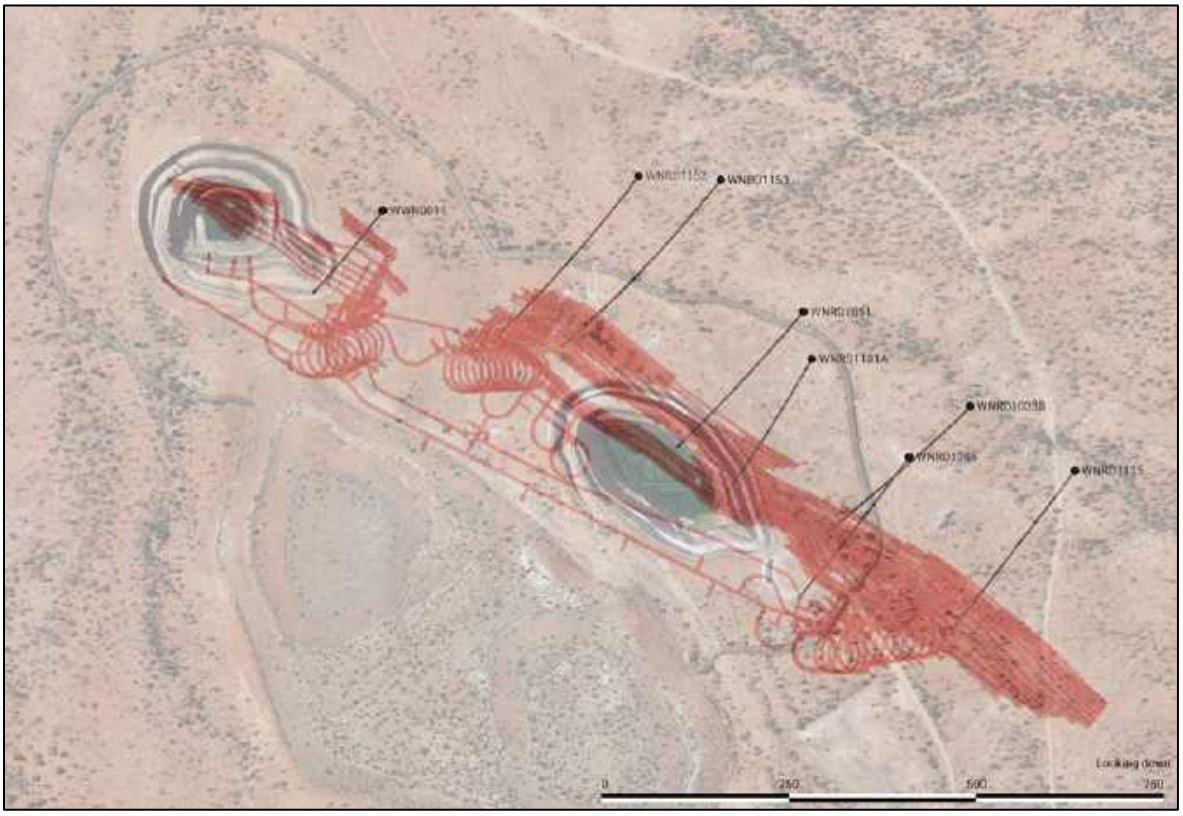

Figure 2-1: Plan View of Drillhole Locations used for Waste Material Characterisation

2.2 Mine Waste Analysis

Samples were analysed at ChemCentre and Intertek in Perth. Waste analysis of 62 samples included the following:

- Bulk geochemistry analysis for Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Hg, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sc, Se, Si, Sn, Sr, Te, Ti, Tl, V, W, Zn.
- Leachate analysis for As, B, Be, Cd, CrVI, Cu, Fe, Hg, Mo, Ni, Pb, Se, Zn.
- Acid base balance analysis for:
    - Total sulphur (S) % and sulphur as SO_4 %
    - Total inorganic carbon (C)%
    - Acid Neutralising Capacity (ANC)
    - Net acid generation (NAG) and NAGpH
    - Maximum Acid Production (MPA) and Net Acid Potential Production (NAPP) were calculated based on oxidisable S values.
- pH and EC

The ChemCentre, which is a NATA accredited laboratory, is operated under the Government of Western Australia under the *Chemistry Centre (WA) Act 2007*. Details on the laboratory analysis method for each parameter is specified in the laboratory report provided in Appendix C.

Data interpretation of laboratory results was undertaken by Botanica Consulting. Qualifications of the personnel involved in the materials characterisation are provided below:

- Anna Timmins - Environmental and Geosciences Consultant, Botanica Consulting Pty Ltd. B.Sc., M.Sc.

2.3 Interpretation of Analyses

2.3.1 Acid Base Accounting

Acid-base accounting (ABA) and net acid generation testing used in conjunction with sulphur (S) and carbon (C) speciation are the primary tools for the analysis of AMD risk. ABA estimates the balance between the potential for a material to generate acid and to neutralise acid. Oxidation of sulphide minerals is the primary source of acidity in mine wastes however the neutralisation of acid can occur from reactions with carbonate minerals. Total sulphur (S) can be used to calculate the estimated maximum potential acidity (MPA) measured in kg of H_2SO_4 per tonne. Acid neutralising capacity can be assessed by measuring the consumption of acid by a sample and is also measured in kg of H_2SO_4 per tonne. This can then be used calculate the ANC to MPA ratio, and the Net Acid Producing Potential (defined as NAPP = MPA – ANC), which can serve as initial classifiers of AMD risk (Australian Government, 2016).

Net acid generation quantified testing (NAG and NAGpH) (using multiple additions of hydrogen peroxide), and acid neutralising capacity quantified testing (by measured addition of hydrochloric acid) were carried out on all samples to provide further information on the acid generating properties of the assessed material. Generally, a

sample is classed as PAF if the NAGpH is <4.5. Conflicts in a materials NAPP and NAGpH qualifiers can indicate the need for further assessment (Australian Government, 2016).

As some sulphate-sulphur bearing minerals (e.g., anhydrite, gypsum) are non-acid or mildly acid generating, and some carbonate minerals (e.g., siderite) have low neutralising capacity, ABA calculations are used as a first pass assessment. Additional minor neutralising capacity can be provided by various silicate and clay minerals. Further analysis therefore includes mineralogy determinations, acid buffering characteristic curves (ABCC) and oxygen consumption tests. As previous work suggested the waste materials were non-acid forming, only initial classifiers were analysed.

Analysis results from ABA were used to classify waste rock as either "Non-Acid Forming (NAF), Uncertain, Potentially Acid Forming (Long Lag) or Potentially Acid Forming according to the ABA classification guidelines (Table), as recommended by the Australian Government 2016 Guide "*Preventing Acid and Metalliferous Drainage*". Where data does not fit the ABA groups the "*Draft Guidance – Materials Characterisation Baseline data Requirements for Mining Proposals*" (2016) Figure 3 (page 16) was used to clarify pathway for classification.

Table 2-3: ABA Preliminary Classification

	Total S%	NAPP	NAGpH	ANC/MPA
ACM	any	<-100	>4.5	>2
NAF	<0.1	any		
	>0.1	negative	>4.5	>2
UNC	>0.1	negative	>4.5	<2
		positive	<4.5	>2
PAF-LC	>0.1	>0 and <10	<4.5	<2
PAF	>0.3	>10	<4.5	<2

2.3.2 Bulk Geochemical Analysis

Materials were analysed for bulk material concentrations of a suite of elements to profile geochemical signatures of the different lithologies and to detect above background level enrichments. Element enrichment was determined using the Geochemical Abundance Index (GAI) using the method presented in the GARD Guide of comparison to the standard median soil abundance values (derived from Bowen 1979). A GAI of 0 indicates that the content of the element is less than, or similar to the median soil content a GAI of 3 corresponds to a 12-fold enrichment, and a GAI of 6 indicates a 96-fold or greater enrichment above the standard median soil content. In general, a GAI >3 indicates significant enrichment (GARD guide).

Elemental compositions were also compared against the Department of Environment and Conservation (DEC) Ecological Investigation Levels (EILs), the Health Investigation Levels (HIL), and the ISQG high trigger levels for

sediments (DEC 2010) to identify metals and metalloids that may pose a risk to the surrounding environment or to environmental values. The EIL used by the DEC are based primarily on the Environmental Investigation Levels listed in the Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC/NHMRC, 1992). They represent screening levels in which to provide a first-pass assessment for a site. It is important to note that these levels do not specifically apply to mineralised zones where elevated metal and metalloid contents often exceed the EIL in a natural functioning ecosystem. Site specific information should therefore be used in conjunction with the EIL to assess the appropriateness of these criteria values. Therefore, the EIL are presented in conjunction the HIL (for recreational use and parklands) and the Interim Sediment Quality Guidelines (ISQG), together with the median soil values (MSV), and average crustal abundance (ACA) values to provide a greater context within which to interpret them.

2.3.3 Elements in Leachate

Leachate analysis is conducted to provide an indication of the solubility of metals and metalloids (elements) in neutral leachate from the tested materials. Low values indicate that metals and metalloids are either tightly bound to minerals or held within the crystal structures. Pathways for elements to the surrounding environment include rainwater derived leachate to surrounding soils, and the seepage of leachate from waste rock landforms (WRLs) to groundwater. The leachate concentrations of different elements in water have been assessed against guidelines for long and short term irrigation use in agriculture and for livestock drinking water (main land use rangelands pastoral).

Trigger levels for long term irrigation were sourced from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC updated in 2018). The trigger values from the ANZECC (2000) guidelines for livestock drinking water are also provided. The trigger values listed are not site specific and are inherently conservative. They are designed to trigger further investigation but may also be interpreted in the context of the site-specific environment where elevated values are associated with naturally occurring mineralisation.

2.3.4 Resistance to Erosion and Chemistry

Resistance to erosion assessment incorporates information as available from drill logging, geological reports and geotechnical assessments together with chemical assessments including electrolyte content and dispersibility. Goldich mineral dissolution series for each lithology is also considered (Churchman and Lowe 2012).

3 RESULTS

3.1 Acid Base Balance Analysis

Overall the waste materials sampled were low in total sulphur and total oxidisable sulphur with maximum total sulphur of 0.77%S. The majority of samples had a high acid neutralising capacity, resulting in 58 out of 62 samples being classified as non acid forming or NAF, three samples as acid consuming material (ACM), with one sample was classified as Uncertain. The majority of samples had a total S% of below 0.1%, with only 13 exceeding 0.1% total S, and only three exceeding 0.3% total S. Sulphur as occurring as sulphate was low, with the highest value 0.06% sulphate S.

Total inorganic carbon (TIC) were moderate to high in many samples. Values ranged from below detection (<0.05%) to 4.09% in a lamprophyre. This resulted in high to very high acid neutralising capacities for most samples and lithologies. Even tonalites which commonly contain low levels of carbonate contained appreciable inorganic C and had appreciable ANC levels ranging from 9 to 74 kg of H_2SO_4 per tonne. Andesites samples had ANCs ranging from 29 to 230 kg of H_2SO_4 per tonne, basalts 8 to 100 kg of H_2SO_4 per tonne, and lamprophyres 18 to 250 kg of H_2SO_4 per tonne. Only the vein materials had low ANCs, ranging from <0.5 to 71 kg of H_2SO_4 per tonne.

The consistently high ANC values, combined with low to moderate sulphur levels of most samples, led to calculated net acid production potential (NAPP) values to be consistently strongly negative ranging from -8.5 to -250 kg of H_2SO_4 per tonne, with only two vein material samples recording values of 0 kg of H_2SO_4 per tonne. Neither of these samples contained any sulphides however. Similarly, all sample ANC/MPA ratios were consistently above 2., with the exception of one sample of tonalite, which returned a calculated ANC/MPA a value of 1.9, resulting in a classification of “Uncertain”. This sample had a NAGpH of 8.5 and a NAPP of –12.2 and contained 0.42% sulphur kg of H_2SO_4 per tonne. The ANC/MPA ratios of all samples are shown in Figure 3-2.

The pH of samples in $CaCl_2$ was universally slightly alkaline with all samples between 8 and 8.9. NAG pH’s ranged between 5.9 and 9 (as shown in Figure 3-1). Widespread inorganic carbon in the granites is likely related to a widespread alteration associated with mineralisation. There is a low risk from all rock types of acid mine drainage. The full tabulated acid base analysis results are shown in Appendix B – Table B1.

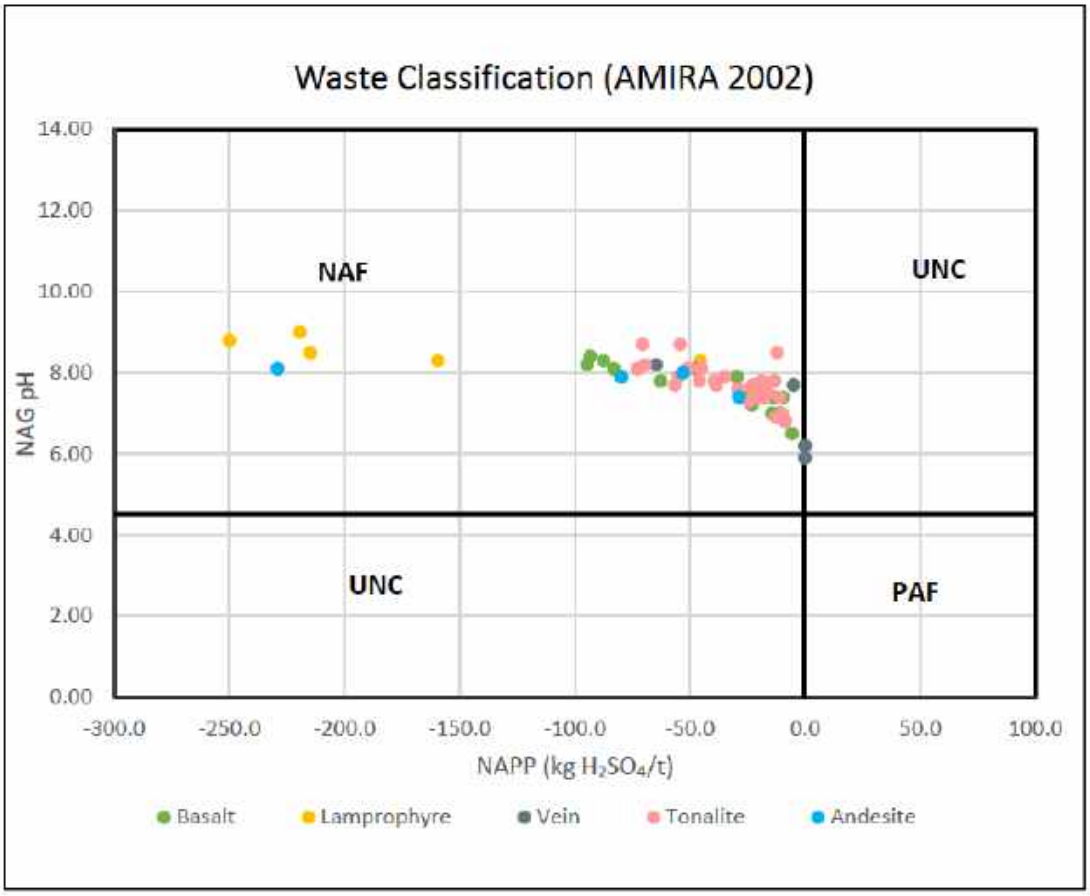

Figure 3-1: NAG – NAPP Acid base Analysis Plot of Wonder Waste by Lithology Type

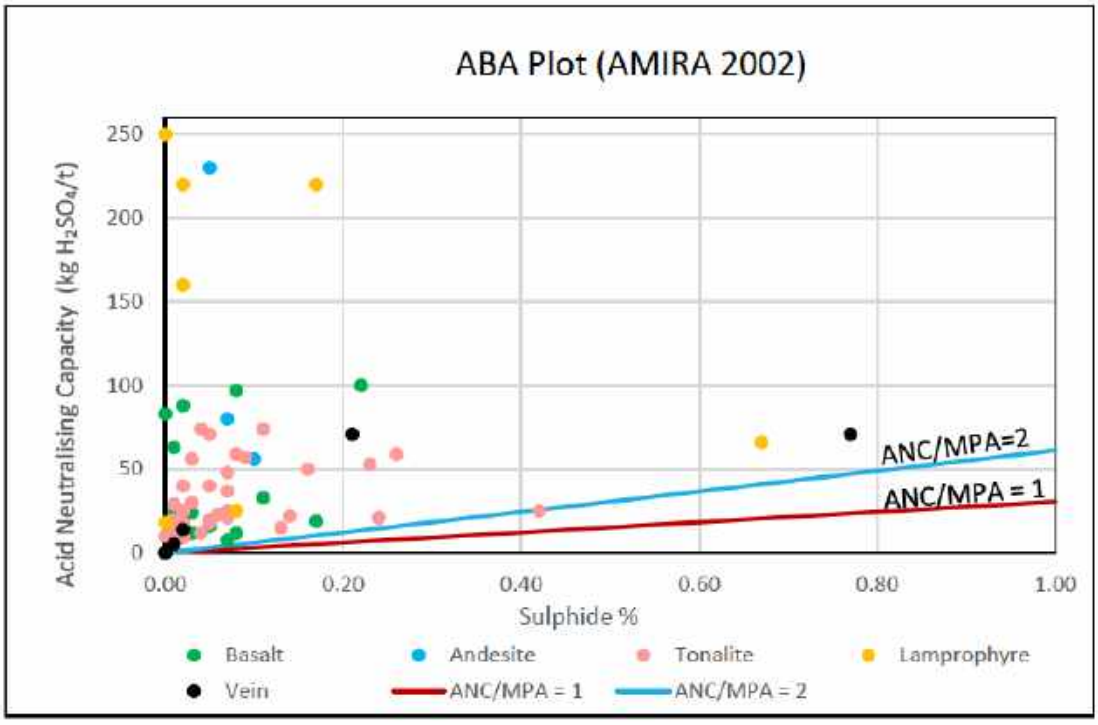

Figure 3-2: ANC to MPA ratio plot of Wonder Waste Samples by Lithology Type

3.2 Bulk Geochemical Analysis

A small proportion of the 62 waste rock samples exceeded EILs for several elements, which were: cobalt (6 samples, 4 of which were vein material, ranging from 51 to 106ppm compared to the EIL of 50ppm), chromium (two samples with values of 738ppm and 1191ppm, compared to the EIL of 400ppm), copper (two samples which were 114ppm and 106ppm compared to the EIL of 100ppm), manganese (16 samples, maximum value 1467ppm compared to the EIL of 500ppm), molybdenum (one sample of 90ppm compared to the EIL of 40ppm), nickel (eight samples maximum value 398ppm, compared to the EIL of 60ppm), vanadium (21 samples, maximum value 201ppm, compared to the EIL of 50ppm), and zinc (two samples, of 250ppm and 281ppm, compared to the EIL of 200ppm). Almost all samples with higher than EIL values were basalt, lamprophyre and vein materials. From 30 samples only two tonalite samples exceeded a EIL, one was a value for copper of 106ppm, and the other of vanadium at 57ppm. Full results of elemental concentrations compared to EIL and HIL values are given in Appendix B – Table B2.

Geochemical abundance index values for the samples showed that only four samples had single elements that were significantly enriched (i.e., GAI ≥3). These were a lamprophyre sample ((THU185187), with 8.6ppm bismuth, two vein samples (THU105242 and THU105203) with 105 and 106ppm of cobalt respectively, and a lamprophyre sample (THU105218) with 1191ppm of chromium. Full results of GAI levels for 3 and 6 for each element and sample are given in Appendix B – Table B3. Overall, there are not high or elevated values of elements of environmental concern in the waste rock, and these levels are typical of these rock types. Additionally the basalt, lamprophyre and vein materials only represent a small proportion of the waste in total, with 85% comprising environmentally benign tonalite,

3.3 Leachate Analysis

Neutral leachate analysis of waste material samples at Wonder showed leachates were very low in all elements tested with the exception of a single sample having the element molybdenum exceed the livestock drinking water fat 0.36mg/L compared to the recommended level of 0.15mg/. All other samples were very low in molybdenum, with the majority <0.001mg/L. Two samples exceeded the recommended short term irrigation value for cobalt, at 0.27 and 0.34mg/L in samples of vein material. All other samples were very low in soluble cobalt with the majority of samples <0.001mg/L. Overall there is very low levels of soluble metals and arsenic in the waste material samples. Full results are shown in Appendix B – Table B4.

3.4 Resistance to Erosion and Chemistry

Resistance to erosion was not assessed, however waste materials are all fresh, and not of rock types that would be expected to be susceptible to erosion.

4 SUMMARY AND RECOMMENDATIONS

4.1 Mine Waste

Based on samples analysed, all materials are categorised as NAF or ACM due to low overall sulphur content (most samples are <0.1%S) and high ANC and are considered suitable for placement on the outer surface of a WRL. The risk from acid metalliferous, neutral or saline drainage is considered very low.

Waste lamprophyre and basalt are sporadically slightly elevated in cobalt, chromium, nickel, however this material constitutes a small portion of the waste and is itself only marginally elevated. The tonalite waste is considered environmentally benign, and overall, the risk to the surrounding environment from the Wonder UG waste requiring placement in a waste rock landform (based on the samples assessed) is considered to be low.

5 BIBLIOGRAPHY

AHA (20121). *Assessment of impacts of mine dewatering on riparian vegetation of Lake Carey*. By Alexander Holm and Associates, for Matsa Gold Pty Ltd, Wonder Gold Project.

AMIRA International (2002). *ARD Test Handbook*. Project 387A: Prediction and Kinetic Control of Acid Mine Drainage).

ANZECC/ARMCANZ, (2000). *Australian and New Zealand Water Quality Guidelines for Irrigation and Livestock, National Water Quality Management Strategy*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand Canberra, Australia.

Black S, Allen D, North M, Price B, Rothniea N, Sharma R. 2019. *Applicability of the chromium reducible sulfur test for acid metalliferous drainage prediction in hard rock mining*. Applied Geochemistry 91 (2018) 45–53.

BoM (2006) – Australian Climate Variability and Change – Average Maps: Pan Evaporation. Prepared by Bureau of Meteorology, Government of Australia. Accessed 2023.

BoM (2016). *Design Rainfall Data System 2016*. Prepared by Bureau of Meteorology, Government of Australia Available: http://www.bom.gov.au/water/designRainfalls/revised-ifd/. Accessed: July 2021.

Churchman DJ, Lowe LJ, (2012). *Alteration , formation and occurrence of minerals in soils*. In Huang PM, Li PY, Sumner EA Ed. *Handbook of Soil Sciences 2nd Edition, Vol 1. Propoerties and Processes*.CRC Press (Taylor and Francis) Boca Raton FL. Pp 20.1-20.72.

Cowan M, (2001). *A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2001; Eastern Murchison (MUR1 –Eastern Murchison subregion).* Department of Conservation and Land Management, September 2001.

Department of Mines and Petroleum (DMP) (2016). *Draft Guidance – Materials Characterisation Baseline requirements for Mining Proposals.* Department of Mines and Petroleum, Western Australia.

DFAT (2016). *Preventing Acid and Metalliferous Drainage – Leading Practice Sustainability and Development Program for the Mining Industry*. Published by Department of Foreign Affairs and Trade, Government of Australia.

DPIRD (2019). *Soil Landscape Mapping* - Western Australia attributed by WA Soil Group. Department of Primary Industries and Regional Development, Western Australia.

DWER (2014). A*ssessment and Management of Contaminated Sites – Contaminated Sites Guidelines*. Department of Water and the Environmental Regulation, Western Australia.

GSWA (1998). *Explanatory Notes for the 1:250,000 map sheet for Edjudina (SH 51-06)*. Geological Survey of Western Australia, Published by Published by Department of Mines Industry and Safety, Western Australia.

GSWA (2016). 1:500 000 *State interpreted bedrock geology (DMIRS-016).* Geological Survey of Western Australia. Published by Department of Mines Industry and Safety, Western Australia.

GSWA (2017). *Digital 1:500 000 regolith map of Western Australia (preliminary edition).* Geological Survey of Western Australia. Published by Department of Mines Industry and Safety, Western Australia.

Green Geotechnical Pty Ltd (2015). *Geotechnical assessment of the Wonder Pit*. 13 November 2015. Unpublished report prepared for GME Resources.

Hayes S, Ramos N, (2018). *Surficial geochemistry and bioaccessibility of tellurium in semiarid mine tailings.* Environ. Chem. 2019, 16, 251–265. https://doi.org/10.1071/EN18215.

Marinios and Hoek (2000). GSI: *A geologically friendly tool for rock mass Strength estimation*. Predicting Tunnel Squeezing. Tunnels and Tunnelling International. Part1 – November 2000, Part 2 – December, 2000.

Hazelton and Murphy (2007). *What do all the numbers mean*?. CSIRO Publishing.

INAP (2009). *Global Acid Rock Drainage Guide (GARD Guide).* The International Network for Acid Prevention. http://www.gardguide.com.

John, J. (1999). *Limnology of Lake Carey with special reference to primary producers*. Proceedings of the Salt Lake Ecology Seminar. Perth Zoo Conference Centre.

Moore G, (2004). *Soil Guide – A handbook for Understanding and managing Agricultural Soils*. Bulletin 4343. Department of Agriculture, Western Australia.

McArthur (2004) - *Reference Soils of southwestern Australia.* Department of Agriculture, Western Australia.

SWC (2015a). *Wonder Gold Project Preliminary Soil Assessment*. Unpublished report prepared for GME Resources. July 2015.

SWC (2015b). Wonder Gold Project *Preliminary Geochemical Assessment*. Unpublished report prepared for GME Resources.

Tille, P.J. (2006). *Soil-landscapes of Western Australia's rangelands and arid interior*. Department of Agriculture and Food, Western Australia, Perth. Report 313.

Timms BV, Datson B, Coleman M, (2006). *The wetlands of the Lake Carey catchment, northeast Goldfields of Western Australia, with special reference to large branchiopods*. Journal of the Royal Society of Western Australia, 89: 175-183.

6 GLOSSARY

Term	Definition
ABA	Acid Base Accounting.
Activity	Elements of the organisation's activities or products or services that can interact with the environment. These include routine and non-routine activities.
AEP	Annual Exceedance Probability.
AHD	Australian Height Datum.
AMD	Acid and Metalliferous Drainage. Mine drainage may consist of acid drainage and/or neutral or saline metalliferous drainage. AMD originates when sulphide material is exposed to air and water. Metalliferous drainage can occur when acid is neutralised, but concentrations of some metals remain elevated at near neutral or alkaline conditions. Potential sulphide-bearing material includes waste rock, pit wall rock and tailings.
ANC	Acid Neutralising Capacity.
ANZECC	Australian and New Zealand Environment and Conservation Council.
ANZMEC	Australian and New Zealand Minerals and Energy Council.
ARI	Average Recurrence Interval.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
BC	Botanica Consulting
BoM	Bureau of Meteorology, Commonwealth.
CEC	Cation Exchange Capacity.
Closure	A whole-of-mine-life process, that typically culminates in completion of all obligations under the *Mining Act 1978*, government "sign-off" and responsibility has been accepted by the next land user or manager. It includes decommissioning and rehabilitation.
Disturbance Envelope	An area within which all aspects of the Mining Proposal will occur.
Disturbance Type	A feature created during mining or exploration activity, e.g. WRLs, haul roads, access roads, ROM, plant site, TSF, borrow pits, drill pads, stockpiles, office blocks, accommodation village, etc.
Disturbed	Area where vegetation has been cleared and/or topsoil (surface cover) removed.
DMIRS	Department of Mines, Industry Regulation and Safety, WA.
DPIRD	Department of Primary Industries and Regional Development, WA.

Term	Definition
DWER	Department of Water and Environmental Regulation, WA.
EC	Electrical Conductivity.
Environment	Living things, their physical, biological and social surroundings and interactions between all of these.
ESP	Exchangeable Sodium Percentage.
Fresh zone	Unweathered rocks
GDA Coordinates	Map coordinates as per the Geocentric Datum of Australia reference system.
IBRA	Interim Biogeographic Regionalisation for Australia classification system.
IFD	Intensity-frequency-duration.
Likelihood	Description of probability or frequency of an event occurring.
LOM	Life of Mine. Expected duration of mining and processing operations.
Mining Disturbances	Features created during mining activities e.g. WRL, haul roads, plant site, TSF, stockpiles, camp etc.
MPA	Maximum Potential Acidity.
MRF	Mining Rehabilitation Fund.
NAF	Non-Acid Forming.
NAPP	Net Acid Producing Potential.
Operations	The active pit, haul roads, workshops, administration; – the collective group of features that are needed to run an operation.
Oxidised	Completely weathered surface and subsurface material
PAF	Potentially Acid Forming.
Phase of Mining	These include yet to commence, construction, operation, care and maintenance, active, rehabilitation and closure.
Pits	All open excavations including active mineral rock, gravel, sand, clay, bauxite and salt-pan extraction areas.
Problematic Materials	Materials that have the potential to detrimentally impact on humans and the environment and require careful and appropriate management (e.g. Potential Acid Forming (PAF) materials, radioactive materials, asbestiform materials, dispersive materials, arsenic etc.).
Project	The total integrated mining operation in which the site(s) contribute to the overall operation to supply ore, processing facilities and disposal of waste products.
Rehabilitation	The return of disturbed land to a safe, stable, non-polluting/non-contaminating landform in an ecologically sustainable manner that is

Term	Definition
	productive and/or self-sustaining consistent with the agreed post-mining land use.
Risk Treatment	Process to modify and reduce risk.
ROM	Run of Mine (used for temporary ore storage).
Stable	A condition where the rates of change of specified parameters meet agreed criteria.
TDS	Total Dissolved Solids.
Tenement	Land tenure granted under the *Mining Act 1978* e.g. Mining Lease, Exploration Licence, Prospecting Licence, Miscellaneous Licence and General Purpose Lease.
TOC	Total organic carbon
TOS	Total oxidisable sulphur
Transition Zone	Zone where partially weathered material is found (usually existing below the completely weathered (oxidised) material and above the unweathered (or fresh) materials.
TSF	Tailings Storage Facility. An area used to store and consolidate tailings.
Void	Surface excavations made as a result of mining operations which exceed five metres in depth from the surrounding levels (also referred to as Pits).
WA	Western Australia.
Water Table	The level below which the ground is saturated with water.
WRL	Waste Rock Landform. Areas associated with the storage of unprocessed waste material resulting from a mining operation.

7 APPENDICES

APPENDIX A - Waste Materials Sample Data Table

Lab ID	Sample ID	Hole ID	Depth From (m)	Depth To (m)	Lithology	Alteration	Sulphides
22S3462/029	THU105181	WNRD1152	459.5	460	Andesite	QAHSC	No
22S3462/030	THU105182	WNRD1152	474	474.5	Andesite	SERHEM	No
22S3462/031	THU105183	WNRD1152	493.5	494	Basalt	CHTCRB	No
22S3462/032	THU105184	WNRD1152	510	510.5	Basalt	CHTCRB	No
22S3462/033	THU105185	WNRD1152	518	518.5	Basalt	CHTCRB	No
22S3462/034	THU105186	WNRD1152	505	505.5	Basalt	SERHEM	No
22S3462/035	THU105187	WNRD1152	459	459.5	Lamprophyre	QASP	Yes
22S3462/036	THU105188	WNRD1152	465	465.5	Tonalite	QAHCH	No
22S3462/037	THU105189	WNRD1152	468.5	469	Tonalite	SERHEM	No
22S3462/038	THU105190	WNRD1152	503	503.5	Tonalite	SERHEM	No
22S3462/009	THU105191	WNRD1085	385	385.5	Tonalite	QAHCH	No
22S3462/010	THU105192	WNRD1085	413	413.5	Tonalite	SERHEM	No
22S3462/011	THU105193	WNRD1085	432	432.5	Tonalite	SERHEM	No
22S3462/012	THU105194	WNRD1085	439	439.5	Tonalite	SERHEM	No
22S3462/013	THU105195	WNRD1115	537	537.3	Tonalite	SERHEM	No
22S3462/014	THU105196	WNRD1115	493	493.4	Tonalite	QAHSC	No
22S3462/015	THU105197	WNRD1115	518	518.5	Tonalite	QAHCH	No
22S3462/016	THU105198	WNRD1115	444	444.5	Tonalite	SERHEM	No
22S3462/017	THU105199	WNRD1115	478	478.5	Tonalite	QAHSC	Yes
22S3462/018	THU105200	WNRD1115	504.8	505.2	Tonalite	QAHCH	No
22S3462/019	THU105201	WNRD1115	456.5	457	Vein/Tonalite	QAHSC	Yes
22S3462/020	THU105202	WNRD1115	479.5	480	vein	QTZ	Yes
22S3462/021	THU105203	WNRD1115	513.1	513.4	vein	QTZ	No
22S3462/022	THU105204	WNRD1115	528.6	529	Lamprophyre	SERHEM	Yes
22S3462/023	THU105205	WNRD1115	523.8	523.03	Andesite	SERHEM	No
22S3462/040	THU105206	WNRD1153	550.62	550.8	Tonalite	SERHEM	No
22S3462/041	THU105207	WNRD1153	567.4	567.63	Tonalite	QAHSC	No
22S3462/042	THU105208	WNRD1153	555	555.3	Tonalite	QAHCH	No

Lab ID	Sample ID	Hole ID	Depth From (m)	Depth To (m)	Lithology	Alteration	Sulphides
22S3462/043	THU105209	WNRD1153	594	594.3	Tonalite	QAHSC	No
22S3462/044	THU105210	WNRD1153	585.9	586.1	Tonalite	QAHSC	No
22S3462/045	THU105211	WNRD1153	603.03	603.4	Tonalite	SERHEM	No
22S3462/046	THU105212	WNRD1153	589	589.3	Basalt	QAHSC	No
22S3462/047	THU105213	WNRD1153	597	597.3	Basalt	QAHSC	No
22S3462/048	THU105214	WNRD1153	600.3	608.5	Basalt	QAHSC	No
22S3462/049	THU105215	WNRD1153	610.7	610.9	Basalt	CHTCRB	No
22S3462/050	THU105216	WNRD1153	620.42	620.6	Basalt	QAHSC	No
22S3462/001	THU105217	WNRD1033B	582	582.3	Tonalite	QAHCH	No
22S3462/051	THU105218	WNRD1153	579.46	579.75	Lamprophyre	CHTCRB	No
22S3462/052	THU105219	WWRD011	190.8	191.25	Tonalite	QAHSC	No
22S3462/053	THU105220	WWRD011	200	200.4	Tonalite	QAHSC	No
22S3462/054	THU105221	WWRD011	213.5	213.7	Tonalite	SERHEM	No
22S3462/055	THU105222	WWRD011	250	250.2	Tonalite	SERHEM	No
22S3462/056	THU105223	WWRD011	240.7	241	Andesite	CHTCRB	No
22S3462/057	THU105224	WWRD011	256.9	257.1	Lamprophyre	QAHCH	No
22S3462/058	THU105225	WWRD011	203.98	204.1	Lamprophyre	QAHCH	No
22S3462/059	THU105226	WWRD011	263.5	263.7	Basalt	CHTCRB	No
22S3462/060	THU105227	WWRD011	272.78	272.98	Basalt	CHTCRB	No
22S3462/061	THU105228	WWRD011	223.7	223.9	Basalt	CHTCRB	No
22S3462/062	THU105229	WWRD011	259.69	259.98	Basalt	SERHEM	No
22S3462/024	THU105230	WNRD1131A	372.1	372.3	Lamprophyre	QAHCH	No
22S3462/025	THU105231	WNRD1131A	385	385.3	Tonalite	SERHEM	No
22S3462/026	THU105232	WNRD1131A	410	410.3	Tonalite	SERHEM	No
22S3462/027	THU105233	WNRD1131A	387	387.2	Tonalite	QAHCH	No
22S3462/028	THU105234	WNRD1131A	450	450.3	Tonalite	SERHEM	No
22S3462/002	THU105235	WNRD1033B	501.9	502.1	Basalt	CHTCRB	No
22S3462/003	THU105236	WNRD1051	396.7	397.3	vein	QTZ	No
22S3462/004	THU105237	WNRD1051	447	447.3	Lamprophyre	CHTCRB	No
22S3462/005	THU105238	WNRD1051	402.08	402.3	Tonalite	QAHCH	No

Lab ID	Sample ID	Hole ID	Depth From (m)	Depth To (m)	Lithology	Alteration	Sulphides
22S3462/006	THU105239	WNRD1051	453	453.4	Tonalite	QAHSC	No
22S3462/007	THU105240	WNRD1051	449.7	450	Tonalite	QAHCH	No
22S3462/008	THU105241	WNRD1051	401	401.3	vein	QTZ	No
22S3462/039	THU105242	WNRD1152	410.5	411	vein	Fresh	No

APPENDIX B
Waste Material Analyses Data

7.1.1 Table B1 - Acid Base Analysis Results of Wonder Waste

Sample No.	Lithology	Alteration	EC (1:5)	pH ($CaCl_2$)	C	TIC	S	S as SO_4	S oxid	ANC	MPA	NAG	NAGpH	NAPP	ANC/MPA	Class
			mS/m		%					kg H_2SO_4/t						
THU105223	Andesite	CHTCRB	24	8.4	2.7	2.56	0.05	0.02	0.03	230	0.92	<0.5	8.1	-229.1	250.6	ACM
THU105181	Andesite	QAHSC	12	8.6	0.65	0.53	0.10	<0.01	0.10	56	3.06	<0.5	8	-52.9	18.3	NAF
THU105205	Andesite	SERHEM	54	8.5	0.98	0.83	0.02	0.06	-0.04	80	-1.32	<0.5	7.9	-81.3	-60.8	NAF
THU105182	Andesite	SERHEM	18	8.7	0.23	0.21	0.01	<0.01	0.01	29	0.31	<0.5	7.4	-28.7	94.8	NAF
THU105235	Basalt	CHTCRB	9	8.6	0.17	0.18	0.01	<0.01	0.01	25	0.31	<0.5	7.4	-24.7	81.7	NAF
THU105183	Basalt	CHTCRB	10	8.8	<0.05	<0.05	0.07	<0.01	0.07	8	2.14	<0.5	6.5	-5.6	3.6	NAF
THU105184	Basalt	CHTCRB	11	8.8	0.06	0.07	0.17	<0.01	0.17	19	5.20	<0.5	7.4	-13.8	3.7	NAF
THU105185	Basalt	CHTCRB	11	8.7	<0.05	<0.05	0.08	<0.01	0.08	12	2.45	<0.5	7.4	-9.6	4.9	NAF
THU105215	Basalt	CHTCRB	13	8.9	<0.05	<0.05	0.03	<0.01	0.03	24	0.92	<0.5	7.2	-23.1	26.2	NAF
THU105226	Basalt	CHTCRB	13	8.7	0.22	0.14	0.11	<0.01	0.11	33	3.36	<0.5	7.9	-29.6	9.8	NAF
THU105227	Basalt	CHTCRB	11	8.7	<0.05	<0.05	0.05	<0.01	0.05	16	1.53	<0.5	7	-14.5	10.5	NAF
THU105228	Basalt	CHTCRB	12	8.7	0.7	0.60	0.01	<0.01	0.01	63	0.31	<0.5	7.8	-62.7	205.9	NAF
THU105212	Basalt	QAHSC	11	8.4	1.02	0.96	0.02	<0.01	0.02	88	0.61	<0.5	8.3	-87.4	143.8	NAF
THU105213	Basalt	QAHSC	13	8.1	1.1	0.98	<0.01	0.03	<0.01	83	0.00	<0.5	8.1	-83.0	na	NAF
THU105214	Basalt	QAHSC	10	8.8	0.13	0.13	0.06	<0.01	0.06	23	1.84	<0.5	7.7	-21.2	12.5	NAF
THU105216	Basalt	QAHSC	10	8.9	<0.05	<0.05	0.03	<0.01	0.03	12	0.92	<0.5	7	-11.1	13.1	NAF
THU105186	Basalt	SERHEM	12	8.5	1.24	1.08	0.22	<0.01	0.22	100	6.73	<0.5	8.4	-93.3	14.9	NAF
THU105229	Basalt	SERHEM	12	8.5	1.09	0.97	0.08	<0.01	0.08	97	2.45	<0.5	8.2	-94.6	39.6	NAF
THU105217	Tonalite	QAHCH	12	8.3	0.34	0.29	0.02	<0.01	0.02	25	0.61	<0.5	7.3	-24.4	40.9	NAF
THU105238	Tonalite	QAHCH	14	8.4	0.44	0.38	0.07	<0.01	0.07	37	2.14	<0.5	7.9	-34.9	17.3	NAF
THU105240	Tonalite	QAHCH	13	8.5	<0.05	0.06	0.13	<0.01	0.13	15	3.98	<0.5	7.4	-11.0	3.8	NAF
THU105191	Tonalite	QAHCH	15	8.4	0.31	0.26	0.07	<0.01	0.07	25	2.14	<0.5	7.7	-22.9	11.7	NAF
THU105197	Tonalite	QAHCH	12	8.2	0.74	0.62	0.03	<0.01	0.03	56	0.92	<0.5	7.9	-55.1	61.0	NAF
THU105200	Tonalite	QAHCH	13	8.3	0.71	0.56	0.23	<0.01	0.23	53	7.04	<0.5	8.1	-46.0	7.5	NAF
THU105233	Tonalite	QAHCH	14	8.6	0.18	0.17	0.06	<0.01	0.06	23	1.84	<0.5	7.5	-21.2	12.5	NAF
THU105188	Tonalite	QAHCH	11	8.5	0.63	0.51	0.07	<0.01	0.07	48	2.14	<0.5	7.8	-45.9	22.4	NAF
THU105208	Tonalite	QAHCH	12	8.4	0.38	0.33	0.03	<0.01	0.03	30	0.92	<0.5	7.6	-29.1	32.7	NAF
THU105239	Tonalite	QAHSC	14	8.4	0.35	0.28	0.01	<0.01	0.01	29	0.31	<0.5	7.6	-28.7	94.8	NAF
THU105196	Tonalite	QAHSC	14	8.1	1.17	0.99	0.11	<0.01	0.11	74	3.36	<0.5	8.7	-70.6	22.0	NAF
THU105207	Tonalite	QAHSC	12	8.4	0.64	0.53	0.16	<0.01	0.16	50	4.89	<0.5	8.1	-45.1	10.2	NAF
THU105209	Tonalite	QAHSC	13	8.3	0.32	0.27	0.07	<0.01	0.07	21	2.14	<0.5	7.8	-18.9	9.8	NAF
THU105210	Tonalite	QAHSC	16	8.2	0.89	0.80	0.09	<0.01	0.09	57	2.75	<0.5	8.7	-54.2	20.7	NAF
THU105219	Tonalite	QAHSC	13	8.3	0.76	0.66	0.08	<0.01	0.08	59	2.45	<0.5	7.7	-56.6	24.1	NAF
THU105220	Tonalite	QAHSC	18	8.3	1.03	0.85	0.04	<0.01	0.04	74	1.22	<0.5	8.1	-72.8	60.5	NAF
THU105199	Tonalite	QAHSC/sulph	15	8.1	1.11	0.94	0.05	<0.01	0.05	71	1.53	<0.5	8.2	-69.5	46.4	NAF
THU105192	Tonalite	SERHEM	15	8.5	0.06	<0.05	<0.01	<0.01	<0.01	10	0.00	<0.5	7	-10.0	na	NAF
THU105193	Tonalite	SERHEM	14	8.4	0.17	0.18	0.01	<0.01	0.01	20	0.31	<0.5	7.4	-19.7	65.4	NAF
THU105194	Tonalite	SERHEM	11	8.7	<0.05	<0.05	0.01	<0.01	0.01	13	0.31	<0.5	6.9	-12.7	42.5	NAF
THU105195	Tonalite	SERHEM	13	8.6	0.1	0.11	0.02	<0.01	0.02	18	0.61	<0.5	7.4	-17.4	29.4	NAF

Sample No.	Lithology	Alteration	EC (1:5)	pH ($CaCl_2$)	C	TIC	S	S as SO_4	S oxid	ANC	MPA	NAG	NAGpH	NAPP	ANC/MPA	Class
			mS/m		%					kg H_2SO_4/t						
THU105198	Tonalite	SERHEM	13	8.4	0.48	0.39	0.02	<0.01	0.02	40	0.61	<0.5	7.8	-39.4	65.4	NAF
THU105231	Tonalite	SERHEM	15	8.6	0.18	0.16	0.14	<0.01	0.14	22	4.28	<0.5	7.5	-17.7	5.1	NAF
THU105232	Tonalite	SERHEM	13	8.7	<0.05	<0.05	0.02	<0.01	0.02	9	0.61	<0.5	6.8	-8.5	14.9	NAF
THU105234	Tonalite	SERHEM	17	8.6	0.15	0.12	0.24	<0.01	0.24	21	7.34	<0.5	7.8	-13.7	2.9	NAF
THU105189	Tonalite	SERHEM	14	8.6	0.16	0.15	0.05	<0.01	0.05	18	1.53	<0.5	7.5	-16.5	11.8	NAF
THU105190	Tonalite	SERHEM	18	8.5	0.32	0.22	0.42	<0.01	0.42	25	12.85	<0.5	8.5	-12.2	1.9	UNC
THU105206	Tonalite	SERHEM	13	8.5	0.22	0.18	0.05	<0.01	0.05	20	1.53	<0.5	7.6	-18.5	13.1	NAF
THU105211	Tonalite	SERHEM	13	8.4	0.52	0.44	0.05	<0.01	0.05	40	1.53	<0.5	7.7	-38.5	26.2	NAF
THU105221	Tonalite	SERHEM	12	8.6	<0.05	<0.05	0.04	<0.01	0.04	12	1.22	<0.5	6.9	-10.8	9.8	NAF
THU105222	Tonalite	SERHEM	13	8.3	0.79	0.60	0.26	<0.01	0.26	59	7.95	<0.5	8.1	-51.0	7.4	NAF
THU105237	Lamprophyre	CHTCRB	10	8.5	0.12	0.13	0.08	<0.01	0.08	25	2.45	<0.5	7.6	-22.6	10.2	NAF
THU105218	Lamprophyre	CHTCRB	20	8.1	5.82	4.09	<0.01	<0.01	<0.01	250	0.00	<0.5	8.8	-250.0	na	NAF
THU105230	Lamprophyre	QAHCH	21	8.3	1.8	1.69	0.05	0.03	0.02	160	0.61	<0.5	8.3	-159.4	261.5	NAF
THU105224	Lamprophyre	QAHCH	16	8.2	0.21	0.19	<0.01	<0.01	<0.01	18	0.00	<0.5	7.4	-18.0	na	NAF
THU105225	Lamprophyre	QAHCH	20	8	3.2	3.16	0.02	<0.01	0.02	220	0.61	<0.5	9	-219.4	359.6	ACM
THU105187	Lamprophyre	QASP/sulph	13	8.4	0.85	0.67	0.68	0.01	0.67	66	20.50	<0.5	8.3	-45.5	3.2	NAF
THU105204	Lamprophyre	SERHEM/sulph	26	8.1	2.94	2.89	0.18	0.01	0.17	220	5.20	<0.5	8.5	-214.8	42.3	ACM
THU105236	Vein	QTZ	17	8.3	<0.05	<0.05	<0.01	<0.01	<0.01	<0.5	0.00	<0.5	6.2	0.0	na	NAF
THU105241	Vein	QTZ	17	8.3	0.15	0.14	0.02	<0.01	0.02	14	0.61	<0.5	7.8	-13.4	22.9	NAF
THU105203	Vein	QTZ	11	8.4	<0.05	0.07	0.03	0.02	0.01	5	0.31	<0.5	7.7	-5.0	17.3	NAF
THU105242	Vein	QTZ	15	8.2	<0.05	<0.05	<0.01	<0.01	<0.01	<0.5	0.00	<0.5	5.9	0.0	na	NAF
THU105202	Vein	QTZ/sulph	18	8.1	1.01	0.81	0.26	0.05	0.21	71	6.42	<0.5	8.2	-64.6	11.1	NAF
THU105201	Vein/Tonalite	QAHSC/sulph	17	8.2	0.99	0.72	0.77	<0.01	0.77	71	23.55	<0.5	8.1	-47.4	3.0	NAF
Detection Limit			*1*	*0.1*	*0.05*	*0.05*	*0.01*	*0.01*		*0.5*		*0.5*	*0.5*			

7.1.2 Table B2 - Bulk Geochemistry Wonder Waste Material Results

Sample ID	Lithology	Alteration	Sulph	As	B	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Ni	P	Pb	Sb	Se	Th	Tl	U	V	Zn
				ppm								%	ppb	ppm													
THU105181	Andesite	QAHSC	No	0.6	X	1.67	0.28	X	12.2	64	29	1.59	3	9097	9416	275	0.7	26	514	9.1	0.33	X	7.07	0.13	4.66	36	40
THU105223	Andesite	CHTCRB	No	0.7	X	3.09	0.03	0.08	43.8	738	49	5.63	2	24408	60032	978	X	261	2445	13	0.27	X	11.8	0.72	2.93	120	92
THU105182	Andesite	SERHEM	No	1.1	X	3.51	0.2	0.03	16.4	62	4	1.64	2	28226	8679	317	0.1	26	525	31.2	0.27	X	7.49	0.6	6.28	35	51
THU105205	Andesite	SERHEM	No	0.9	X	2.78	0.34	0.02	17.9	93	11	2.08	2	24511	8574	363	0.2	39	667	32.6	0.58	X	7.72	0.42	4.81	45	51
THU105183	Basalt	CHTCRB	No	1.7	X	0.71	0.1	0.06	29.2	74	9	4.15	2	10710	18250	705	0.5	49	575	2.5	0.18	X	2.24	0.17	0.62	88	70
THU105184	Basalt	CHTCRB	No	3.1	X	0.88	0.24	0.09	54.8	62	28	9.24	3	7822	38850	1470	6.9	126	1355	5.2	0.6	X	0.65	0.12	0.29	191	122
THU105185	Basalt	CHTCRB	No	1.5	X	0.68	0.07	0.1	30.9	56	114	3.59	5	10520	16185	572	0.2	44	504	3.4	0.11	X	3.06	0.16	0.74	76	65
THU105215	Basalt	CHTCRB	No	0.8	X	0.84	0.04	0.03	32.5	23	1	7.76	2	23983	22826	494	0.4	22	1117	2.5	0.14	X	1.8	0.44	0.48	192	61
THU105226	Basalt	CHTCRB	No	1	X	0.98	0.04	0.03	29.2	X	15	8.04	X	18091	19824	825	0.4	9	982	5.4	0.15	X	1.84	0.32	0.54	189	93
THU105227	Basalt	CHTCRB	No	1	X	0.82	0.06	0.11	41.7	X	5	8.65	2	11299	20980	1440	0.4	9	1121	6.1	0.15	X	1.67	0.26	0.48	198	135
THU105228	Basalt	CHTCRB	No	0.9	X	0.82	X	0.1	29.6	40	9	5.13	2	12265	28382	1380	7.1	71	827	5.9	0.17	X	1.78	0.2	0.46	116	281
THU105235	Basalt	CHTCRB	No	0.7	X	1.25	0.07	X	32.2	X	2	6.22	2	3290	13693	1467	2	4	1668	3.6	0.11	X	2.96	0.08	0.81	90	66
THU105212	Basalt	QAHSC	No	1.5	X	1.04	0.05	0.04	34.6	X	2	7.49	1	14090	18980	1084	0.5	11	1040	7.9	0.59	X	1.29	0.25	0.36	183	137
THU105213	Basalt	QAHSC	No	0.5	X	0.65	0.02	0.04	20.5	X	X	3.97	1	26264	11878	639	0.7	11	623	3.3	0.22	X	2.22	0.32	0.57	94	64
THU105214	Basalt	QAHSC	No	3.9	X	0.92	0.11	0.07	51.1	66	24	9.3	2	8457	39923	1472	0.8	137	1393	4.4	1.59	X	0.7	0.14	0.42	201	120
THU105216	Basalt	QAHSC	No	1.5	X	0.68	0.06	0.08	37.4	41	6	6.4	X	9688	27147	961	0.6	82	1036	3.3	0.46	X	1.39	0.11	0.41	144	86
THU105186	Basalt	SERHEM	No	1.2	X	1.16	0.09	0.04	26.1	87	6	5.16	X	14597	22021	1122	0.9	65	538	4.8	0.26	X	3.52	0.44	0.87	107	121
THU105229	Basalt	SERHEM	No	0.8	X	1.36	0.03	0.04	27.5	X	9	7.87	1	20560	21861	977	0.2	10	1056	5.1	0.18	X	2.66	0.4	0.81	187	165
THU105188	Tonalite	QAHCH	No	1.1	X	1.28	0.13	X	14.6	14	10	2.64	X	18221	6824	488	3	7	533	6.2	0.38	X	5.53	0.3	1.21	42	58
THU105191	Tonalite	QAHCH	No	X	X	1.2	0.03	X	21.1	13	7	1.27	4	21013	3614	264	0.4	5	214	11.3	0.14	X	7.77	0.25	1.67	16	31
THU105197	Tonalite	QAHCH	No	0.6	X	0.84	0.01	X	16.4	16	8	2.11	3	12585	5470	397	0.6	10	399	5	0.29	X	5.22	0.17	0.34	29	45
THU105200	Tonalite	QAHCH	No	0.9	X	1.63	0.14	X	19.6	15	9	2.2	1	14173	5473	355	1.1	9	377	7.2	0.32	X	6.84	0.19	0.98	35	43
THU105208	Tonalite	QAHCH	No	0.7	X	1.24	0.02	X	19.1	8	3	2.03	2	12452	5978	363	0.3	6	403	3.8	0.2	X	5.17	0.17	0.71	27	46
THU105217	Tonalite	QAHCH	No	X	X	1.13	0.01	X	24.2	9	1	1.26	5	20266	3134	225	0.5	3	225	7.1	0.12	X	7.03	0.23	1.35	15	30
THU105233	Tonalite	QAHCH	No	1.5	X	1.22	0.05	0.03	23.4	14	7	2.44	3	13253	7631	442	0.4	10	448	6.6	0.46	X	7.54	0.15	0.74	42	51
THU105238	Tonalite	QAHCH	No	X	X	1.32	0.07	0.02	21.1	15	13	2.08	4	17213	7370	370	0.4	9	397	3.8	0.19	X	6.61	0.25	0.91	33	49
THU105240	Tonalite	QAHCH	No	0.6	X	0.84	0.03	0.38	28.8	15	106	2.58	13	12582	7049	417	1.3	8	270	5.7	0.08	X	6.72	0.18	0.67	35	250
THU105196	Tonalite	QAHSC	No	0.7	X	1.25	0.03	0.04	15.9	14	12	2.22	2	19193	6488	440	0.5	10	405	12.1	0.39	X	5.83	0.26	0.76	37	45
THU105199	Tonalite	QAHSC	Yes	X	X	1.29	0.03	0.03	13.5	14	43	1.89	1	18034	6109	411	0.4	8	375	6.9	0.29	X	5.74	0.25	1.07	36	49
THU105207	Tonalite	QAHSC	No	1	X	1.57	0.13	X	16.1	10	11	1.64	5	12885	5273	295	0.7	7	310	6.8	0.39	X	4.3	0.17	0.65	33	36
THU105209	Tonalite	QAHSC	No	0.8	X	1.38	0.04	X	19.6	X	24	0.87	3	10656	1012	99	0.8	1	X	4.9	0.14	X	6.2	0.11	3.19	3	15
THU105210	Tonalite	QAHSC	No	0.8	X	1.3	0.04	0.02	24.4	X	45	3.21	2	19046	7138	319	2	6	347	6.4	0.37	X	7.71	0.33	1.1	28	52
THU105219	Tonalite	QAHSC	No	0.9	X	1.23	0.04	0.03	13	9	6	2.34	3	17982	5985	472	0.3	6	454	10.3	0.66	X	8.51	0.21	2.16	38	51
THU105220	Tonalite	QAHSC	No	1.3	X	1.6	0.03	X	16.8	8	4	2.36	1	18952	5519	436	0.3	6	556	15	1.2	X	5.24	0.26	0.95	46	39
THU105239	Tonalite	QAHSC	No	X	X	0.86	0.03	X	20.8	12	11	2.11	2	14044	7314	395	0.4	7	364	6.1	0.07	X	6.27	0.22	0.99	31	52
THU105189	Tonalite	SERHEM	No	1.5	X	0.94	0.11	X	16.9	8	4	1.85	2	12613	4464	304	0.3	4	349	8.7	0.5	X	4.72	0.18	0.67	27	43
THU105190	Tonalite	SERHEM	No	1.3	X	1.08	0.09	0.05	27.7	6	56	2.28	9	8748	1006	261	1.6	X	67	6.7	0.18	X	6.04	0.1	1.36	5	30
THU105192	Tonalite	SERHEM	No	X	X	1.33	0.02	X	30.2	17	X	1.35	6	21645	3404	347	0.7	5	243	7.4	X	X	8.5	0.19	1.72	18	30
THU105193	Tonalite	SERHEM	No	1.1	X	0.95	0.02	X	26.8	15	9	2.41	2	13311	7323	490	0.6	10	469	11.8	0.15	X	5.73	0.21	1.06	38	56
THU105194	Tonalite	SERHEM	No	0.6	X	0.9	0.03	0.03	46.8	14	6	2.19	4	11965	6319	399	0.7	10	428	4.9	X	X	4.15	0.17	1.06	36	48
THU105195	Tonalite	SERHEM	No	0.8	X	0.9	0.01	X	39.7	15	10	2.43	4	10890	6801	415	0.5	10	457	5.1	0.15	X	6.57	0.14	0.65	38	51
THU105198	Tonalite	SERHEM	No	0.9	X	1.16	0.03	0.02	19.2	24	15	2.41	3	12909	8301	461	0.6	14	450	7	0.17	X	4.73	0.18	1.96	42	51
THU105206	Tonalite	SERHEM	No	1	X	1.1	0.07	0.05	22.2	10	6	1.96	3	12215	5780	415	0.5	7	395	9.4	0.21	X	5.17	0.15	1.18	29	47
THU105211	Tonalite	SERHEM	No	1	X	1.55	0.01	X	24.7	X	2	1.95	4	14680	3463	297	2.2	1	340	2.7	0.26	X	5.18	0.17	0.8	22	32
THU105221	Tonalite	SERHEM	No	0.9	X	0.99	0.04	0.04	28.5	10	19	3.1	3	11910	8886	485	0.3	11	555	4.9	0.11	X	5.11	0.21	1.1	57	53
THU105222	Tonalite	SERHEM	No	1.1	X	0.97	0.09	0.03	15.8	X	5	2.57	2	8282	5121	407	0.4	3	516	8.2	0.58	X	5.08	0.11	1.27	29	51

Sample ID	Lithology	Alteration	Sulph	As	B	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Ni	P	Pb	Sb	Se	Th	Tl	U	V	Zn
				ppm								%	ppb	ppm													
THU105231	Tonalite	SERHEM	No	1.9	X	1.19	0.07	0.02	21.3	14	6	2.38	2	15469	7083	454	0.4	10	454	7.9	0.51	X	6.24	0.23	0.88	39	54
THU105232	Tonalite	SERHEM	No	1.5	X	0.85	0.02	0.07	28.9	12	10	2.36	5	11189	6710	455	0.4	10	467	7.6	0.26	X	5.83	0.15	0.88	38	110
THU105234	Tonalite	SERHEM	No	1	X	1.05	0.82	0.03	23.9	12	8	2.13	4	10132	6502	409	0.7	9	408	25.7	0.09	X	4.38	0.13	0.86	35	46
THU105218	Lamprophyre	CHTCRB	No	0.8	X	2.61	0.09	0.12	49	1191	23	5.69	X	20054	75501	999	0.4	398	1124	13.7	0.98	X	3.06	0.36	0.96	127	125
THU105237	Lamprophyre	CHTCRB	No	1	X	1.11	0.09	0.05	45.8	33	40	7.56	2	13071	26745	1330	1	34	1759	6.7	0.24	X	1.62	0.32	0.51	259	135
THU105224	Lamprophyre	QAHCH	No	0.6	X	1.73	0.03	0.11	25.5	X	6	2.19	5	16422	1310	220	1.6	X	73	6.5	0.06	X	6.6	0.14	1.36	X	42
THU105225	Lamprophyre	QAHCH	No	0.7	X	2.06	0.03	0.08	27.2	38	12	5.12	X	22732	21288	1081	0.2	62	710	5.8	1.05	X	1.99	0.35	0.59	132	65
THU105230	Lamprophyre	QAHCH	No	0.8	X	2.04	1.21	0.08	34.5	304	27	5.14	1	3404	28946	1051	X	147	1770	47.7	0.42	X	6.03	0.11	2.28	123	116
THU105187	Lamprophyre	QASP	Yes	1.6	X	0.9	8.58	X	20.5	71	22	1.88	14	3230	7574	342	90.1	18	256	70.3	0.5	0.8	3.36	0.21	2.09	26	29
THU105204	Lamprophyre	SERHEM	Yes	0.8	X	2.16	0.16	0.08	31.9	255	71	5.72	2	17812	35743	889	0.6	69	1302	12.8	0.64	X	2.31	0.55	0.72	181	96
THU105242	vein	Fresh	No	X	X	X	0.01	X	104.8	X	X	0.05	5	268	205	8	0.1	X	X	X	X	X	0.03	X	0.01	X	2
THU105202	vein	QTZ	Yes	X	X	1.17	0.14	0.04	23.5	12	9	1.4	4	13751	3395	374	1.5	6	267	2.5	0.21	X	2.75	0.19	0.38	34	22
THU105203	vein	QTZ	No	X	X	X	X	X	105.9	10	1	0.04	6	193	74	28	0.4	X	X	0.7	0.16	X	0.04	X	0.02	X	1
THU105236	vein	QTZ	No	X	X	0.08	X	X	93.8	9	1	0.13	4	391	387	11	0.2	X	X	0.5	X	X	0.1	X	0.02	1	2
THU105241	vein	QTZ	No	X	X	0.29	0.03	X	61	10	2	0.63	6	4035	2479	150	0.4	3	117	0.8	X	X	1.6	0.07	0.25	10	14
THU105201	Vein/Tonalite	QAHSC	Yes	0.7	X	1.19	1.05	X	20.1	13	14	1.72	3	8931	3481	391	1.4	9	446	8.4	0.3	X	3.76	0.12	0.37	32	19
Detection Limit				*0.5*	*50*	*0.05*	*0.01*	*0.02*	*0.1*	*5*	*1*	*0.01*	*1*	*20*	*20*	*1*	*0.1*	*1*	*50*	*0.5*	*0.05*	*0.5*	*0.01*	*0.02*	*0.01*	*1*	*1*
Soil Ecological Investigation Levels[1]				20				3	50	400	100		1000			500	40	60		600						50	200
Soil Health investigation levels for parks and recreation use[2]				200	6000	40		40	200	24000	2000		30000			3000		600		600							14000
ISQG (Sediments) Low[3]				70				1.5			65		450					21		50	2						200
ISQG (sediments) High[3]				70				10			270		1000					52		220	25						410
Global Median Soil Content[4]				6		6		0.35	8	70	30	0.04	0.06	1.40%	5000	1000	2	50		35	5	0.4		0.5	2	90	90
Average Crustal Abundance[5]				1.5	10			0.11	20	100	50	0.041	0.05	2.30%	2.30%	950	1.5	80		14	0.2	0.05			2.4	160	75

[1] Ecological investigation levels - Department of Environment and Conservation 2010. *Contaminated Sites Management Series*, Assessment levels for Soil.

[2] Health investigation levels (for parks and recreation) - Department of Environment and Conservation 2010. Contaminated Sites Management Series, Assessment levels for Soil.

[3] Interim Sediment Quality Guidelines -adopted by the Department of Environment and Conservation in the 2010 Contaminated Sites Management Series, and originating from ANZECC & ARMCANZ (2000)

[4] Average crustal abundance (GARD Guide).

[5] Median Soil Value (GARD Guide).

7.1.3 Table B3 - Geochemical Abundance Indices for Wonder Waste Materials

Sample ID	Lithology	Alteration	Sulphs	As	B	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Ni	P	Pb	Sb	Se	Th	Tl	U	V	Zn
				ppm								%	ppb	ppm													
THU105181	Andesite	QAHSC	No	0.6	X	1.67	0.28	X	12.2	64	29	1.59	3	9097	9416	275	0.7	26	514	9.1	0.33	X	7.07	0.13	4.66	36	40
THU105223	Andesite	CHTCRB	No	0.7	X	3.09	0.03	0.08	43.8	738	49	5.63	2	24408	60032	978	X	261	2445	13	0.27	X	11.8	0.72	2.93	120	92
THU105182	Andesite	SERHEM	No	1.1	X	3.51	0.2	0.03	16.4	62	4	1.64	2	28226	8679	317	0.1	26	525	31.2	0.27	X	7.49	0.6	6.28	35	51
THU105205	Andesite	SERHEM	No	0.9	X	2.78	0.34	0.02	17.9	93	11	2.08	2	24511	8574	363	0.2	39	667	32.6	0.58	X	7.72	0.42	4.81	45	51
THU105183	Basalt	CHTCRB	No	1.7	X	0.71	0.1	0.06	29.2	74	9	4.15	2	10710	18250	705	0.5	49	575	2.5	0.18	X	2.24	0.17	0.62	88	70
THU105184	Basalt	CHTCRB	No	3.1	X	0.88	0.24	0.09	54.8	62	28	9.24	3	7822	38850	1470	6.9	126	1355	5.2	0.6	X	0.65	0.12	0.29	191	122
THU105185	Basalt	CHTCRB	No	1.5	X	0.68	0.07	0.1	30.9	56	114	3.59	5	10520	16185	572	0.2	44	504	3.4	0.11	X	3.06	0.16	0.74	76	65
THU105215	Basalt	CHTCRB	No	0.8	X	0.84	0.04	0.03	32.5	23	1	7.76	2	23983	22826	494	0.4	22	1117	2.5	0.14	X	1.8	0.44	0.48	192	61
THU105226	Basalt	CHTCRB	No	1	X	0.98	0.04	0.03	29.2	X	15	8.04	X	18091	19824	825	0.4	9	982	5.4	0.15	X	1.84	0.32	0.54	189	93
THU105227	Basalt	CHTCRB	No	1	X	0.82	0.06	0.11	41.7	X	5	8.65	2	11299	20980	1440	0.4	9	1121	6.1	0.15	X	1.67	0.26	0.48	198	135
THU105228	Basalt	CHTCRB	No	0.9	X	0.82	X	0.1	29.6	40	9	5.13	2	12265	28382	1380	7.1	71	827	5.9	0.17	X	1.78	0.2	0.46	116	281
THU105235	Basalt	CHTCRB	No	0.7	X	1.25	0.07	X	32.2	X	2	6.22	2	3290	13693	1467	2	4	1668	3.6	0.11	X	2.96	0.08	0.81	90	66
THU105212	Basalt	QAHSC	No	1.5	X	1.04	0.05	0.04	34.6	X	2	7.49	1	14090	18980	1084	0.5	11	1040	7.9	0.59	X	1.29	0.25	0.36	183	137
THU105213	Basalt	QAHSC	No	0.5	X	0.65	0.02	0.04	20.5	X	X	3.97	1	26264	11878	639	0.7	11	623	3.3	0.22	X	2.22	0.32	0.57	94	64
THU105214	Basalt	QAHSC	No	3.9	X	0.92	0.11	0.07	51.1	66	24	9.3	2	8457	39923	1472	0.8	137	1393	4.4	1.59	X	0.7	0.14	0.42	201	120
THU105216	Basalt	QAHSC	No	1.5	X	0.68	0.06	0.08	37.4	41	6	6.4	X	9688	27147	961	0.6	82	1036	3.3	0.46	X	1.39	0.11	0.41	144	86
THU105186	Basalt	SERHEM	No	1.2	X	1.16	0.09	0.04	26.1	87	6	5.16	X	14597	22021	1122	0.9	65	538	4.8	0.26	X	3.52	0.44	0.87	107	121
THU105229	Basalt	SERHEM	No	0.8	X	1.36	0.03	0.04	27.5	X	9	7.87	1	20560	21861	977	0.2	10	1056	5.1	0.18	X	2.66	0.4	0.81	187	165
THU105188	Tonalite	QAHCH	No	1.1	X	1.28	0.13	X	14.6	14	10	2.64	X	18221	6824	488	3	7	533	6.2	0.38	X	5.53	0.3	1.21	42	58
THU105191	Tonalite	QAHCH	No	X	X	1.2	0.03	X	21.1	13	7	1.27	4	21013	3614	264	0.4	5	214	11.3	0.14	X	7.77	0.25	1.67	16	31
THU105197	Tonalite	QAHCH	No	0.6	X	0.84	0.01	X	16.4	16	8	2.11	3	12585	5470	397	0.6	10	399	5	0.29	X	5.22	0.17	0.34	29	45
THU105200	Tonalite	QAHCH	No	0.9	X	1.63	0.14	X	19.6	15	9	2.2	1	14173	5473	355	1.1	9	377	7.2	0.32	X	6.84	0.19	0.98	35	43
THU105208	Tonalite	QAHCH	No	0.7	X	1.24	0.02	X	19.1	8	3	2.03	2	12452	5978	363	0.3	6	403	3.8	0.2	X	5.17	0.17	0.71	27	46
THU105217	Tonalite	QAHCH	No	X	X	1.13	0.01	X	24.2	9	1	1.26	5	20266	3134	225	0.5	3	225	7.1	0.12	X	7.03	0.23	1.35	15	30
THU105233	Tonalite	QAHCH	No	1.5	X	1.22	0.05	0.03	23.4	14	7	2.44	3	13253	7631	442	0.4	10	448	6.6	0.46	X	7.54	0.15	0.74	42	51
THU105238	Tonalite	QAHCH	No	X	X	1.32	0.07	0.02	21.1	15	13	2.08	4	17213	7370	370	0.4	9	397	3.8	0.19	X	6.61	0.25	0.91	33	49
THU105240	Tonalite	QAHCH	No	0.6	X	0.84	0.03	0.38	28.8	15	106	2.58	13	12582	7049	417	1.3	8	270	5.7	0.08	X	6.72	0.18	0.67	35	250
THU105196	Tonalite	QAHSC	No	0.7	X	1.25	0.03	0.04	15.9	14	12	2.22	2	19193	6488	440	0.5	10	405	12.1	0.39	X	5.83	0.26	0.76	37	45
THU105199	Tonalite	QAHSC	Yes	X	X	1.29	0.03	0.03	13.5	14	43	1.89	1	18034	6109	411	0.4	8	375	6.9	0.29	X	5.74	0.25	1.07	36	49
THU105207	Tonalite	QAHSC	No	1	X	1.57	0.13	X	16.1	10	11	1.64	5	12885	5273	295	0.7	7	310	6.8	0.39	X	4.3	0.17	0.65	33	36
THU105209	Tonalite	QAHSC	No	0.8	X	1.38	0.04	X	19.6	X	24	0.87	3	10656	1012	99	0.8	1	X	4.9	0.14	X	6.2	0.11	3.19	3	15
THU105210	Tonalite	QAHSC	No	0.8	X	1.3	0.04	0.02	24.4	X	45	3.21	2	19046	7138	319	2	6	347	6.4	0.37	X	7.71	0.33	1.1	28	52
THU105219	Tonalite	QAHSC	No	0.9	X	1.23	0.04	0.03	13	9	6	2.34	3	17982	5985	472	0.3	6	454	10.3	0.66	X	8.51	0.21	2.16	38	51
THU105220	Tonalite	QAHSC	No	1.3	X	1.6	0.03	X	16.8	8	4	2.36	1	18952	5519	436	0.3	6	556	15	1.2	X	5.24	0.26	0.95	46	39
THU105239	Tonalite	QAHSC	No	X	X	0.86	0.03	X	20.8	12	11	2.11	2	14044	7314	395	0.4	7	364	6.1	0.07	X	6.27	0.22	0.99	31	52
THU105189	Tonalite	SERHEM	No	1.5	X	0.94	0.11	X	16.9	8	4	1.85	2	12613	4464	304	0.3	4	349	8.7	0.5	X	4.72	0.18	0.67	27	43
THU105190	Tonalite	SERHEM	No	1.3	X	1.08	0.09	0.05	27.7	6	56	2.28	9	8748	1006	261	1.6	X	67	6.7	0.18	X	6.04	0.1	1.36	5	30
THU105192	Tonalite	SERHEM	No	X	X	1.33	0.02	X	30.2	17	X	1.35	6	21645	3404	347	0.7	5	243	7.4	X	X	8.5	0.19	1.72	18	30
THU105193	Tonalite	SERHEM	No	1.1	X	0.95	0.02	X	26.8	15	9	2.41	2	13311	7323	490	0.6	10	469	11.8	0.15	X	5.73	0.21	1.06	38	56
THU105194	Tonalite	SERHEM	No	0.6	X	0.9	0.03	0.03	46.8	14	6	2.19	4	11965	6319	399	0.7	10	428	4.9	X	X	4.15	0.17	1.06	36	48
THU105195	Tonalite	SERHEM	No	0.8	X	0.9	0.01	X	39.7	15	10	2.43	4	10890	6801	415	0.5	10	457	5.1	0.15	X	6.57	0.14	0.65	38	51
THU105198	Tonalite	SERHEM	No	0.9	X	1.16	0.03	0.02	19.2	24	15	2.41	3	12909	8301	461	0.6	14	450	7	0.17	X	4.73	0.18	1.96	42	51
THU105206	Tonalite	SERHEM	No	1	X	1.1	0.07	0.05	22.2	10	6	1.96	3	12215	5780	415	0.5	7	395	9.4	0.21	X	5.17	0.15	1.18	29	47
THU105211	Tonalite	SERHEM	No	1	X	1.55	0.01	X	24.7	X	2	1.95	4	14680	3463	297	2.2	1	340	2.7	0.26	X	5.18	0.17	0.8	22	32

Sample ID	Lithology	Alteration	Sulphs	As	B	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Ni	P	Pb	Sb	Se	Th	Tl	U	V	Zn
				ppm								%	ppb	ppm													
THU105221	Tonalite	SERHEM	No	0.9	X	0.99	0.04	0.04	28.5	10	19	3.1	3	11910	8886	485	0.3	11	555	4.9	0.11	X	5.11	0.21	1.1	57	53
THU105222	Tonalite	SERHEM	No	1.1	X	0.97	0.09	0.03	15.8	X	5	2.57	2	8282	5121	407	0.4	3	516	8.2	0.58	X	5.08	0.11	1.27	29	51
THU105231	Tonalite	SERHEM	No	1.9	X	1.19	0.07	0.02	21.3	14	6	2.38	2	15469	7083	454	0.4	10	454	7.9	0.51	X	6.24	0.23	0.88	39	54
THU105232	Tonalite	SERHEM	No	1.5	X	0.85	0.02	0.07	28.9	12	10	2.36	5	11189	6710	455	0.4	10	467	7.6	0.26	X	5.83	0.15	0.88	38	110
THU105234	Tonalite	SERHEM	No	1	X	1.05	0.82	0.03	23.9	12	8	2.13	4	10132	6502	409	0.7	9	408	25.7	0.09	X	4.38	0.13	0.86	35	46
THU105218	Lamprophyre	CHTCRB	No	0.8	X	2.61	0.09	0.12	49	1191	23	5.69	X	20054	75501	999	0.4	398	1124	13.7	0.98	X	3.06	0.36	0.96	127	125
THU105237	Lamprophyre	CHTCRB	No	1	X	1.11	0.09	0.05	45.8	33	40	7.56	2	13071	26745	1330	1	34	1759	6.7	0.24	X	1.62	0.32	0.51	259	135
THU105224	Lamprophyre	QAHCH	No	0.6	X	1.73	0.03	0.11	25.5	X	6	2.19	5	16422	1310	220	1.6	X	73	6.5	0.06	X	6.6	0.14	1.36	X	42
THU105225	Lamprophyre	QAHCH	No	0.7	X	2.06	0.03	0.08	27.2	38	12	5.12	X	22732	21288	1081	0.2	62	710	5.8	1.05	X	1.99	0.35	0.59	132	65
THU105230	Lamprophyre	QAHCH	No	0.8	X	2.04	1.21	0.08	34.5	304	27	5.14	1	3404	28946	1051	X	147	1770	47.7	0.42	X	6.03	0.11	2.28	123	116
THU105187	Lamprophyre	QASP	Yes	1.6	X	0.9	8.58	X	20.5	71	22	1.88	14	3230	7574	342	90.1	18	256	70.3	0.5	0.8	3.36	0.21	2.09	26	29
THU105204	Lamprophyre	SERHEM	Yes	0.8	X	2.16	0.16	0.08	31.9	255	71	5.72	2	17812	35743	889	0.6	69	1302	12.8	0.64	X	2.31	0.55	0.72	181	96
THU105242	vein	Fresh	No	X	X	X	0.01	X	104.8	X	X	0.05	5	268	205	8	0.1	X	X	X	X	X	0.03	X	0.01	X	2
THU105202	vein	QTZ	Yes	X	X	1.17	0.14	0.04	23.5	12	9	1.4	4	13751	3395	374	1.5	6	267	2.5	0.21	X	2.75	0.19	0.38	34	22
THU105203	vein	QTZ	No	X	X	X	X	X	105.9	10	1	0.04	6	193	74	28	0.4	X	X	0.7	0.16	X	0.04	X	0.02	X	1
THU105236	vein	QTZ	No	X	X	0.08	X	X	93.8	9	1	0.13	4	391	387	11	0.2	X	X	0.5	X	X	0.1	X	0.02	1	2
THU105241	vein	QTZ	No	X	X	0.29	0.03	X	61	10	2	0.63	6	4035	2479	150	0.4	3	117	0.8	X	X	1.6	0.07	0.25	10	14
THU105201	Vein/Tonalite	QAHSC	Yes	0.7	X	1.19	1.05	X	20.1	13	14	1.72	3	8931	3481	391	1.4	9	446	8.4	0.3	X	3.76	0.12	0.37	32	19
Detection Limit				*0.5*	*50*	*0.05*	*0.01*	*0.02*	*0.1*	*5*	*1*	*0.01*	*1*	*20*	*20*	*1*	*0.1*	*1*	*50*	*0.5*	*0.05*	*0.5*	*0.01*	*0.02*	*0.01*	*1*	*1*
GAI 3				72	360	72	3.6	4.2	96	840	360		720			12000	24	600	9600	420	60	4.8	108	6	24	1080	1080
GAI 6				576	2880	576	28.8	33.6	768	6720	2880		576			96000	192	4800	76800	3360	480	38.4	864	48	192	8640	8640

The Geochemical Abundance Index (GAI)

One measure of enrichment of elements in whole rock samples is the Geochemical Abundance Index (GAI). The GAI compares the actual concentration of an element in a sample with the median abundance for that element in the most relevant media (such as crustal abundance, soils, or a particular rock type). The main purpose of the GAI is to provide an indication of any elemental enrichments that may be of environmental importance. The GAI for an element is calculated as follows:

GAI = log2 [C / (1.5*S)]

where C is the concentration of the element in the sample and S is the median content for that element in the reference material (mean world soil, crustal abundance, etc). The GAI values are truncated to integer increments (0 through to 6, respectively) where a GAI of 0 indicates the element is present at a concentration similar to, or less than, median abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above median abundance. The actual enrichment ranges for the GAI values are as follow:

GAI=0 represents <3 times median soil content

GAI=1 represents 3 to 6 times median soil content

GAI=2 represents 6 to 12 times median soil content

GAI=3 represents 12 to 24 times median soil content

GAI=4 represents 24 to 48 times median soil content

GAI=5 represents 48 to 96 times median soil content

GAI=6 represents more than 96 times median soil content

As a general guide, a GAI of 3 or above is considered significant and such an enrichment may warrant further examination.

Table 1 presents an example of the elemental composition of mineralized mine rock and corresponding GAI values compared to median world soil concentrations.

7.1.4 *Table B4 - Leachate Results of Wonder Waste*

Sample ID	Lithology	Alteration	As	B	Be	Bi	Cd	Co	Cr	CrVI	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Se	Th	Tl	U	V	Zn	pH
			mg/L																					
THU105223	Andesite	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	0.0017	<0.004	<0.0001	<0.005	<0.0001	0.0005	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0086	0.003	9.3
THU105181	Andesite	QAHSC	<0.001	0.008	<0.0001	<0.0001	<0.0001	<0.0001	0.0006	<0.004	<0.0001	<0.005	<0.0001	0.0004	0.003	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.013	0.001	9.3
THU105182	Andesite	SERHEM	<0.001	0.012	<0.0001	<0.0001	<0.0001	0.0002	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0003	0.015	0.001	9.5
THU105205	Andesite	SERHEM	<0.001	0.006	<0.0001	<0.0001	<0.0001	0.0007	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0045	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.0033	0.001	8.2
THU105183	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	0.0002	0.007	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0045	<0.001	9.2
THU105184	Basalt	CHTCRB	<0.001	0.006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	0.007	<0.0001	0.0002	0.002	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0095	<0.001	9.4
THU105185	Basalt	CHTCRB	0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0046	0.001	9.4
THU105215	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0005	<0.0005	<0.004	<0.0001	0.058	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.012	0.002	9.4
THU105226	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	0.017	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0093	0.002	9.2
THU105227	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	0.008	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0066	0.006	9.1
THU105228	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	0.001	0.006	<0.0001	0.0005	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.008	0.002	9.3
THU105235	Basalt	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	0.007	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0053	<0.001	9.1
THU105212	Basalt	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0015	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0056	0.002	9.1
THU105213	Basalt	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0009	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0011	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0045	0.003	9.2
THU105214	Basalt	QAHSC	<0.001	0.005	<0.0001	<0.0001	<0.0001	0.0006	<0.0005	<0.004	<0.0001	0.006	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0093	0.001	9.3
THU105216	Basalt	QAHSC	<0.001	0.008	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0001	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.007	0.001	9.3
THU105186	Basalt	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0005	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0072	0.001	9.4
THU105229	Basalt	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.011	0.004	9.1
THU105188	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0011	0.002	<0.001	0.0002	<0.001	<0.0001	<0.0001	0.0002	0.0051	0.016	9.4
THU105191	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0009	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0003	0.0028	<0.001	9.2
THU105197	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0008	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0015	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0031	<0.001	8
THU105200	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0013	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.0042	0.002	9.1
THU105208	Tonalite	QAHCH	<0.001	0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.003	0.004	9.3
THU105217	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0004	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0003	0.0025	0.001	9.3
THU105233	Tonalite	QAHCH	<0.001	0.008	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0062	0.002	9.3
THU105238	Tonalite	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0021	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0005	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0001	0.0045	<0.001	9.1
THU105240	Tonalite	QAHCH	<0.001	0.006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0038	0.004	9.3
THU105196	Tonalite	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0007	<0.0005	<0.004	0.0004	<0.005	<0.0001	0.0021	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.0023	0.001	9
THU105199	Tonalite	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0022	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0005	0.0026	0.003	9.2
THU105207	Tonalite	QAHSC	<0.001	0.006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0007	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0038	0.006	9.4
THU105209	Tonalite	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	<0.0001	0.005	<0.0001	0.0017	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0024	0.0006	0.003	9.3
THU105210	Tonalite	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0014	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0003	0.0019	0.005	9.3
THU105219	Tonalite	QAHSC	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0014	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0005	0.0041	0.004	9.2
THU105220	Tonalite	QAHSC	<0.001	0.008	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	0.0001	0.009	<0.0001	0.0018	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0003	0.0057	0.005	9.3
THU105239	Tonalite	QAHSC	<0.001	0.006	<0.0001	0.0003	<0.0001	<0.0001	<0.0005	<0.004	0.0003	<0.005	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0047	0.011	9.3
THU105189	Tonalite	SERHEM	<0.001	0.005	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0051	0.013	9.5
THU105190	Tonalite	SERHEM	<0.001	0.007	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	0.0002	0.005	<0.0001	0.0015	0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0006	0.0014	0.006	9.4
THU105192	Tonalite	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0008	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.0031	<0.001	9.4
THU105193	Tonalite	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0002	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0002	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0032	0.008	9.3
THU105194	Tonalite	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0004	<0.0005	<0.004	0.0001	0.007	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0035	0.013	9.4
THU105195	Tonalite	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0039	0.011	9.3
THU105198	Tonalite	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0001	0.0006	<0.004	<0.0001	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0001	0.0053	0.002	9.3
THU105206	Tonalite	SERHEM	<0.001	0.007	<0.0001	<0.0001	<0.0001	0.0009	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.003	0.001	9.3
THU105211	Tonalite	SERHEM	<0.001	0.011	<0.0001	<0.0001	<0.0001	0.0002	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0001	0.0034	0.01	9.4
THU105221	Tonalite	SERHEM	<0.001	0.015	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	0.009	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0049	0.005	9.2

Sample ID	Lithology	Alteration	As	B	Be	Bi	Cd	Co	Cr	CrVI	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Se	Th	Tl	U	V	Zn	pH
			mg/L																					
THU105222	Tonalite	SERHEM	<0.001	0.007	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0012	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0002	0.0026	0.006	9.2
THU105231	Tonalite	SERHEM	<0.001	0.007	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	0.006	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0053	0.005	9.4
THU105232	Tonalite	SERHEM	<0.001	0.009	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0028	0.001	9.2
THU105234	Tonalite	SERHEM	<0.001	0.009	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0045	<0.001	9.3
THU105218	Lamprophyre	CHTCRB	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	0.0013	<0.004	0.0001	<0.005	<0.0001	0.0006	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0067	0.001	9.3
THU105237	Lamprophyre	CHTCRB	<0.001	0.006	<0.0001	0.0004	<0.0001	<0.0001	<0.0005	<0.004	0.0003	<0.005	<0.0001	0.0002	<0.001	<0.001	0.0002	<0.001	<0.0001	<0.0001	<0.0001	0.012	0.023	9.2
THU105224	Lamprophyre	QAHCH	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0004	0.002	<0.001	<0.0001	<0.001	<0.0001	<0.0001	0.0004	0.0004	0.002	9
THU105225	Lamprophyre	QAHCH	<0.001	0.006	<0.0001	<0.0001	<0.0001	0.0004	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0026	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0024	0.002	9
THU105230	Lamprophyre	QAHCH	<0.001	0.011	<0.0001	<0.0001	<0.0001	0.0002	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0013	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0016	0.001	8.6
THU105187	Lamprophyre	QASP	<0.001	0.008	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0009	0.36	<0.001	0.0004	0.003	<0.0001	0.0001	<0.0001	0.0044	0.003	8.9
THU105204	Lamprophyre	SERHEM	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0011	0.0014	<0.004	0.0001	<0.005	<0.0001	0.0013	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0085	0.001	9.2
THU105202	vein	QTZ	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0003	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0025	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0014	<0.001	8.8
THU105203	vein	QTZ	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.029	<0.0005	<0.004	0.0002	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0002	0.002	9.1
THU105236	vein	QTZ	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.27	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0007	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	6.8
THU105241	vein	QTZ	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.0004	<0.0005	<0.004	0.0001	<0.005	<0.0001	0.0004	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0023	0.012	9.3
THU105242	vein	QTZ	<0.001	<0.005	<0.0001	<0.0001	<0.0001	0.34	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0003	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	0.002	6.9
THU105201	Vein/Granite	QAHSC	<0.001	0.006	<0.0001	<0.0001	<0.0001	0.0001	<0.0005	<0.004	<0.0001	<0.005	<0.0001	0.0021	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	0.0022	0.002	9
Detection Limit			*0.001*	*0.005*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0005*	*0.004*	*0.0001*	*0.005*	*0.0001*	*0.0001*	*0.001*	*0.001*	*0.0001*	*0.001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.001*	
*ANZECC livestock water (mg/L)**			*0.5*	*5*	*NA*		*0.01*	*1*	*1*		*0.5*		*0.002*		*0.15*	*1*	*0.1*	*0.05*			*0.2*		*20*	
*ANZECC long term trigger value for irrigation water (mg/L)**			*0.1-2.0*	*0.5*	*0.1*		*0.01*	*0.05*		*0.1*	*0.2*		*0.002*	*0.2*	*0.01*	*0.2*	*2*	*0.02*			*0.01*	*0.1*	*2*	
*ANZECC Short term Irrigation trigger (mg/L)**			*2*		*0.5*		*0.05*	*0.1*		*1*	*5*			*10*	*0.05*	*2*	*5*	*0.05*			*0.1*	*0.5*	*5*	

*Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000

APPENDIX C:
Laboratory Reports

APPENDIX B – BUNDARRA RECONNAISSANCE FLORA & VEGETATION AND BASIC FAUNA SURVEY

Bundarra Project

Reconnaissance Flora/ Vegetation

& Basic Fauna Assessment

Prepared for Northern Star Resources Limited
July 2022

Prepared by
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Document Information

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Disclaimer

Quality Assurance

An internal quality review process has been implemented to each project task undertaken by BC. Each document and its contents is carefully reviewed by core members of the Consultancy team and signed off at Director Level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Cover Photo: View from breakaway within the survey area. Taken 7th April 2022

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EXECUTIVE SUMMARY

Botanica Consulting Pty Ltd (Botanica) was commissioned by Northern Star Resources Limited to undertake a reconnaissance flora/ vegetation and basic fauna survey of their proposed Bundarra Project. The survey area is approximately 2,647 ha and is located approximately 60 km north of Leonora, Western Australia (Figure 1-1).

The study area lies within the Eastern Murchison (MUR1) subregion of the Murchison Bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA).

Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey of the survey area on the 6-7th April 2022. The area was traversed on foot and all-terrain vehicle by Lauren Pick (Senior Consultant, BSc) and Jennifer Jackson (Senior Botanist, BSc (Honours) Environmental Management).

Prior to the field assessment a desktop review was undertaken to identify any potential significant flora, vegetation and fauna that may occur within the survey area. The desktop review consisted of a literature review of previous flora and fauna assessments conducted within the local region, NatureMap Database search (DBCA, 2022a) and the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters search tool (DAWE, 2020a). Database search requests were also submitted to the Department of Biodiversity, Conservation and Attractions (DBCA) for records of significant flora (Ref: 35_0422FL), significant fauna (Ref: 7085) and Ecological Communities (Ref: 29_0322EC) occurring within 40 km of the survey area.

Eight vegetation types were identified within the survey area. These vegetation types were identified within four landform types and comprised of four major vegetation groups, which were represented by a total of 26 families, 45 genera and 82 taxa. No Threatened Flora or Threatened Ecological Communities as listed under the Western Australian *Biodiversity Conservation (BC) Act 2016* or Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* were identified within the survey area.

Based on the vegetation condition rating scale specified in the Environmental Protection Authority (EPA) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016a), vegetation ranged from 'good' to 'very good' with the majority of vegetation rated as 'very good'. Disturbance in the area was a result of existing mining, exploration, pastoral land use road siding of the Goldfields Highway and introduced species. Three introduced flora taxa were identified within the survey area, none of which are listed as a Declared Pest or Weed of National Significance.

One Priority Flora taxon was listed on the Department of Biodiversity, Conservation and Attractions (DBCA) database as occurring within the survey area; *Hemigenia exilis* (P4). The location of this taxon were confirmed by Botanica. No other Priority Flora were identified within the survey area. No Priority Ecological Communities (as listed by DBCA) were identified within the survey area.

Five fauna habitats were identified within the survey area. Results of the desktop assessment identified 148 bird, 17 mammal, 41 reptile and four amphibian taxa as having been previously recorded in the general area, some of which have the potential to occur within the survey area. A total of nine species (including two introduced fauna) were observed during the field survey.

No Threatened fauna taxa as listed under the Western Australian BC Act and Commonwealth EPBC Act were identified within the survey area. No Priority fauna as listed by DBCA were recorded within the survey area.

There are no wetlands of international importance (Ramsar Wetlands) or national importance (Australian Nature Conservation Agency Wetlands) within the survey area nor proposed or gazetted conservation reserves within the survey area.

Based on the outcomes from the survey undertaken, Botanica assessed the results of the desktop and field survey with regards to the native vegetation clearing principles listed under Schedule 5 of the *Environmental Protection (EP Act) 1986*. The assessment found that the proposed vegetation clearing activities may be at variance with clearing principle (f).

1 INTRODUCTION

Botanica Consulting Pty Ltd (Botanica) was commissioned by Northern Star Resources Limited to undertake a reconnaissance flora/ vegetation and basic fauna survey of their proposed Bundarra Project. The survey area is approximately 2,647 ha and is located approximately 60 km north of Leonora, Western Australia (Figure 1-1).

1.1 Objectives

The flora assessment was conducted in accordance with the requirements of a reconnaissance flora survey as defined in *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016a). The objectives of the assessment were to:

- gather background information on flora and vegetation in the target area (literature review, database and map-based searches);
- identify significant flora, vegetation and ecological communities and assess the potential sensitivity to impact;
- conduct a field survey to verify / ground truth the desktop assessment findings;
- undertake floristic community mapping to a scale appropriate for the bioregion and described according to the National Vegetation Information System (NVIS) structure and floristics;
- undertake vegetation condition mapping;
- assess the project area's plant species diversity, density, composition, structure and weed cover, using NVIS classification system for vegetation description;
- assess Matters of National Environmental Significance (MNES) and indicate whether potential impacts on MNES as protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* are likely to require referral of the project to the Commonwealth Department of Agriculture, Water and the Environment (DAWE); and
- determine the State legislative context of environmental aspects required for the assessment.

The fauna assessment was conducted in accordance with the requirements of a basic terrestrial fauna survey as defined in *Technical Guidance - Terrestrial Fauna Surveys for Environmental Impact Assessment – June 2020* (EPA, 2020). The objectives of the assessment were to:

- Undertake a literature review, including map-based information searches of all current and relevant literature sources and databases relating to the survey area;
- Undertake a desktop investigation to identify any previously recorded occurrences of or potentially occurring Threatened and Priority listed fauna within the survey area;
- Undertake searches on available databases for details relating to any Threatened and Priority listed fauna previously identified as occurring or potentially occurring within the survey area;
- Conduct fauna habitat mapping and identify habitat types which are suitable for each significant fauna considered likely or possible to occur, or fauna recorded in the survey area;
- Compile an inventory of fauna species occurrences within the survey area;
- Undertake opportunistic, low intensity sampling of fauna; and
- Report on the conservation status of species present using the Western Australian Museum and EPBC Act databases for presence of Threatened and Priority listed fauna species within the survey area.

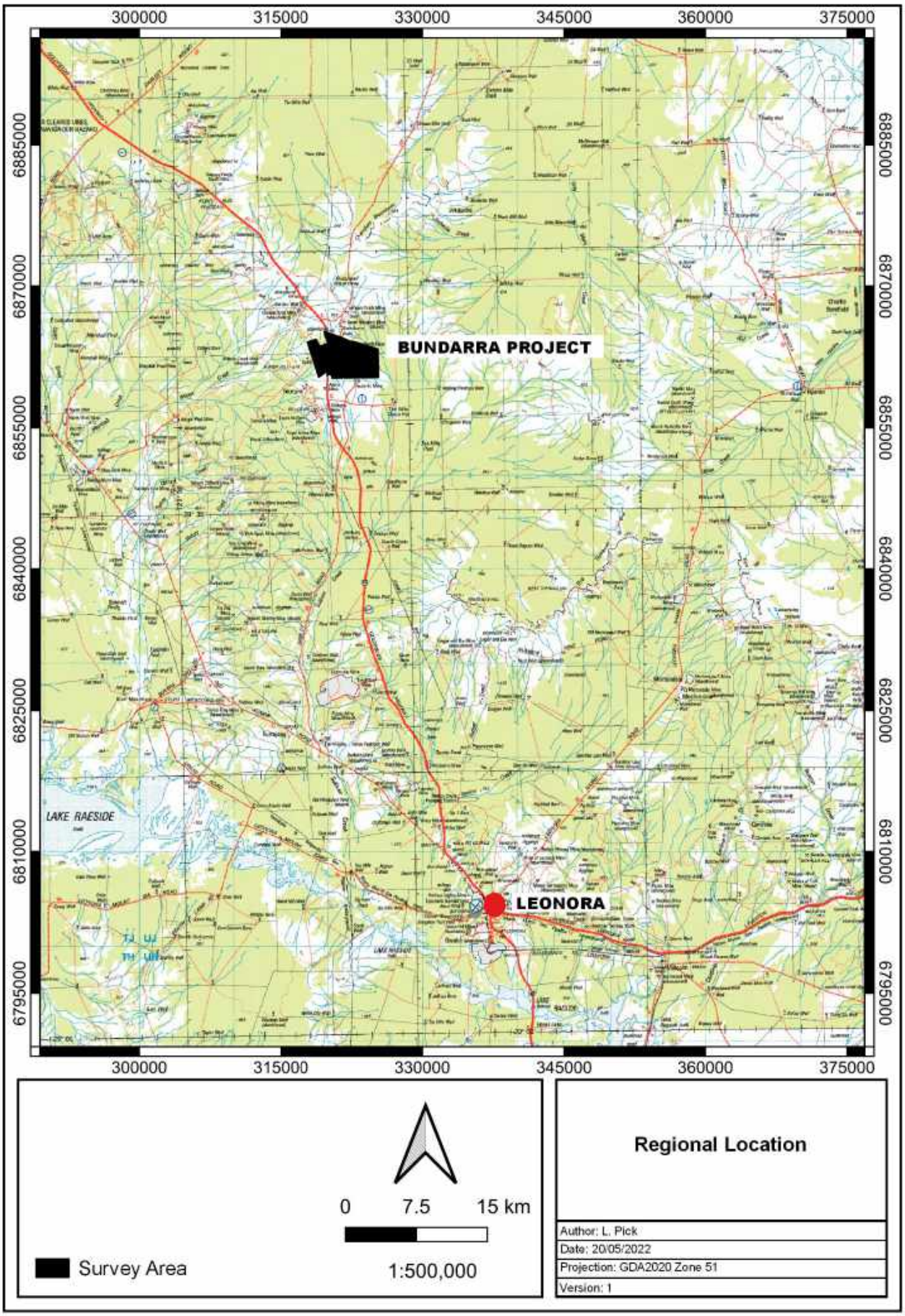

Figure 1-1: Regional map of the Bundarra survey area

2 BIOPHYSICAL ENVIRONMENT

2.1 Regional Environment

The survey area lies within the Eremaean Province of Western Australia (WA). Based on the Interim Biogeographic Regionalisation of Australia (IBRA, Version 7) (DotEE, 2012) the survey area is located within the Murchison Bioregion of WA. This bioregion is further divided into subregions with the survey area located within the Eastern Murchison (MUR1) subregion of the Murchison Bioregion (Figure 2-1).

The landscape of the Murchison Bioregion comprises low hills, mesas of duricrust separated by flat colluvium and alluvial plains (Commonwealth Government, 2020. It is dominated by the Archaean (over 2500 million years ago) granite greenstone terrain of the Yilgarn Craton (Commonwealth Government, 2008). Alluvial soils and sands mantle the granitic and greenstone units of the Yilgarn Craton. These soils are shallow, sandy and infertile. Underlying the soils in low areas is a red-brown siliceous hard pan (Curry et al. 1994). The soils in the eastern half of the bioregion are typically red sands, calcareous red earth soil, duplex soil and clays. There are 41 vegetation associations (hummock grasslands, succulent steppe or low woodlands) that have at least 85 per cent of their total area in the bioregion. The bioregion is rich and diverse in both its flora and fauna but most species are wide ranging and usually occur in adjoining regions (McKenzie, May and McKenna, 2002).

The Eastern Murchison subregion comprises the northern parts of the craton's Southern Cross and Eastern Goldfields Terrains and is characterised by internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt Lake systems are associated with the occluded paleodrainage system. Broad plains of red-brown soils and breakaways complexes as well as red sandplains are widespread. Vegetation is dominated by Mulga woodlands and is often rich in ephemerals, hummock grasslands, saltbush shrublands and Samphire shrublands (McKenzie *et. al.,* 2002). The Eastern Murchison subregion comprises diverse mulga woodlands, which occur on low greenstone belts. The sand plains have red loamy earths and red deep sands which are found on the sandy banks.

2.2 Land Use

The dominant land uses of the Eastern Murchison subregion include grazing native pastures (85.47%), unallocated crown reserves (11.34%), conservation (1.4%) and mining (1.79%) (Cowan, 2001). The survey area is located within the Tarmoola and Weebo Pastoral Lease.

Figure 2-1: Map of IBRA Bioregions in relation to the survey area

2.3 Soil Landscape Systems

The survey area lies within the Murchison Province of Western Australia. The Murchison Province consists of hardpan wash plains and sandplains (with some stony plains, hills, mesas and salt lakes) on the granitic rocks and greenstone of the Yilgarn Craton. This Province is located in the inland Mid-west and northern Goldfields between Three Springs, the Gascoyne River, Wiluna, Cosmo Newberry and Menzies (Tille, 2006). The Murchison Province is further divided into soil-landscape zones, with the assessment area located within the Salinaland Plains Zone (279).

The Salinaland Plains Zone comprises of sandplains (with hardpan wash plains and some mesas, stony plains and salt lakes) on granitic rocks (and some greenstone) of the Yilgarn Craton. Soils include red sandy earths, red deep sands, red shallow loams and red loamy earths with some red-brown hardpan shallow loams, salt lake soils and red shallow sandy duplexes. Vegetation is dominated by mulga shrublands with spinifex grasslands (and some halophytic shrublands and eucalypt woodlands). This zone is located in the northern Goldfields from Lake Barlee and Lake Ballard to Wiluna and Laverton (Tille, 2006).

The Salinaland Plains Zone is further divided into soil landscape systems, with the survey area located within three soil landscape systems, as listed in Table 2-1 shown in Figure 2-2.

Table 2-1: Soil landscape systems within the survey area

Soil Landscape System	Description	Extent within Survey Area
Gransal System	Stony plains and low rises based on granite supporting mainly halophytic low shrublands.	1441 ha (54.5%)
Hamilton System	Hardpan plains, stony plains and incised drainage lines supporting mulga tall shrublands.	979.5 ha (37%)
Nubev System	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands.	226.5 ha (8.5%)

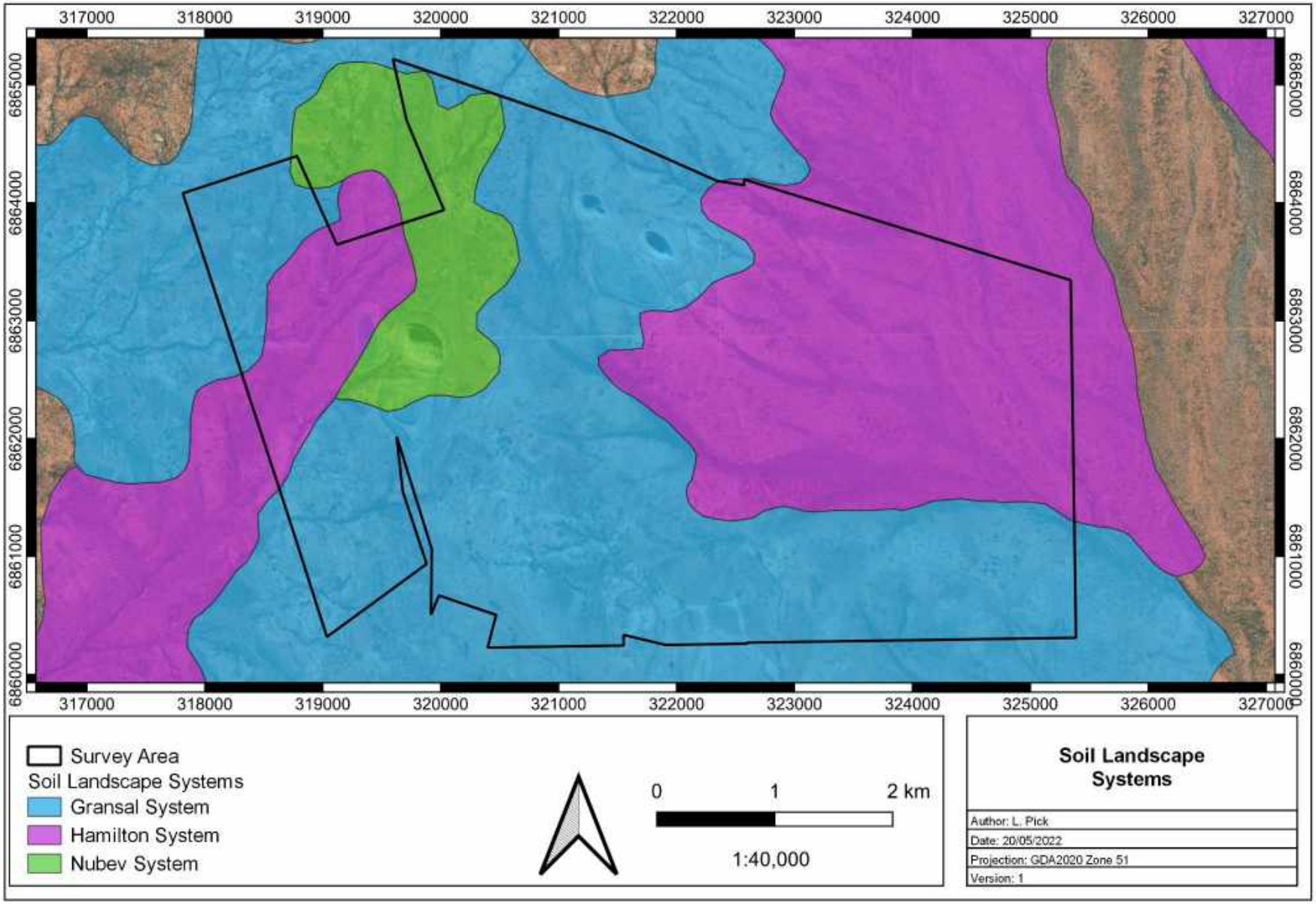

Figure 2-2: Map of soil landscape systems within the survey area

2.4 Pre-European Vegetation

Vegetation of the Murchison Bioregion in the Austin Botanical District is predominantly Mulga low woodlands on plains, often rich in ephemerals, which reduce to scrub on hills. It is also characterised by hummock grasslands, Saltbush shrublands and Samphire shrublands (Beard, 1990; Cowan, 2001).

The Department of Primary Industries and Regional Development GIS file (DPIRD, 2020) indicates that the survey area is located within pre-European Beard vegetation associations of the Barlee and Laverton system in the Eastern Murchison subregion. The extent of these vegetation associations as specified in the *2018 Statewide Vegetation Statistics* (Government of Western Australia, 2019) is provided in Table 2-2-2 and shown in Figure 2-3.

Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered "endangered" (EPA, 2000).

Table 2-2-2: Pre-European Vegetation Associations within the survey area

Pre-European Vegetation	Description	Pre-European Extent Remaining (%)	Current Extent Reserved for Conservation (%)	Extent within Assessment Area
Laverton 18	Low woodland of Mulga (*Acacia aneura*) and associated species.	99.55	0.0	353 ha (13.3%)
Laverton 28	Open Low woodland of Mulga (*Acacia aneura*) and associated species.	98.35	0.0	2294 ha (86.7%)

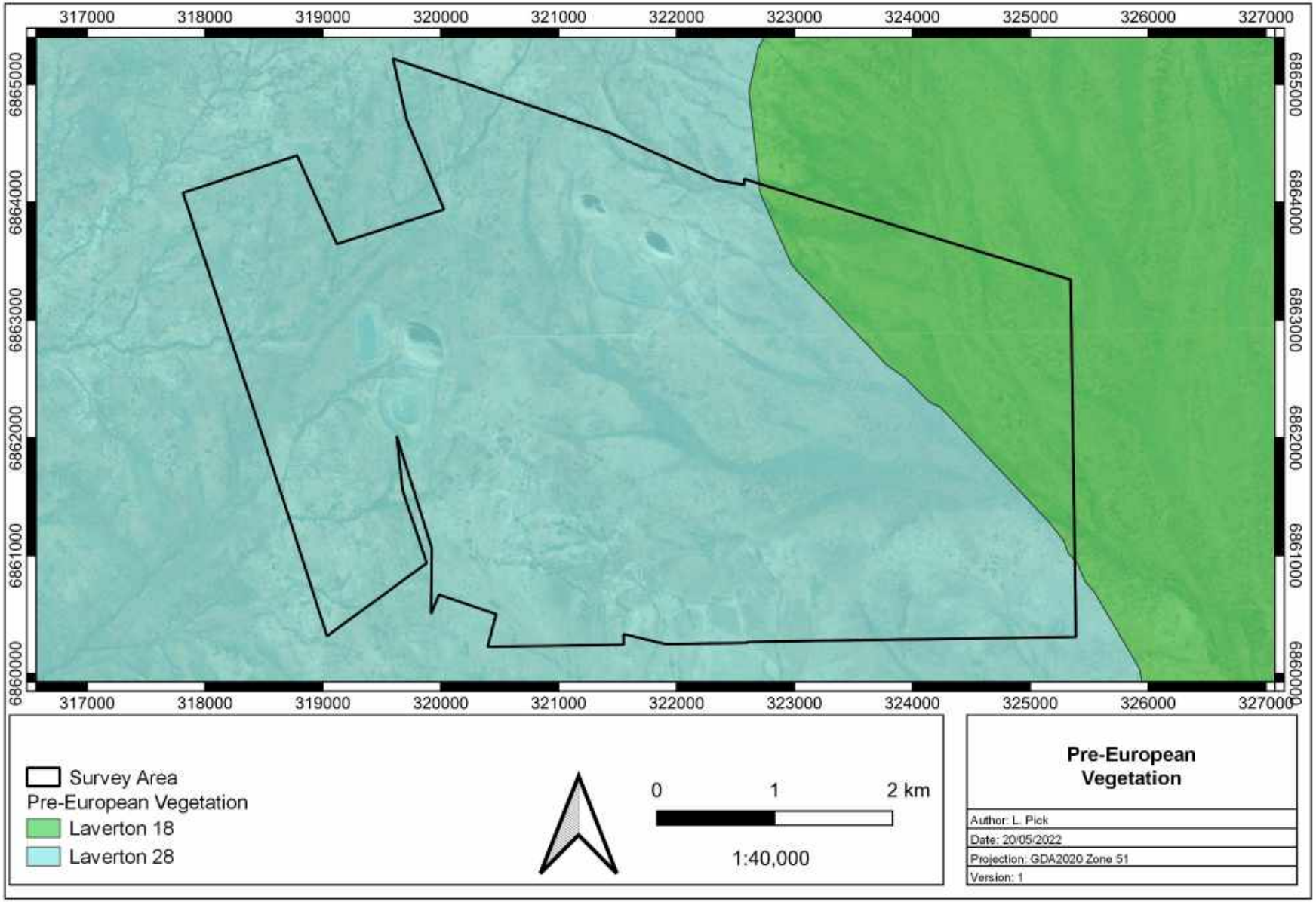

Figure 2-3: Pre-European vegetation within the survey area

2.5 Climate

The climate of the Eastern Murchison subregion is characterised as an arid climate with mainly winter rainfall and annual rainfall of approximately 200 millimetres (mm) (Beard, 1990; Cowan, 2001). Rainfall data for the Leonora weather station (#12241) located approximately 60 km south of the survey area is shown in Figure 2-4 (BoM, 2022a). Rainfall received for the first three months of 2022 was below average. Total rainfall for 2021 was 186 mm, below the annual average of 236.4 mm.

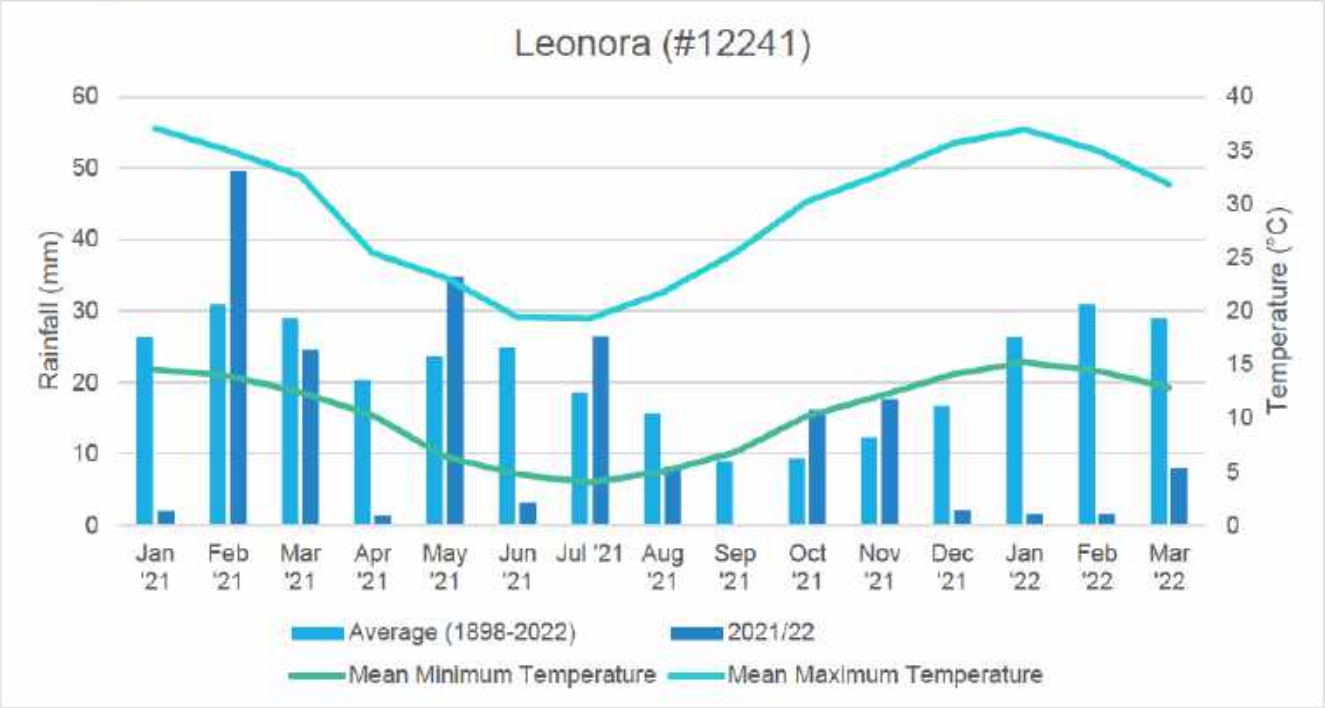

Figure 2-4: Climate data for Leonora (BoM, 2022a)

2.6 Conservation Values

No Threatened Ecological Communities listed under the Commonwealth EPBC Act or the Western Australian BC Act are known to occur within the survey area or within 40 km of the survey area. One Priority 1 Ecological Community (PEC) as listed by DBCA occurs 35 km to the north east of the survey area, the Nambi calcrete groundwater assemblage type on Carey palaeodrainage on Nambi Station. The Sturt Meadows calcrete groundwater assemblage type on Raeside palaeodrainage on Sturt Meadows Station is also a Priority 1 Ecological Community, this is 40 km to the south west of the survey area.

There are no Ramsar wetlands or wetlands of national importance (ANCA Wetlands) within the survey area (Figure 2-5). The nearest Environmentally Sensitive Area (ESA) as listed under the EP Act is the Wanjarri Nature Reserve which is located approximately 100 km to the north-west of the survey area.

A map showing conservation areas in relation to the assessment area is provided in Figure 2-5.

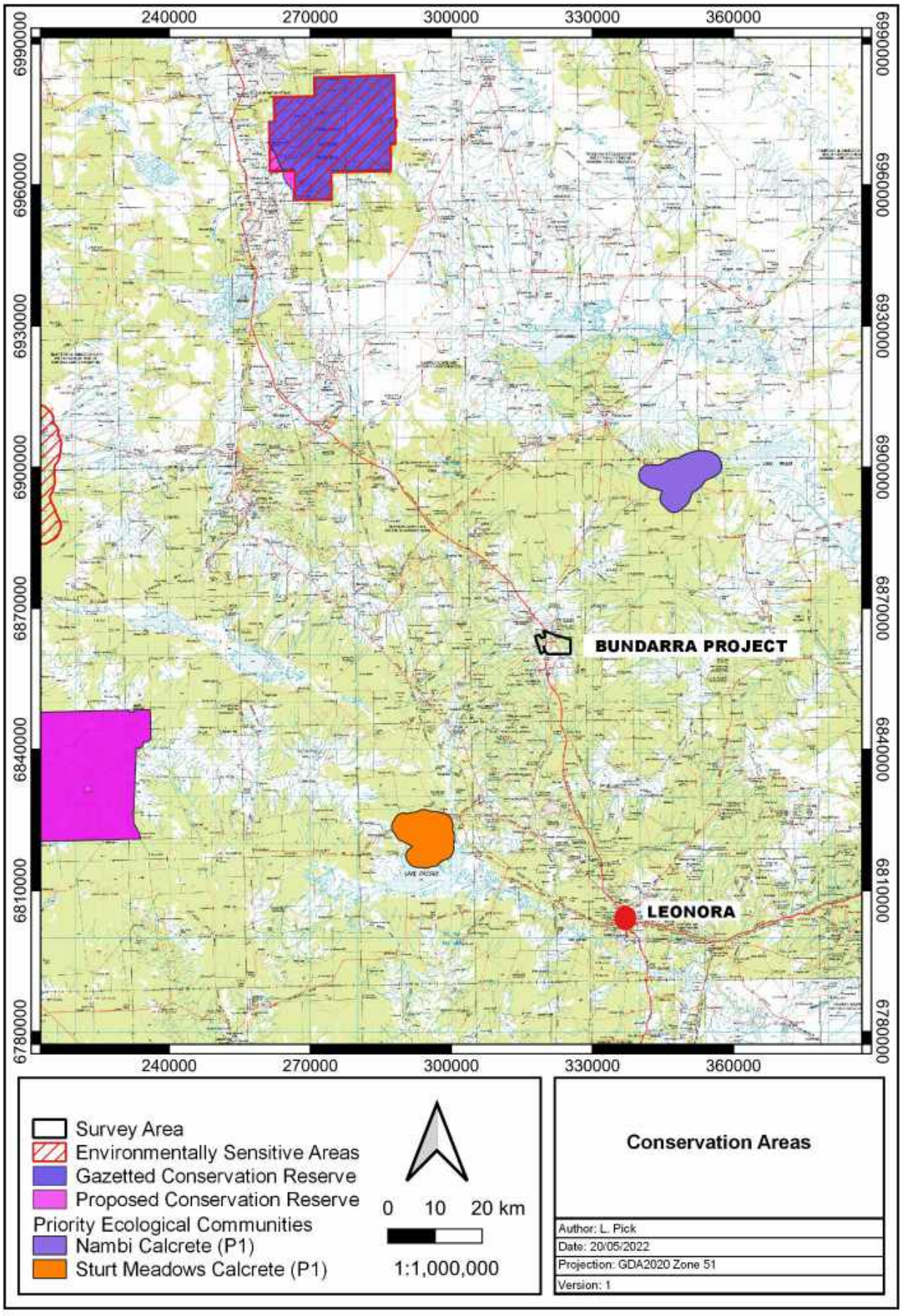

Figure 2-5: Conservation areas in relation to the survey area

2.7 Hydrology

According to the Geoscience Australia database (2015), there are no permanent/ perennial inland waters or drainage lines within the survey area. There are numerous minor ephemeral drainage lines occurring through the survey area (Figure 2-6).

Groundwater Dependent Ecosystems (GDE) includes biological assemblages of species such as wetlands or woodlands that use groundwater either opportunistically or as their primary water source. For the purposes of this report, a GDE is defined as any vegetation community that derives part of its water budget from groundwater and must be assumed to have some degree of groundwater dependency. According to the BoM *Atlas of Groundwater Dependent Ecosystems* database (BoM, 2022b), there are no known or potential aquatic or terrestrial GDEs located within the survey area (Figure 2-6).

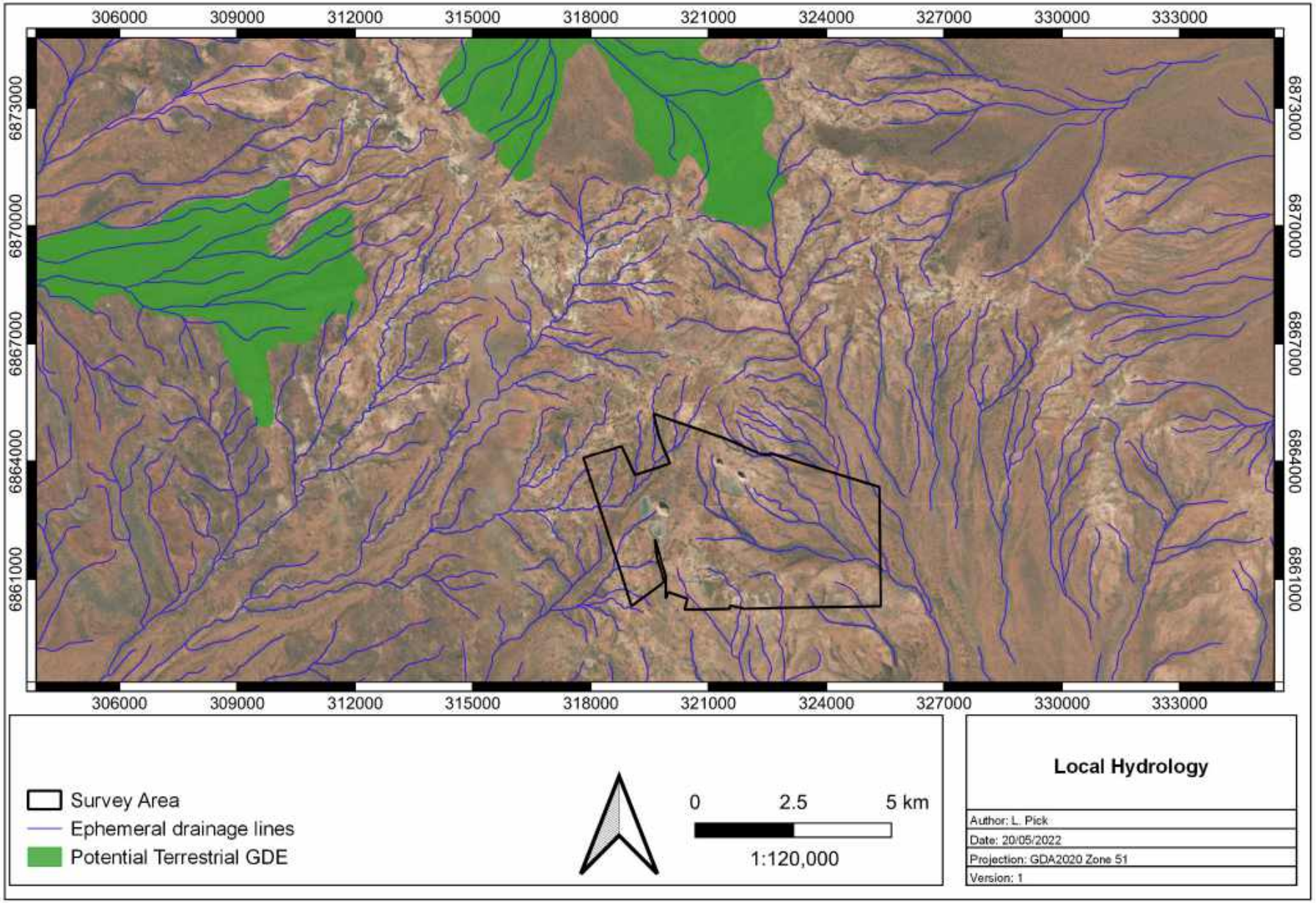

Figure 2-6: Regional hydrology of the survey area

3 SURVEY METHODOLOGY

3.1 Desktop Assessment

Prior to the field assessment a literature review was undertaken of previous flora and fauna assessments conducted within the local region. Documents reviewed included:

- Botanica. (2021). Detailed flora/vegetation survey and basic fauna survey of the Redcliffe Gold Project. Unpublished report prepared for Dacian Gold Ltd., October 2021.
- Botanica (2014). Level 1 flora and vegetation survey of the Thunderbox to Bannockburn Project. Unpublished report prepared for Saracen, August 2014.
- Botanica (2021). Reconnaissance Flora and Basic Fauna Survey of the proposed Bronzewing to Thunderbox Haul Road (L36/246). Unpublished report prepared for Northern Star Resources Ltd., October 2021.

Database search requests were submitted to the DBCA for records of significant flora (Ref: 35-0422FL) (DBCA, 2022a), significant fauna (ref: 7085) (DBCA, 2022b) and ecological communities (Ref: 29-0322EC) (DBCA, 2022c), with a centre-point located at coordinates: 28^0 21’ 06” S, 121^0 10’ 55” E and with a 40 km buffer applied.

In addition to the literature review and DBCA database search requests, searches of the following online databases were also undertaken (using the same centre-point and 40 km buffer as stated above) to aid in the compilation of a list of potential significant flora and fauna within the survey area:

- Atlas of Living Australia (ALA) database (ALA, 2022); and
- EPBC Protected Matters search tool (DAWE, 2022).

Significant flora species identified by the desktop review were assessed with regards to their population extent and distribution and preferred habitat to determine their likelihood of occurrence within the survey area. The assessment categorised flora species as follows:

- **Unlikely:** Suitable habitat is not expected to occur and/or the survey area is outside the known range of the species.
- **Possible:** Suitable habitat may be present, and the area is within the known range of the species. This option is also used when there is insufficient information to determine the preferred habitat of a species.
- **Likely:** Suitable habitat is expected to occur and there are records within 10 km of the survey area.
- **Previously Recorded:** A record for this species is located within the survey area. Field survey will ground-truth currently occurring individuals and populations.

Significant fauna species identified by the desktop review were assessed with regards to their distribution and preferred habitat to determine their likelihood of occurrence within the survey area. The assessment categorised fauna species as follows:

- **Would Not Occur:** There is no suitable habitat for the species in the survey area and/or there is no documented record of the species in the general area since records have been kept and/or the species is generally accepted as being locally/regionally extinct (supported by a lack of recent records).

- **Locally Extinct:** Populations no longer occur within a small part of the species natural range, in this case within 10 or 20 km of the survey area. Populations do however persist outside of this area.
- **Regionally Extinct:** Populations no longer occur in a large part of the species natural range, in this case within the Southern Cross region. Populations do however persist outside of this area.
- **Unlikely to Occur:** The survey area is outside of the currently documented distribution for the species in question, or no suitable habitat (type, quality and extent) was identified as being present during the field assessment. Individuals of some species may occur occasionally as vagrants/transients especially if suitable habitat is located nearby but the site itself would not support a population or part population of the species.
- **Possibly Occurs:** Survey area is within the known distribution of the species in question and habitat of at least marginal quality was identified as likely to be present during the field survey and literature review, supported in some cases by recent records being documented in literature from within or near the survey area. In some cases, while a species may be classified as possibly being present at times, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.
- **Known to Occur:** The species in question has been positively identified as being present (for sedentary species) or as using the survey area as habitat for some other purpose (for non-sedentary/mobile species) during field surveys within or near the survey area. This information may have been obtained by direct observation of individuals or by way of secondary evidence (e.g. tracks, foraging debris, scats). In some cases, while a species may be classified as known to occur, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

It should be noted that these lists are based on observations from a broader area than the assessment area (40 km radius) and therefore may include taxa not present. The databases also often include very old records that may be incorrect or in some cases the taxa in question have become locally or regionally extinct. Information from these sources should therefore be taken as indicative only and local knowledge and information also needs to be taken into consideration when determining what actual species may be present within the specific area being investigated.

The conservation significance of flora and fauna taxa was assessed using data from the following sources:

- *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. Administered by the Australian Government (DAWE);
- *Biodiversity Conservation* (BC) *Act 2016*. Administered by the WA Government (DBCA);
- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List – the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria; and
- Priority Flora/ Fauna list. A non-legislative list maintained by DBCA for management purposes (fauna list released 10th April 2019; flora list released 5th December 2018).

The EPBC Act also requires the compilation of a list of migratory species that are recognised under international treaties including the:

- Japan Australia Migratory Bird Agreement 1981 (JAMBA)[1];
- China Australia Migratory Bird Agreement 1998 (CAMBA);
- Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA); and
- Bonn Convention 1979 (The Convention on the Conservation of Migratory Species of Wild Animals).

Most but not all migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as Matters of National Environmental Significance (MNES) under the EPBC Act. Descriptions of conservation significant species and communities are provided in Appendix A.

3.2 Flora and Vegetation Field Assessment

Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey of the Bundarra Project survey area on the 6-7th April 2022. The area was traversed using an all-terrain vehicle and 4WD by Lauren Pick (Senior Consultant, BSc) and Jennifer Jackson (Senior Botanist, BSc (Honours) Environmental Management). The GPS track log of the survey effort is shown in Figure 3-1. Given the degree of existing disturbance within the survey area (existing mining/ pastoral land use), the survey area is not located in a fragmented landscape, high biodiversity region or a conservation reserve and the desktop assessment identified low potential for significant habitats (i.e. widespread/ common habitats), a reconnaissance survey was conducted.

Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the coordinates of the boundaries between existing vegetation communities.

The survey was conducted using a series of survey sites (relevés) as shown in Figure 3-1. At each relevé site, the area was walked on foot to observe and record all flora species. The distance surveyed at each relevé varied dependent on the diversity/ variability of species and landforms/ vegetation types. At each relevé, the following information was recorded:

At each sample point, the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant taxa for each stratum;
- All vascular taxa (including annual taxa);
- Landform classification;
- Vegetation condition rating;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of flora of conservation significance (if encountered).

[1] Most but not all species listed under JAMBA are also specially protected under Specially Protected Species of the BC Act.

Unknown specimens collected during the survey were identified with the aid of samples housed at the Botanica Herbarium and Western Australian Herbarium. Vouchering of the specimens with the Western Australian Herbarium was not required as none of the specimens were of significance (i.e. conservation flora, novel taxa, range extensions etc.). A complete species list was generated from the relevé data for each of the vegetation types identified within the survey area (Appendix B). Structural vegetation classification was used to characterise the different vegetation types. Vegetation types were described in accordance with NVIS classifications-Vegetation Types (Level V).

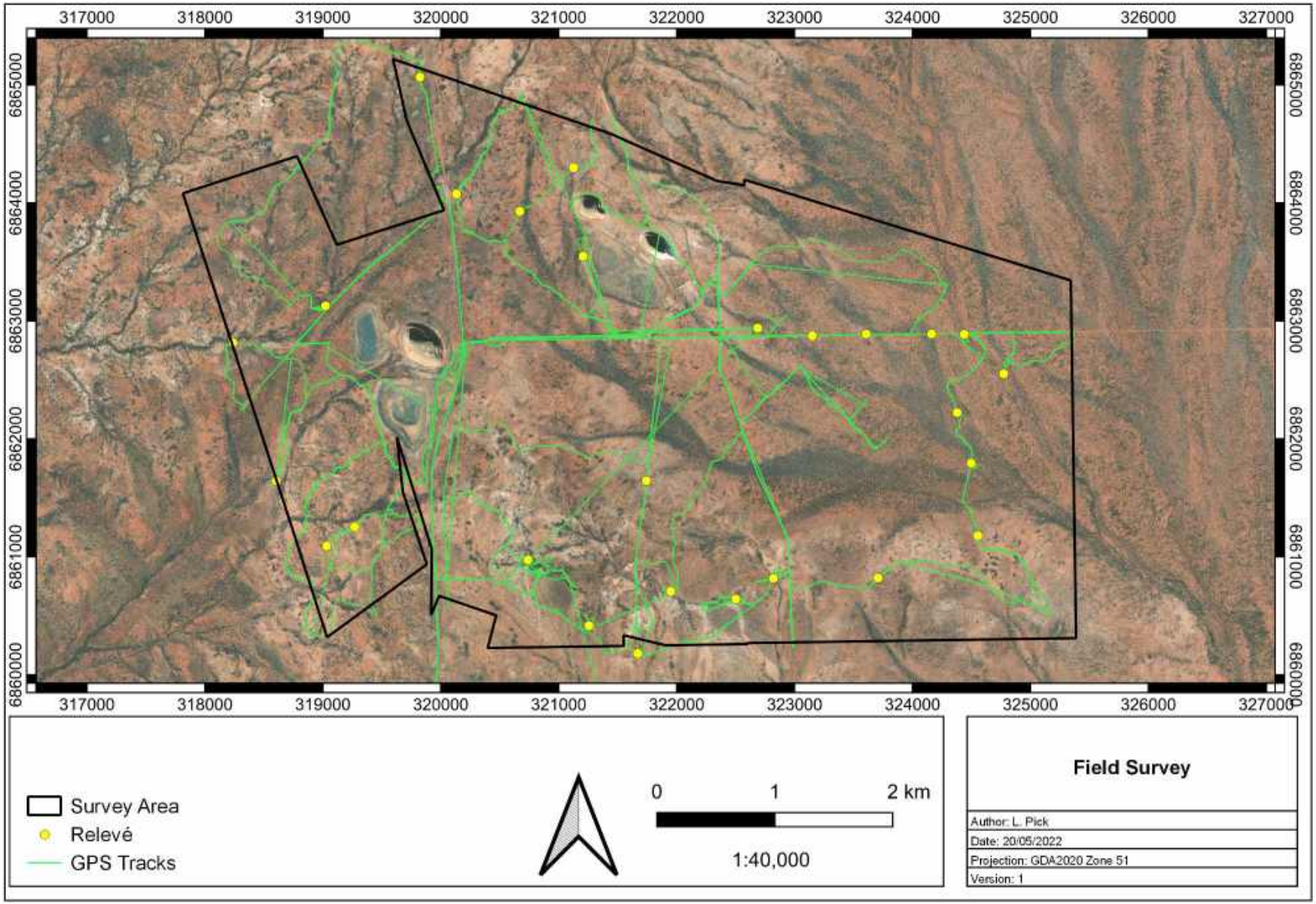

Figure 3-1: GPS track log of the survey effort

3.3 Data Analysis Tools

Following field assessments, vegetation types and condition were mapped using the GIS program QGIS, and the hectare area/ percentage area of each vegetation type and condition within the survey area was calculated. Spatial maps illustrating the location of vegetation types and any significant flora/ vegetation and fauna were generated using QGIS.

3.4 Terrestrial Fauna Field Assessment

Botanica conducted a basic fauna survey of the survey area in conjunction with the reconnaissance flora/ vegetation survey.

Fauna habitat types were identified across the survey area based on broad major vegetation groups and associated landform. A handheld GPS unit was used to record the coordinates of the boundaries between fauna habitats and each habitat was photographed.

The main aim of the fauna habitat assessment was to determine the likelihood of a species of conservation significance utilising habitat within the survey area. The habitat information obtained was also used to aid in finalising the overall potential fauna list.

Available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area (determined from the desktop assessment) was researched. During the field survey, the habitats within the survey area were assessed and specific elements identified, if present, to determine the likelihood of listed Threatened and Priority species utilising habitat within the survey area.

Opportunistic observations of fauna species were made during all field survey work.

3.5 Scientific Licences

Table 3-1: Scientific Licenses of Botanica Staff coordinating the survey

Licensed Staff	Permit Number	Date of Expiry
Lauren Pick	FB62000109 (licence to take flora for scientific purposes)	27/05/2022
Jennifer Jackson	FB62000309 (Licence to take flora for scientific purposes)	11/01/2024

3.6 Survey Limitations and Constraints

It is important to note that flora surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 3-2.

The conclusions presented in this report are based upon field data and environmental assessments and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. Also, it should be recognised that site conditions can change with time. Information not available at the time of this assessment which may subsequently become available may alter the conclusions presented.

Some species are reported as potentially occurring based on there being suitable habitat (quality and extent) within the survey area or immediately adjacent. The habitat requirements and ecology of many of the species known to occur in the wider area are however often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitats or microhabitats within the survey area. As a consequence of this limitation, the potential species list produced is most likely an overestimation of those species that actually utilise the survey area for some purpose.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any flora species that would possibly occur within the survey area (or immediately adjacent), as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of the author, has been listed as having the potential to occur.

Table 3-2: Limitations and constraints associated with the flora/ vegetation and fauna survey

Variable	Potential Impact on Survey	Details
Access problems	Not a constraint	The survey was conducted via 4WD and using an all-terrain vehicle. Numerous access tracks were present within the survey area providing ease of access.
Competency/ Experience	Not a constraint	The Botanica personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Staff**: Lauren Pick (Senior Consultant, BSc) and Jennifer Jackson (Senior Botanist / BSc, Environmental Management, Hons) **Data Interpretation**: Lauren Pick and Jennifer Jackson.
Timing of survey, weather & season	Minor constraint	Fieldwork was undertaken in April during the EPA's recommended primary survey time period for the Eremaean Province (i.e., 6-8 post wet season March-June), however below average rainfall was received during the summer period preceding the survey.
Area disturbance	Not a constraint	The area has been disturbed from exploration and mining operations, cattle grazing and other human impacts; however, vegetation was mostly intact and comprised of native vegetation.
Survey Effort/ Extent	Minor constraint	Survey intensity was appropriate for the size/significance of the area with a reconnaissance flora/ vegetation survey and basic fauna survey completed to identify vegetation types/ fauna habitats. Targeted searches for significant flora within potential habitats (i.e. breakaway habitat) during optimal flowering period is recommended to be conducted.
Availability of contextual information at a regional and local scale	Not a constraint	Conservation significant flora database searches provided by the DBCA were used to identify any potential locations of Threatened/Priority flora species. BoM, DWER, DPIRD, DBCA and DAWE databases were reviewed to obtain appropriate regional desktop information on the biophysical environment of the local region. Botanica has conducted numerous surveys within the Murchison bioregion and was also able to obtain information about the area from previous research conducted within the area. Results of previous assessments in the local area were reviewed to provide context on the local environment.
Completeness	Minor constraint	In the opinion of Botanica, the survey area was covered sufficiently in order to identify vegetation assemblages. Survey work was conducted within EPAs recommended approximate timing (6-8 weeks post wet season), however below average rainfall was received during the summer period preceding the survey. As a result limited annual species were present and not all taxa were able to be identified to species level. Targeted searches for significant flora within potential habitats (i.e. breakaway habitat) during optimal flowering period is recommended to be conducted. The vegetation associations for this study were based on visual descriptions of locations in the field. The distribution of these vegetation associations outside the study area is not known, however vegetation associations identified were categorised via comparison to vegetation distributions throughout WA given on NVIS (DotEE, 2017).

4 RESULTS

4.1 Desktop Assessment

4.1.1 Flora

The NatureMap database search (DBCA, 2022a) identified 398 vascular flora species as occurring within 40 km of the survey area. The full list of vascular flora identified by the desktop search is contained in Appendix D.

4.1.1.1 Introduced Flora

The desktop review identified eight introduced flora (weed) species as potentially occurring in the vicinity of the survey area. Of these, five species are listed as a Declared Pest on the Western Australian Organism List (WAOL) under the *Biosecurity and Agriculture Management* (BAM) *Act 2007* and as Weeds of National Significance (Table 4-1).

Table 4-1: introduced flora potentially occurring within 40 km of the survey area

Taxon	Common Name	Declared Pest	WONS
Agave americana	Century Plant	Yes	Yes
Cuscuta planiflora		Yes	Yes
Cylindropuntia fulgida var. mamillata		Yes	Yes
Cylindropuntia imbricata		Yes	Yes
Lysimachia arvensis	Pimpernel	No	No
Nicotiana rosulata	Rosetted Tobacco	No	No
Nicotiana stenocarpa		No	No
Opuntia elata	Prickly Pear	Yes	Yes

4.1.1.2 Significant Flora

Assessment of the DBCA's Threatened and Priority Flora database records (Ref: 12-0322FL) (DBCA, 2022b), EPBC Protected Matters (DAWE, 2022a) and NatureMap database (DBCA, 2022a) and previous relevant literature identified one Threatened Flora and 11 Priority Flora as occurring within a 40 km radius of the survey area.

These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment identified on Priority Flora taxon as known to occur within the survey area. The locations of DBCA database records for Significant Flora (DBCA, 2022b) in relation to the survey area is shown in Figure 4-1.

Table 4-2: Significant flora potentially occurring within the survey area

Taxon	Rank			Habitat Description	Assessment	Likelihood
	EPBC	BC Act	DBCA			
Acacia megacephala	-	-	P3	White/yellow sand. Sandplains.	No DBCA database spatial records within 40km of the survey area. Suitable habitat unlikely to be present.	Unlikely
Acacia sp. Marshall Pool (G. Cockerton 3024)	-	-	P3	Greenstone/ basalt rocky hillslopes.	Recorded approximately 13km west of the survey area. Suitable habitat may be present.	Possible
Eremophila simulans subsp. *megacalyx*	-	-	P3	Alluvial plains of orange sands.	Recorded approximately 28km south-east of the survey area. Suitable habitat unlikely to be present.	Unlikely
Grevillea inconspicua	-	-	P4	Loam, gravel. Along drainage lines on rocky outcrops, creeklines.	Recorded approximately 13km west of the survey area. Suitable habitat may be present.	Possible
Hemigenia exilis	-	-	P4	Laterite. Breakaways, slopes.	Two records previously recorded within the survey area (recorded in 1996)	Previously Recorded
Korthalsella leucothrix	-	-	P1	On *Acacia acuminata* and *A. craspedocarpa*.	Recorded approximately 12km north-west of the survey area. Habitat preferences unknown.	Possible
Lysiandra baeckeoides	-	-	P3	Gentle slope, gravelly ironstone soils.	Recorded approximately 1.5km south of the survey area. Suitable habitat may be present.	Likely
Micromyrtus chrysoderma	-	-	P1	Red sands. Sandplains.	Recorded approximately 28km north-west of the survey area. Suitable habitat unlikely to be present.	Unlikely
Philotheca tubiflora	-	-	P1	Rocky rises & hills, outcrops.	Recorded approximately 25km north of the survey area. Suitable habitat may be present.	Possible
Seringia exastia	CR	CR	-	Pindan (red soil) heathland.	Recorded approximately 30km north-west of the survey area. Suitable habitat unlikely to be present.	Unlikely
Stenanthemum patens	-	-	P1	Rocky hillside.	Recorded approximately 12km west of the survey area. Suitable habitat may be present.	Possible
Thryptomene sp. Leinster (B.J. Lepschi & L.A. Craven 4362)	-	-	P3	Edge of low breakaway/ flat top of breakaway. Rocky brown sandy clay loam.	Recorded approximately 27km north-west of the survey area. Suitable habitat may be present.	Possible

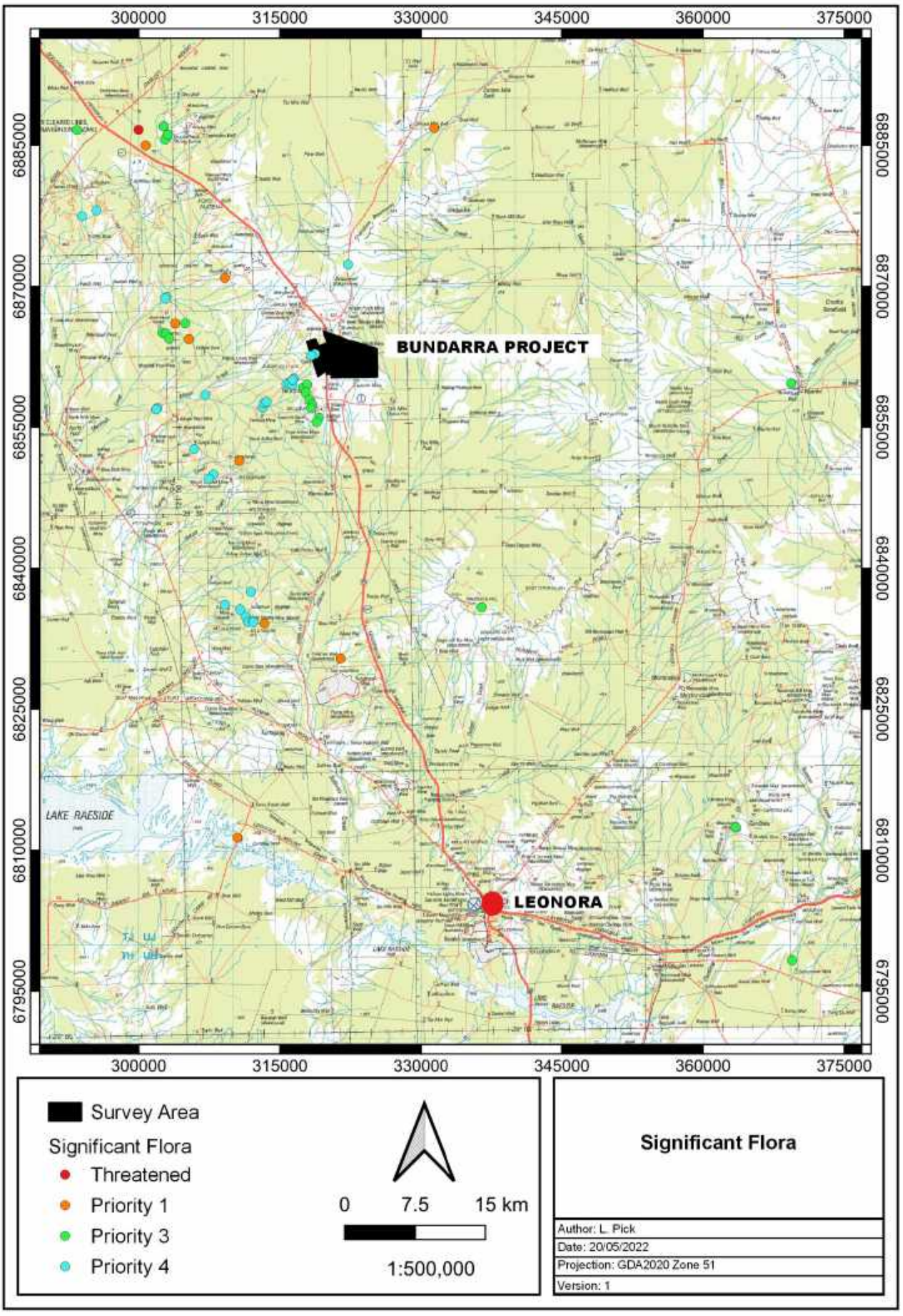

Figure 4-1: Significant flora records in relation to the survey area

4.1.2 Fauna

The NatureMap database search (DBCA, 2022a) identified a total of 210 terrestrial vertebrate fauna taxa within 40 km of the survey area, consisting of 148 bird, 17 mammal, 41 reptile and four amphibian taxa. The full list of vertebrate fauna identified by the desktop search is contained in Appendix D.

4.1.2.1 Conservation Significant Fauna

The desktop review identified eight terrestrial vertebrate fauna species of conservation significance as previously being recorded in the regional area, consisting of five Threatened species, two migratory terrestrial species and one otherwise protected species. In addition several migratory shorebirds were identified in the desktop assessment which were assessed collectively based on shared habitat requirements. Habitat and distribution data was used to determine the likelihood of occurrence within the survey area (Table 4-3). The locations of DBCA database records for Significant Fauna (DBCA, 2022d) in relation to the survey area is shown in Figure 4-2.

Table 4-3: Potentially occurring significant fauna

Species	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Chuditch *Dasyurus geoffroii*	VU	VU	-	Chuditch use a range of habitats including forest, mallee shrublands, woodland and desert. The densest populations have been found in riparian Jarrah Forest (DEC 2012).	No known records on the DBCA database within 130km of the survey area. Considered to be locally extinct. Suitable habitat unlikely to be present.	Unlikely to Occur
Greater Bilby *Macrotis lagotis*	VU	VU	-	Suitable habitat includes; open tussock grassland (both grasses and forbs) growing on uplands and hills, mulga woodland/shrubland (both pure mulga and mixed stands of mulga/witchetty bush) growing on ridges and rises, and hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems and other alluvial areas Pavey, C., 2006).	Previously recorded approximately 20km west of the survey area (recorded in 1981). Considered to be locally extinct. Suitable habitat unlikely to be present.	Unlikely to Occur
Grey Falcon *Falco hypoleucos*	VU	-	-	This species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter (DAWE, 2022b).	Nearest known record located approximately 80km south-east of the survey area (recorded in 1996). Potential for individuals to occur aerially over the survey area however generally uncommon and suitable breeding habitat unlikely to be present.	Unlikely to Occur
Grey Wagtail *Motacilla cinerea*	MI	MI	-	Running water in disused quarries, sandy, rocky streams in escarpments and rainforest, sewerage ponds, ploughed fields and airfields (Morecombe 2004).	No suitable habitat present within the survey area.	Would not Occur
Malleefowl *Leipoa ocellata*	VU	VU	-	Scrublands and woodlands dominated by mallee and wattle species (DAWE, 2022b).	Previously recorded approximately 30km north-west of the survey area (recorded in 1995). Suitable habitat may be present.	Possibly Occurs
Peregrine Falcon *Falco peregrinus*	-	OS	-	The Peregrine Falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites and prefers coastal and inland cliffs or open woodlands near water, and may even be found nesting on high city buildings (Birdlife Australia, 2022).	Previously recorded approximately 30km south-east of the survey area (recorded in 1978). Potential for individuals to occur aerially over the survey area however suitable breeding habitat unlikely to be present.	Unlikely to Occur
Princess Parrot *Polytelis alexandrae*	VU	-	P4	Inhabits sand dunes and sand flats in the arid zone of western and central Australia. It occurs in open savanna woodlands and shrublands that usually consist of scattered stands of Eucalyptus (including E. gongylocarpa, E. chippendalei and mallee species), Casuarina or Allocasuarina trees; an understorey of shrubs such as Acacia (especially A. aneura), Cassia, Eremophila, Grevillea, Hakea and Senna; and a ground cover dominated by Triodia species (DAWE, 2022b)	Previously recorded approximately 115km north-west of the survey area (recorded in 1964). Suitable habitat unlikely to be present.	Unlikely to Occur

Species	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Yellow Wagtail *Motacilla flava*	MI	MI	-	Occurs in a variety of damp or wet habitats with low vegetation, from rushy pastures, meadows, hay fields and marshes to damp steppe and grassy tundra (Morecombe 2004).	No suitable habitat present within the survey area.	Would not Occur
Migratory Shorebirds (various species)	MI	MI	-	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland (DAWE, 2022b).	No suitable habitat (wetlands) present within the survey area.	Would not Occur

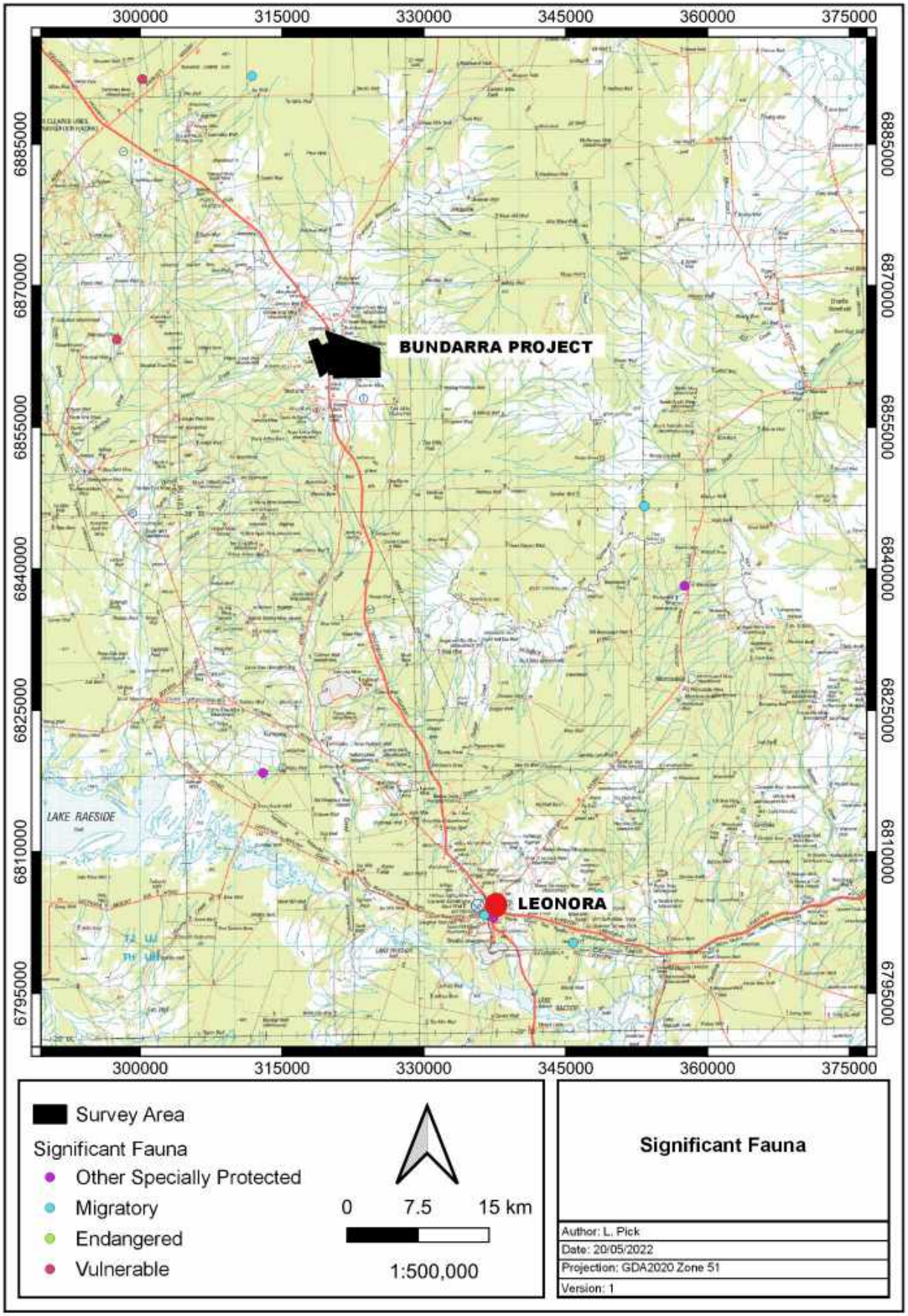

Figure 4-2: Significant fauna records in relation to the survey area

4.2 Field Assessment

4.2.1 Flora

The field survey identified 82 vascular flora taxa within the survey area. These taxa represented 45 genera across 26 families, with the most diverse families being Chenopodiaceae, Fabaceae and Scrophulariaceae. Dominant genera include, *Acacia, Eremophila* and *Maireana*. The full field species inventory is listed in Appendix B.

4.2.1.1 Introduced Flora

A total of three species of introduced flora were recorded within the survey area (Table 4-4 and). None of these species are listed as a Weed of National Significance or a Declared Pest in Western Australia.

Table 4-4: Introduced flora species within the survey area

Family	Taxon	Common Name
Cucurbitaceae	*Cucumis myriocarpus*	Paddy Melon
Lamiaceae	*Salvia verbenaca*	Wild Sage
Poaceae	*Cenchrus ciliaris*	Buffel Grass

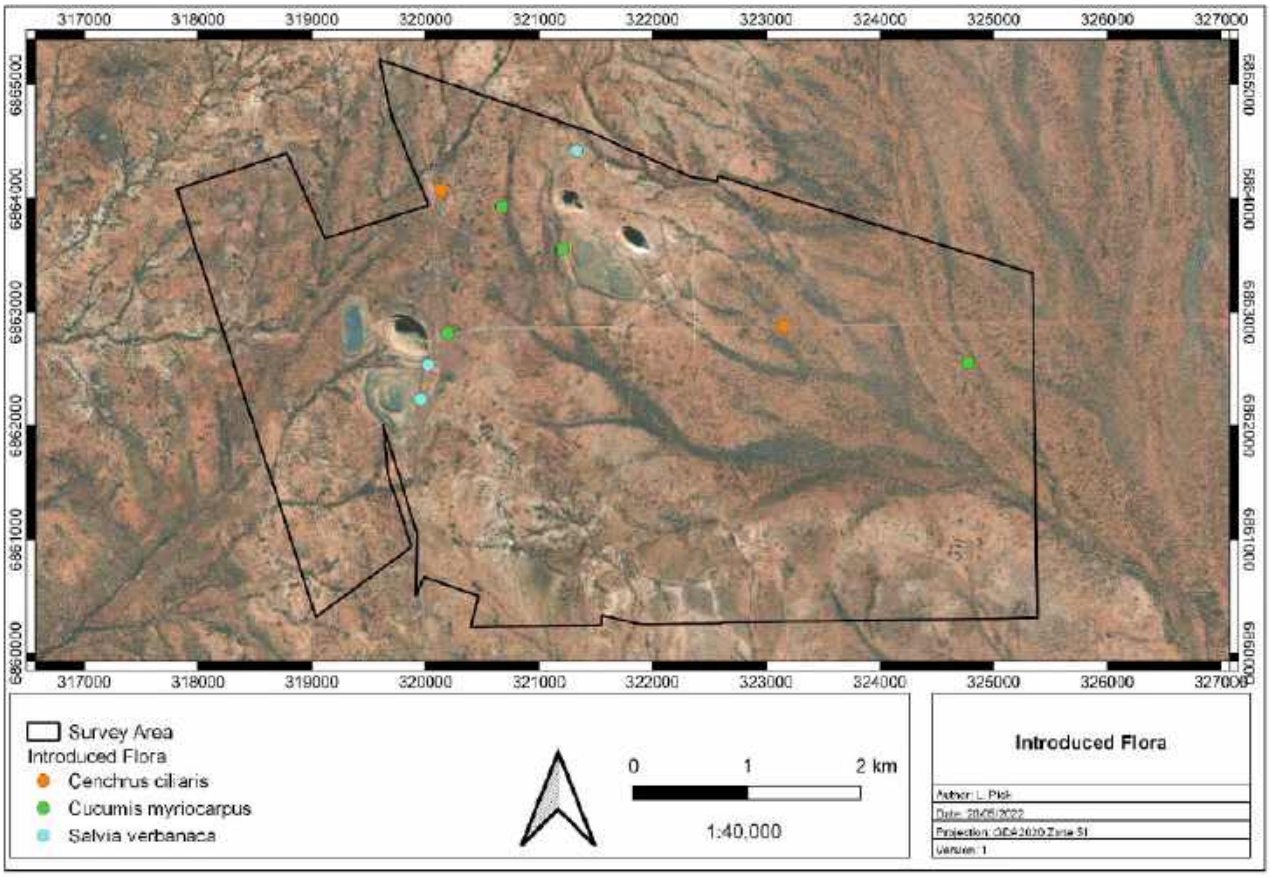

Figure 4-3: Introduced flora recorded within the survey area

4.2.1.2 Significant Flora

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant flora includes:

- flora being identified as threatened or priority species;
- locally endemic flora or flora associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- new species or anomalous features that indicate a potential new species;
- flora representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- flora with relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

One Priority Flora taxon was listed on the DBCA database as occurring within the survey area; *Hemigenia exilis* (P4). These records (shown spatially in Figure 4-1) were obtained in 1996. The locations of this taxon were confirmed by Botanica (total of 15 plants recorded) as shown in Figure 4-4. No Threatened or otherwise significant flora species were recorded within the survey area.

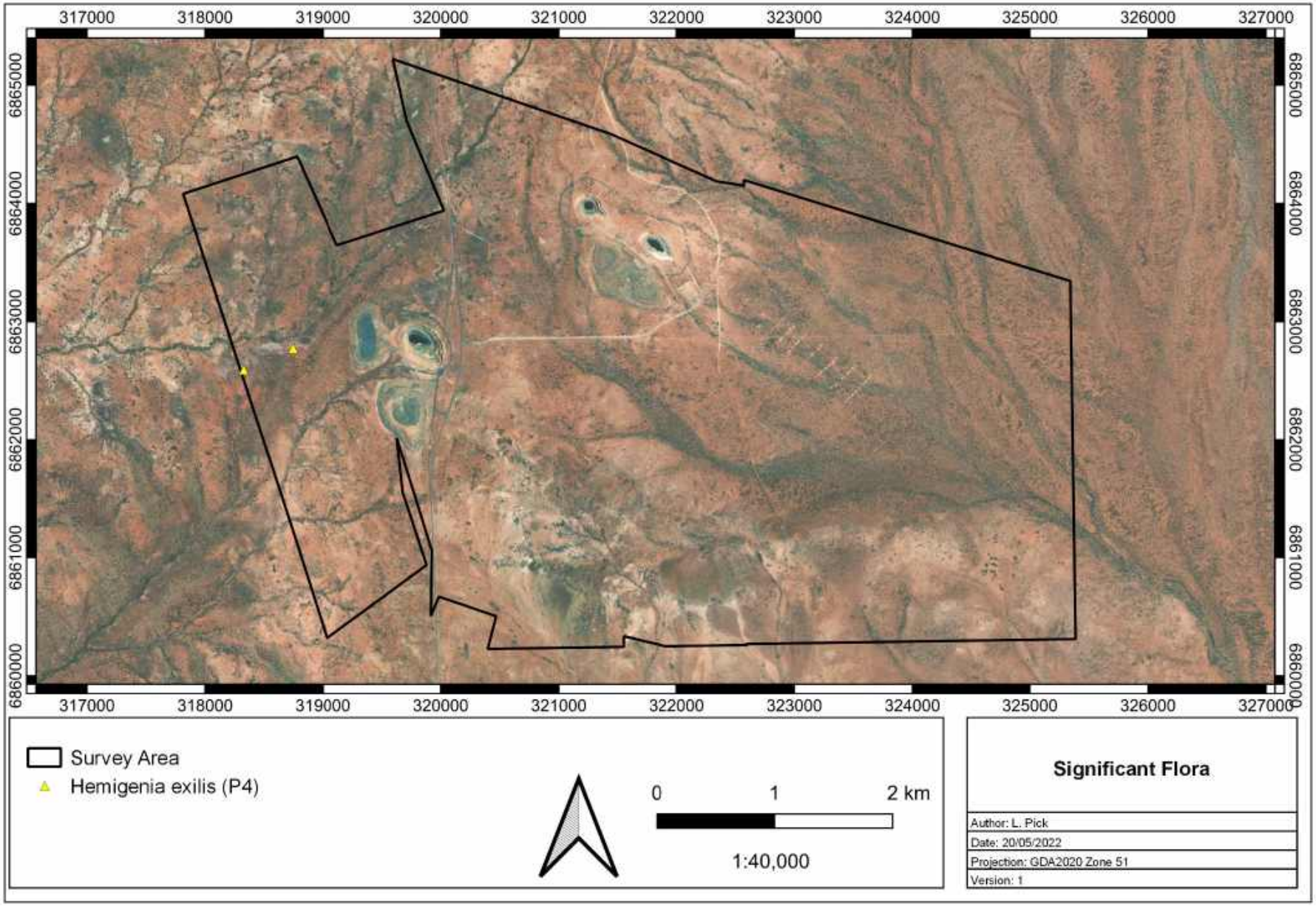

Figure 4-4: Significant Flora recorded within the survey area

4.2.2 Vegetation

4.2.2.1 Vegetation Communities

A total of eight broad-scale vegetation communities were identified within the survey area. Vegetation community descriptions and extent are listed below in Table 4-5 and illustrated spatially in Figure 4-5. Vegetation community descriptions and extents were determined from field survey results, aerial imagery interpretation and extrapolation of the communities.

Table 4-5: Summary of vegetation types within the survey area

Landform	NVIS Vegetation Group	Veg Code	Vegetation Type	Area (ha)	Area (%)	Image
Breakaway	Acacia Forest and Woodlands (MVG 6)	B-AFW1	Low woodland of *Acacia caesaneura/ A. incurvaneura* over mid open shrubland of *Dodonaea adenophora* and low shrubland of *Ptilotus obovatus* on breakaway	107	4.0	
	Mallee Woodlands and Shrublands (MVG 14)	B-MWS1	Mid open mallee woodland of *Eucalyptus carnei* over mid open shrubland of *Scaevola spinescens* and low open samphire shrubland of *Tecticornia indica* subsp. *bidens* on breakaway	167	6.3	

Landform	NVIS Vegetation Group	Veg Code	Vegetation Type	Area (ha)	Area (%)	Image
Open Depression	Acacia Forest and Woodlands (MVG 6)	OD-AFW1	Low open woodland of *Acacia aptaneura* over tall open shrubland of *Acacia tetragonophylla* in open depression	536	20.2	
	Eucalypt Woodlands (MVG 5)	OD-EW1	Mid open woodland of *Eucalyptus camaldulensis* over tall open shrubland of *Hakea recurva* subsp. *recurva* in open depression	7	0.3	

Landform	NVIS Vegetation Group	Veg Code	Vegetation Type	Area (ha)	Area (%)	Image
	Mallee Woodlands and Shrublands (MVG 14)	OD-MWS1	Mid open mallee woodland of *Eucalyptus lucasii* over low open woodland of *Acacia aptaneura* and tall open shrubland of *Acacia tetragonophylla* in open depression	33	1.2	
Rocky Plain	Acacia Forest and Woodlands (MVG 6)	RP-AFW1	Low woodland of *Acacia quadrimarginea* over low shrubland of *Eremophila forrestii* subsp. *forrestii* and low open tussock grassland of *Aristida contorta* on rocky-plain	1246	47.1	

Landform	NVIS Vegetation Group	Veg Code	Vegetation Type	Area (ha)	Area (%)	Image
	Acacia Open Woodlands (MVG 13)	RP-AOW1	Low open woodland of *Acacia incurvaneura* over mid shrubland of *Cratystylis subspinescens/ Maireana sedifolia* on quartz-rocky plain	348	13.1	
Rocky Slope	Acacia Forest and Woodlands (MVG 6)	RS-AFW1	Low woodland of *Acacia incurvaneura* over low open chenopod shrubland of *Maireana triptera* on rocky hillslope	36	1.4	

Landform	NVIS Vegetation Group	Veg Code	Vegetation Type	Area (ha)	Area (%)	Image
N/A		CV	Cleared Vegetation	167	6.3	

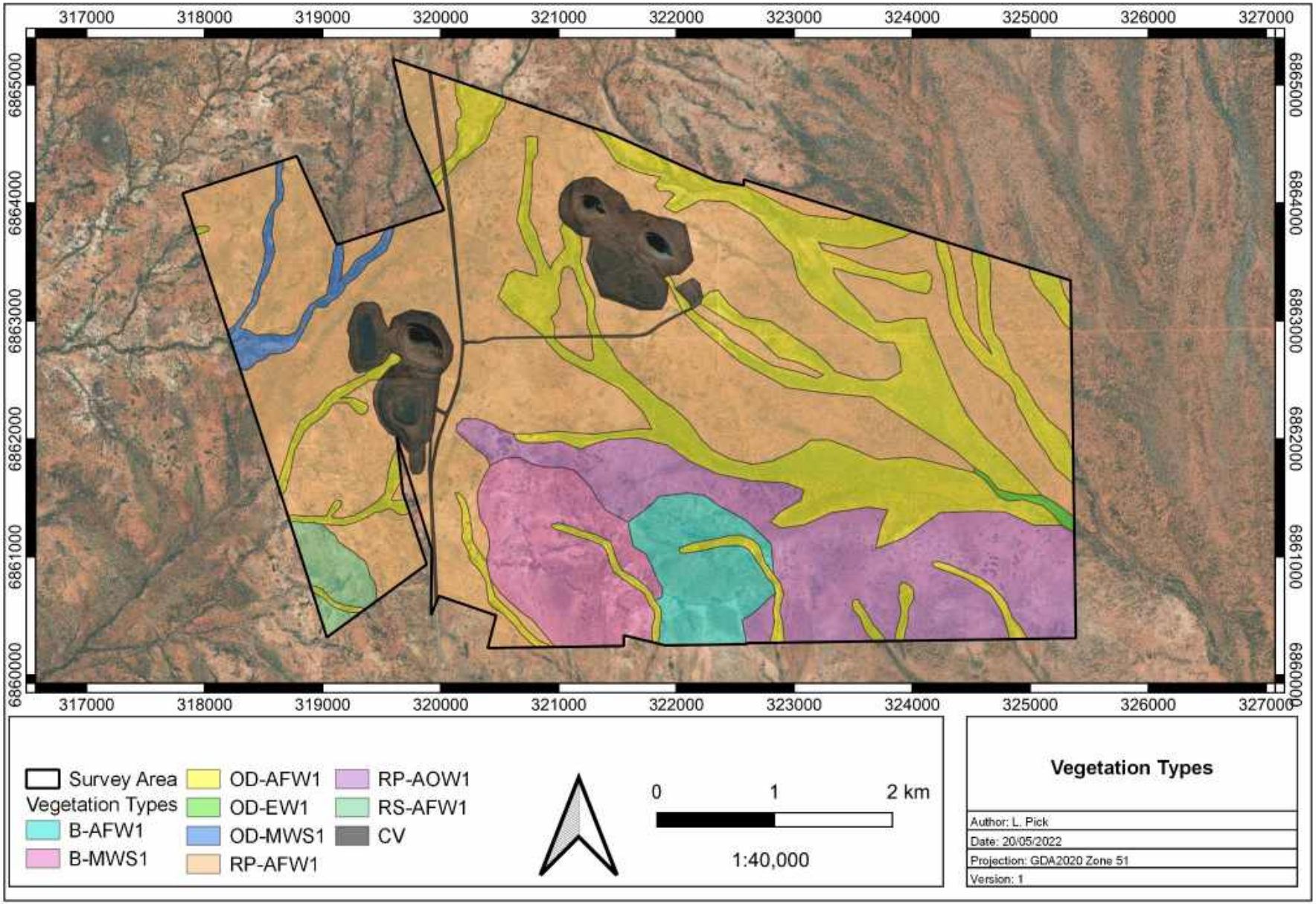

Figure 4-5: Vegetation types within the survey area

4.2.2.2 *Vegetation Condition*

Based on the vegetation condition rating scale adapted from Keighery (1994) and Trudgen, (1988), native vegetation within the survey area ranged from 'good to 'very good'. (Table 4-6, Figure 4-6). Vegetation condition rating descriptions are listed in Appendix C. Disturbances within the survey area include existing mining, exploration, pastoral land use, road siding of the Goldfields Highway and introduced species.

Table 4-6: Vegetation condition rating within the survey area

Condition rating	Description	Area (ha)	Area (%)
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.	349	13.2
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.	2,131	80.5
Cleared Vegetation	Cleared Vegetation	167	6.3

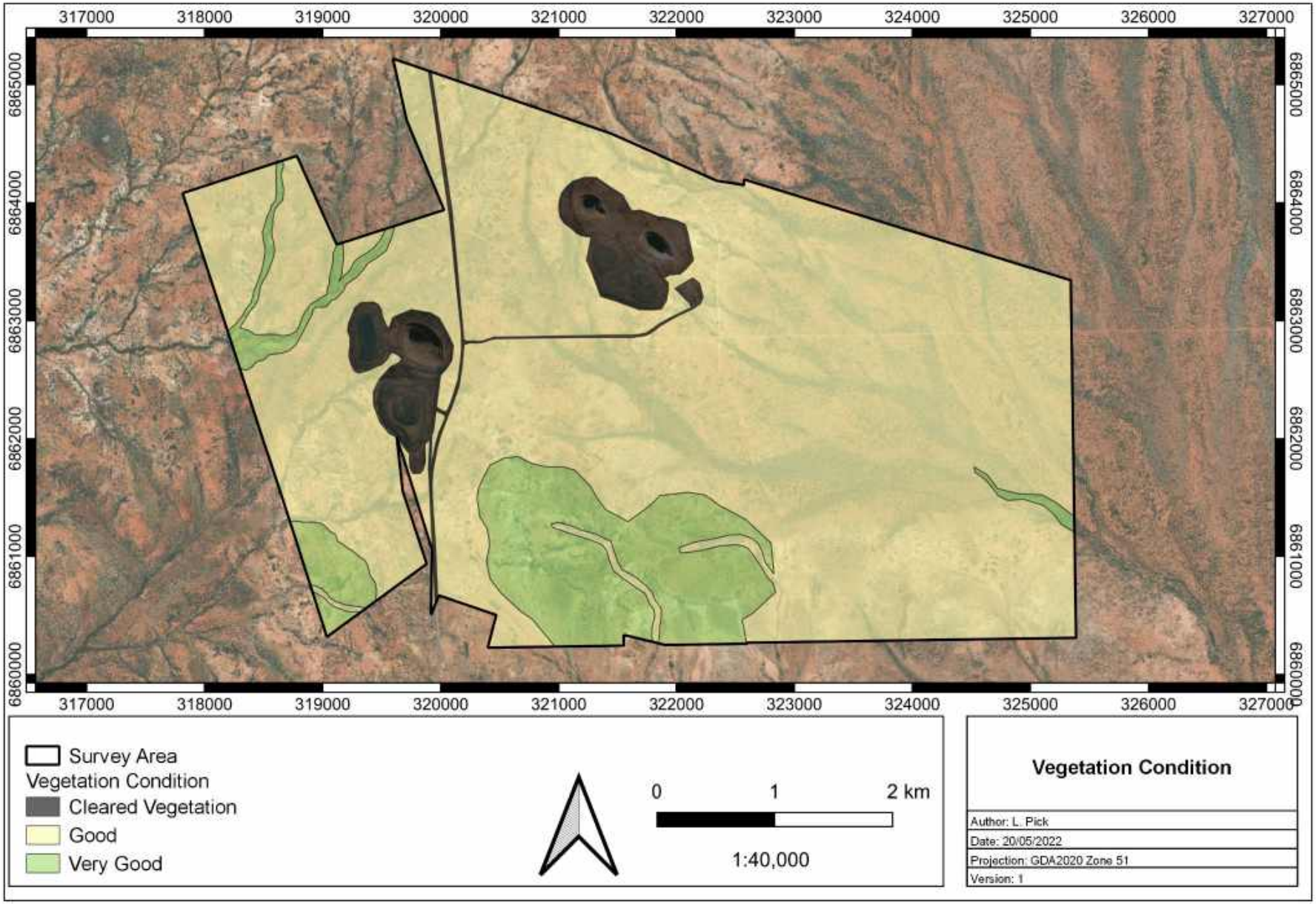

Figure 4-6: Vegetation condition within the survey area

4.2.2.3 Significant Vegetation

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant vegetation includes:

- vegetation being identified as threatened or priority ecological communities;
- vegetation with restricted distribution;
- vegetation subject to a high degree of historical impact from threatening processes;
- vegetation which provides a role as a refuge; and
- vegetation providing an important function required to maintain ecological integrity of a significant ecosystem.

No TECs listed under State or Commonwealth legislation or PECs listed by DBCA were identified within the survey area. The breakaway vegetation communities which represent 10.4% of the total survey area are considered as significant vegetation as they potentially provide a role as refuge for fauna. No other significant vegetation was identified within the survey area.

4.2.3 Fauna

4.2.3.1 Fauna Habitat

Based on vegetation and associated landforms identified during the flora and vegetation assessment, five broad scale terrestrial fauna habitats were identified as occurring within the survey area. Table 4-7 provides the area and a visual representation of fauna habitat types, and the extent of fauna habitats is shown spatially in Figure 4-7.

During the field survey opportunistic observations of fauna species were made with a total of nine fauna species observed (including two introduced fauna).

Table 4-7: Fauna species observed during the field survey

Taxon	Common Name
Psephotellus varius	Mulga Parrot
Macropus fuliginosus melanops	Western Grey Kangaroo
Oryctolagus cuniculus	Rabbit
Cracticus nigrogularis	Pied Butcherbird
Gymnorhina tibicen	Australian Magpie
Corvus coronoides	Australian Raven
Varanus gouldii	Bungarra
Coracina novaehollandiae	Black-faced Cuckooshrike
Bos primigenius taurus	European Cattle

Table 4-8: Main terrestrial fauna habitats within the survey area

Fauna Habitat	Description	Representative Fauna Attributes	Example Image
Breakaway: Acacia/ Mallee Woodland Area= 274 ha (10.4%)	Mulga/ Mallee Woodland over low mixed shrubland on breakaway	• Ground not suited to burrowing species. • Potential refuge for small fauna under rocks/ with breakaway crevices. • Low diversity vegetation strata. • Low vegetation density and leaf litter.	
Drainage Line: Acacia/ Mallee Woodland Area= 569 ha (21.5%)	Mulga/ Mallee Woodland over low mixed shrubland in ephemeral drainage line	• Ground well suited to burrowing species. • Moderate diversity vegetation strata supporting avifauna assemblage. • Moderate vegetation density and leaf litter. • Potential freshwater source during floods.	

Fauna Habitat	Description	Representative Fauna Attributes	Example Image
Drainage Line: Eucalypt Woodland Area= 7 ha (0.3%)	River Red Gum Woodland over low mixed shrubland in ephemeral drainage lime	• Ground well suited to burrowing species. • Moderate diversity vegetation strata supporting avifauna assemblage. • Moderate vegetation density and leaf litter. • Potential freshwater source during floods.	
Rocky Hillslope: Acacia Woodland Area= 36 ha (1.4%)	Mulga Woodland over low open bluebush shrubland on rocky hillslope	• Ground not particularly suited to burrowing species. • Potential refuge for small fauna under rocks • Low diversity vegetation strata • Low vegetation density and leaf litter	

Fauna Habitat	Description	Representative Fauna Attributes	Example Image
Rocky Plain: Acacia Woodland Area= 1,594 ha (60.2%)	Mulga/ Acacia Woodland over mixed Chenopod shrubland and tussock grassland on rocky plain	• Ground not particularly suited to burrowing species. • Low diversity vegetation strata • Low vegetation density and leaf litter	

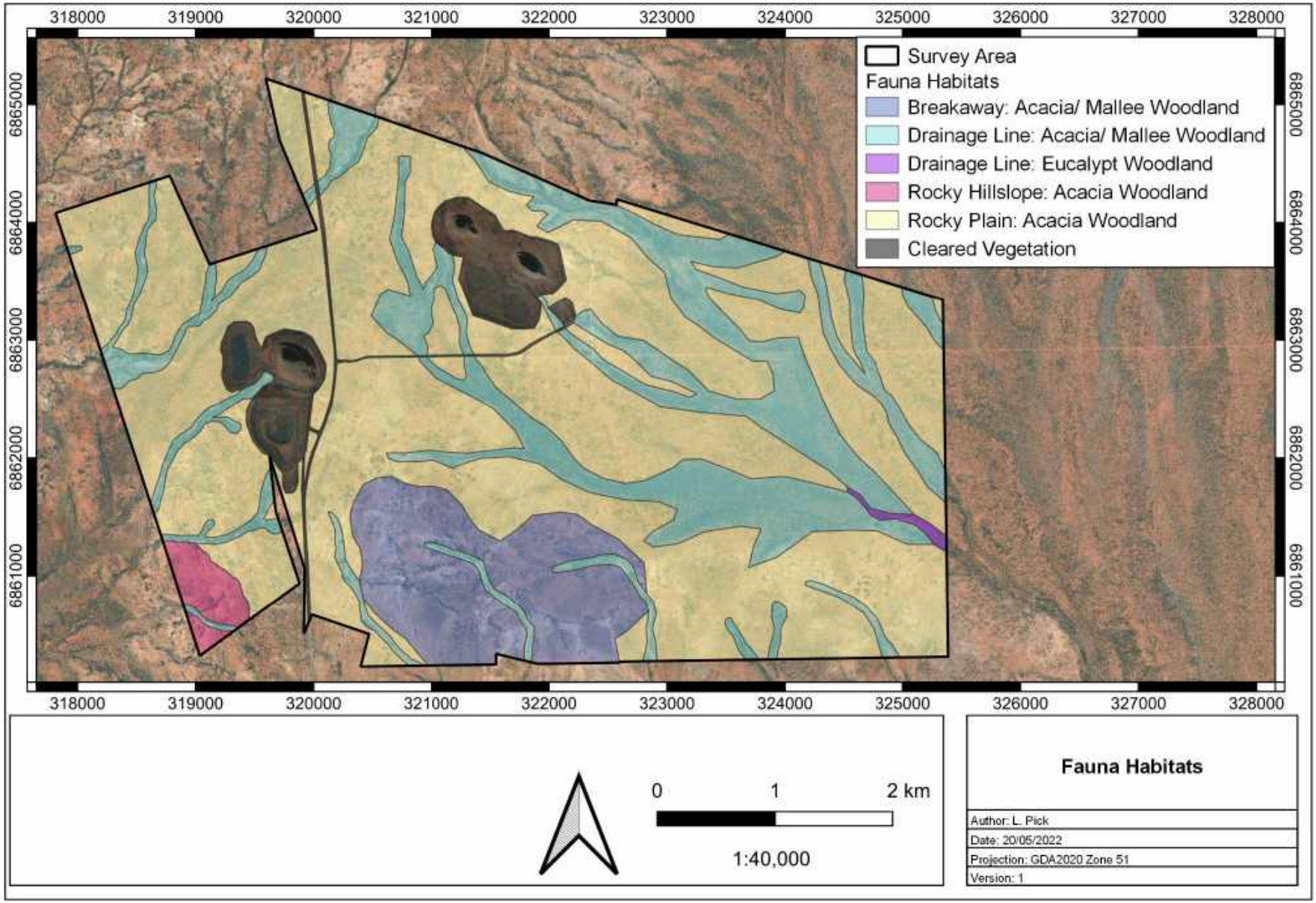

Figure 4-7: Fauna habitats within the survey area

4.2.3.2 Significant Fauna

According to the EPA *Environmental Factor Guideline for Terrestrial Fauna* (EPA, 2016c) significant fauna includes:

- Fauna being identified as a Threatened or Priority species;
- Fauna species with restricted distribution;
- Fauna subject to a high degree of historical impact from threatening processes; and
- Fauna providing an important function required to maintain the ecological integrity of a significant ecosystem.

The current status of some species on site and/or in the general area is difficult to determine, however, based on the habitats present and, in some cases, direct observations or recent nearby records, the following species of conservation significance can be regarded as possibly utilising the survey area for some purpose at times, these being:

- **Malleefowl (*Leipoa ocellata)* - Vulnerable (EPBC Act and BC Act)**

This species is occasionally recorded in the Eastern Murchison subregion. The majority of habitat within the survey area appears unsuitable for breeding due to the moderately low density of the vegetation and leaf litter, with no evidence of this species occurring within the survey area, including nesting mounds, tracks or other signs, recorded within the survey area. Habitat appears to be marginal in extent/quality however this species is considered as possibly occurring as it may visit the area for short periods as infrequent vagrants.

No evidence of significant fauna species were observed during the survey.

4.3 Matters of National Environmental Significance

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects Matters of National Environmental Significance (MNES) and is used by the Commonwealth DAWE to list threatened taxa and ecological communities into categories based on the criteria set out in the EPBC Act (www.environment.gov.au/epbc/index.html). The EPBC Act provides a national environmental assessment and approval system for proposed developments and enforces strict penalties for unauthorised actions that may affect matters of national environmental significance. MNES as defined by the Commonwealth EPBC Act include:

- Nationally threatened flora and fauna species;
- World heritage properties;
- National heritage places;
- Wetlands of international importance (often called ‘Ramsar’ wetlands after the international treaty under which such wetlands are listed);
- Nationally threatened ecological communities;
- Commonwealth marine area;
- The Great Barrier Reef Marine Park; and
- Nuclear actions (including uranium mining) a water resource, in relation to coal seam gas development and large coal mining development.

No MNES were identified within the survey area.

4.4 Matters of State Environmental Significance

4.4.1 *Environmental Protection Act 1986* (WA)

The EP Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment. The Act is administered by The Department of Water and Environment Regulation (DWER), which is the State Government's environmental regulatory agency.

Under Section 51C of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations (Regulations) 2004* (WA) any clearing of native vegetation in Western Australia that is not eligible for exemption under Schedule 6 of the EP Act or under the Regulations requires a clearing permit from the DWER or the Department of Mines, Industry Regulation and Safety (DMIRS). Under Section 51A of the EP Act native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent. Section 51A of the EP Act defines clearing as "the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above". Exemptions under Schedule 6 of the EP Act and the EP Regulations do not apply in ESAs as declared under Section 51B of the EP Act or TEC listed under State and Commonwealth legislation.

No Environmentally Sensitive Areas were identified within the survey area.

4.4.2 *Biodiversity Conservation Act 2016*

The BC Act is used by the Western Australian DBCA for the conservation and protection of biodiversity and biodiversity components in Western Australia and to promote the ecologically sustainable use of biodiversity components in the State. Taxa are classified as 'Threatened" when their populations are geographically restricted or are threatened by local processes (see following sections for Threatened definitions). Under the BC Act all native flora and fauna are protected throughout the State. Financial penalties are enforced under the BC Act if threatened species are collected without an appropriate licence.

Under Section 54(1) of the BC Act, habitat is eligible for listing as critical habitat if:

a) it is critical to the survival of a threatened species or a threatened ecological community; and
b) its listing is otherwise in accordance with the ministerial guidelines.

No threatened species or critical habitat listed under the BC Act were recorded within the survey area.

4.5 Other Areas of Conservation Significance

The DBCA lists 'Priority' species and communities which are under consideration for declaration as 'Threatened' under the BC Act. These Priority species/ communities have no formal legal protection until they are endorsed by the Minister as being Threatened. No PEC's as listed by DBCA were identified within the survey area. One Priority Flora taxon was listed on the DBCA database as occurring within the survey area; *Hemigenia exilis* (P4). The locations of this taxon were confirmed by Botanica.

There are no wetlands of international importance (Ramsar Wetlands) or national importance (Australian Nature Conservation Agency Wetlands) within the survey area.

There are no proposed nor gazetted conservation reserves within the survey area. The closest conservation reserve is the Wanjarri Nature Reserve which is located approximately 100 km to the north-west of the survey area.

4.6 Native Vegetation Clearing Principles

Based on the outcomes from the survey undertaken, Botanica assessed the results of the desktop and field survey with regards to the native vegetation clearing principles listed under Schedule 5 of the EP Act (Table 4-9). The assessment found that the proposed vegetation clearing activities may be at variance with clearing principle (f).

Table 4-9: Assessment against native vegetation clearing principles

Letter	Principle Native vegetation should not be cleared if it:	Assessment	Outcome
(a)	comprises a high level of biological diversity.	Vegetation identified within the survey area is not considered to be of high biological diversity and is well represented outside of the survey area.	Clearing is unlikely to be at variance with this principle
(b)	comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	No significant fauna were observed within the survey area.	Clearing is unlikely to be at variance with this principle
(c)	includes, or is necessary for the continued existence of rare flora.	No Threatened Flora taxa, pursuant to the BC Act and the EPBC Act were identified within the survey area.	Clearing is not at variance with this principle
(d)	comprises the whole or part of or is necessary for the maintenance of a threatened ecological community (TEC).	No TEC listed under the EPBC Act or by the BC Act occur within the survey area or the Eastern Murchison subregion.	Clearing is not at variance with this principle
(e)	is significant as a remnant of native vegetation in an area that has been extensively cleared	Vegetation associations within the survey area retain >98% of their pre-European extent, and development within the survey area will not significantly reduce the current extent of these vegetation associations.	Clearing is unlikely to be at variance with this principle
(f)	is growing, in, or in association with, an environment associated with a watercourse or wetland	There are no permanent/ perennial inland waters or drainage lines within the survey area. There are however numerous minor ephemeral drainage lines occurring through the survey area. These ephemeral drainage lines were represented by three vegetation types; OD-AFW1, OD-EW1 and OD-MWS1 which represent approximately 21.8% of the total survey area.	Clearing may be at variance with this principle
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The survey area and surrounding region has not been extensively cleared. Clearing within the survey area is not considered likely to lead to land degradation issues such as salinity, water logging or acidic soils.	Clearing is unlikely to be at variance with this principle
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The closest significant environmental feature is Wanjarri Nature Reserve, located approximately 100 km north of the survey area. Disturbances within the survey area are unlikely to impact this area.	Clearing is unlikely to be at variance with this principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to	No surface water bodies are located within the survey area. Clearing in ephemeral drainage lines is unlikely to result in significant impacts to water	Clearing is unlikely to be at variance with this principle

Letter	Principle Native vegetation should not be cleared if it:	Assessment	Outcome
	cause deterioration in the quality of surface or underground water.	quality.	
(j)	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	Rainfall in the Eastern Murchison subregion has an average rainfall of 200mm. Rainfall events are unlikely to result in localised flooding. Clearing within the survey area is not likely to increase the incidence or intensity of flooding within the survey area or surrounds.	Clearing is unlikely to be at variance with this principle

5 BIBLIOGRAPHY

Atlas of Living Australia (2022). *Spatial Portal*. Accessed 25/01/2022.

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

Birdlife Australia (2022). *Birdlife Australia Species Profiles.* Available: https://www.birdlife.org.au/. Accessed 30/05/2022.

BoM, (2022a). *Climate Data*. Bureau of Meteorology. Available: http://www.bom.gov.au/climate

BoM (2022b). *Groundwater Dependent Ecosystems Atlas*. Bureau of Meteorology. Available: http://www.bom.gov.au/water/groundwater/gde/map.shtml

Botanica. (2021). Detailed flora/vegetation survey and basic fauna survey of the Redcliffe Gold Project. Unpublished report prepared for Dacian Gold Ltd., October 2021.

Botanica (2014). Level 1 flora and vegetation survey of the Thunderbox to Bannockburn Project. Unpublished report prepared for Saracen, August 2014.

Botanica (2021). Reconnaissance Flora and Basic Fauna Survey of the proposed Bronzewing to Thunderbox Haul Road (L36/246). Unpublished report prepared for Northern Star Resources Ltd., October 2021.

Cowan, M. et. al., (2001). *A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2001; Eastern Murchison (MUR01 –Eastern Murchison subregion)*. pp 143-155, Department of Conservation and Land Management, August 2001.

DBCA (2021a). *Priority Ecological Communities for Western Australia Version 31*. Species and Community Branch, June 2021.

DBCA (2022a). NatureMap database search. Department of Biodiversity, Conservation and Attractions, WA.

DBCA (2022b). *Threatened and Priority flora database search (35_0422FL)*. Department of Biodiversity, Conservation and Attractions, WA.

DBCA (2022c). *Threatened and Priority ecological communities database search (29_0322EC)*. Department of Biodiversity, Conservation and Attractions, WA.

DBCA (2022d). *Threatened and Priority fauna database search (7085)*. Department of Biodiversity, Conservation and Attractions, WA.

DBCA (2022e). *Fauna Profiles*. Available: www.library.dbca.wa.gov.au, accessed 28/05/2022.

DAWE (2022a). *Protected Matters Search Tool*. *Environment Protection and Biodiversity Conservation Act 1999*, Department of Agriculture, Water and Environment, Australian Government.

DAWE (2022b). *Species Profile and Threats Database*. Department of Agriculture, Water and Environment, Australian Government.

DotEE (2012). *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7.* Department of the Environment and Energy.

DotEE (2017). *National Vegetation Information System (NVIS) Major Vegetation Groups, Version 4.2.* Department of the Environment and Energy.

DPIRD (2019). *Pre-European Vegetation (DPIRD_006).* Department of Primary Industries and Regional Development, Western Australia, 24 July 2019.

DPIRD (2020). *Declared Organism database search*. Department of Primary Industries and Regional Development, Western Australia. Available: http://www.biosecurity.wa.gov.au/

EPA, (2000). *Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia.* Environmental Protection Authority.

EPA (2016a). *Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016.* Environmental Protection Authority.

EPA (2016b). *Environmental Factor Guideline for Flora and Vegetation – December 2016.* Environmental Protection Authority.

EPA (2020). *Technical Guide – Terrestrial Fauna Surveys for Environmental Impact Assessment – June 2020.* Environmental Protection Authority.

Geoscience Australia (2015). *Surface Hydrology GIS*. Australian Government.

Government of Western Australia (2019). 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis. (Full Report). Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth.

Government of Western Australia (2019). *Soil Landscape Mapping – Systems (DPIRD-064).* GIS data obtained from data.wa.gov.au, last updated 27 June 2019.

Keighery, B. J., (1994). *Bushland Plant Survey: A guide to plant community survey for the community*. Wildflower Society of Western Australia (Inc.), Nedlands.

Tille, P. (2006). *Soil Landscapes of Western Australia's Rangelands and Arid Interior*. Department of Agriculture and Food Western Australia

APPENDIX A:
CONSERVATION RATINGS BC ACT AND EPBC ACT

Definitions of Conservation Significant Species

Code	Category
State categories of Threatened and Priority species	
Threatened Species (T) Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as Threatened species under section 26(2) of the Biodiversity Conservation Act 2016 (BC Act).	
CR	**Critically Endangered** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	**Endangered** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.
VU	**Vulnerable** Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.
Extinct species Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.	
EX	**Extinct** Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
EW	**Extinct in the Wild** Species that *"is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form"*, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no Threatened fauna or Threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as Threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.	
IA	**International Agreement/ Migratory** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory*

Code	Category
	Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.
CD	**Species of special conservation interest** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as Threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.
OS	**Other specially protected species** Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.
Priority species Possibly Threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of Priority for survey and evaluation of conservation status so that consideration can be given to their declaration as Threatened Fauna or Flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.	
P1	**Priority 1: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority 2: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority 3: Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	**Priority 4: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Commonwealth categories of Threatened species	
EX	**Extinct** Taxa where there is no reasonable doubt that the last member of the species has died.
EW	**Extinct in the Wild**

Code	Category
	Taxa where it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CR	**Critically Endangered** Taxa that are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
EN	**Endangered** Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
VU	**Vulnerable** Taxa which are not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Definitions of Conservation Significant Communities

Category Code	Category
State categories of Threatened Ecological Communities (TEC)	
PD	**Presumed Totally Destroyed**
	An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies:
	• records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or;
	• all occurrences recorded within the last 50 years have since been destroyed.
CR	**Critically Endangered**
	An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting any one of the following criteria:
	The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification;
	The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area;
	The ecological community is highly modified with potential of being rehabilitated in the immediate future.
EN	**Endangered**
	An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. The ecological community must meet any one of the following criteria:
	The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short-term future, or is unlikely to be substantially rehabilitated in the short-term future due to modification;

Category Code	Category
	The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area;
	The ecological community is highly modified with potential of being rehabilitated in the short-term future.
VU	**Vulnerable**
	An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria:
	The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated;
	The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution;
	The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.
Commonwealth categories of Threatened Ecological Communities (TEC)	
CE	**Critically Endangered** If, at that time, an ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).
EN	**Endangered** If, at that time, an ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).
VU	**Vulnerable** If, at that time, an ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).
Priority Ecological Communities	
P1	**Poorly-known ecological communities**
	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist.
P2	**Poorly-known ecological communities**
	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, un-allocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.
P3	**Poorly known ecological communities**
	Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
	Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
	Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Ecological communities that are adequately known, rare but not threatened** or meet criteria for near threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
P5	**Conservation Dependent ecological communities**
	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX B:
LIST OF SPECIES IDENTIFIED WITHIN THE SURVEY AREA

(W) denotes introduced (weed) species; (A) denotes ephemeral (annual) species.

Family	Genus	Taxon	B-AFW1	B-MWS1	OD-AFW1	OD-EW1	OD-MWS1	RP-AFW1	RP-AOW1	RS-AFW1
Amaranthaceae	*Ptilotus*	*obovatus*	*	*	*		*	*	*	
Amaranthaceae	*Ptilotus*	*schwartzii*	*					*		*
Apocynaceae	*Cynanchum*	*viminale* subsp. *australe*								*
Apocynaceae	*Leichhardtia*	*australis*			*		*			
Asteraceae	*Cratystylis*	*subspinescens*							*	
Campanulaceae	*Isotoma*	*petraea (A)*	*							
Casuarinaceae	*Casuarina*	*obesa*	*					*		
Chenopodiaceae	*Atriplex*	*bunburyana*						*		
Chenopodiaceae	*Atriplex*	*vesicaria*						*		
Chenopodiaceae	*Enchylaena*	*tomentosa*						*		
Chenopodiaceae	*Maireana*	*brevifolia*						*		
Chenopodiaceae	*Maireana*	*georgei*							*	
Chenopodiaceae	*Maireana*	*glomerata*		*					*	
Chenopodiaceae	*Maireana*	*pyramidata*							*	*
Chenopodiaceae	*Maireana*	*sedifolia*							*	
Chenopodiaceae	*Maireana*	*tomentosa*		*						
Chenopodiaceae	*Maireana*	*triptera*							*	*
Chenopodiaceae	*Sclerolaena*	*densiflora*		*					*	
Chenopodiaceae	*Sclerolaena*	*diacantha*							*	
Chenopodiaceae	*Sclerolaena*	*patenticuspis*		*					*	
Chenopodiaceae	*Tecticornia*	*indica* subsp. *bidens*		*					*	
Cucurbitaceae	*Cucumis*	*myriocarpus (W)*			*			*		
Cupressaceae	*Callitris*	*columellaris*		*						
Fabaceae	*Acacia*	*acuminata*						*		*
Fabaceae	*Acacia*	*aptaneura*			*		*	*		
Fabaceae	*Acacia*	*caesaneura*	*		*		*	*	*	
Fabaceae	*Acacia*	*incurvaneura*	*	*	*		*	*	*	*
Fabaceae	*Acacia*	*quadrimarginea*	*		*	*	*	*	*	*
Fabaceae	*Acacia*	*ramulosa* var. *ramulosa*						*		
Fabaceae	*Acacia*	*tetragonophylla*		*	*	*	*	*	*	
Fabaceae	*Mirbelia*	*rhagodioides*	*							
Fabaceae	*Olearia*	*stuartii*		*						

Family	Genus	Taxon	B-AFW1	B-MWS1	OD-AFW1	OD-EW1	OD-MWS1	RP-AFW1	RP-AOW1	RS-AFW1
Fabaceae	*Senna*	*artemisioides* subsp. *artemisioides*			*		*			
Fabaceae	*Senna*	*artemisioides* subsp. *filifolia*						*	*	*
Fabaceae	*Senna*	*artemisioides* subsp. *helmsii*				*				
Fabaceae	*Senna*	sp. Meekatharra (E. Bailey 1-26)		*						
Frankeniaceae	*Frankenia*	sp. (sterile)		*					*	
Goodeniaceae	*Scaevola*	*spinescens*		*				*	*	*
Hemerocallidaceae	*Dianella*	*revoluta*			*		*	*		
Lamiaceae	*Prostanthera*	*althoferi* subsp. *althoferi*	*							
Lamiaceae	*Salvia*	*verbenaca (W)*						*		
Lamiaceae	*Teucrium*	*teucriiflorum*			*	*	*			
Malvaceae	*Abutilon*	*oxycarpum*			*		*			
Malvaceae	*Brachychiton*	*gregorii*						*		
Malvaceae	*Sida*	*calyxhymenia*		*	*	*	*	*	*	*
Malvaceae	*Sida*	*ectogama*	*					*		
Myrtaceae	*Eucalyptus*	*camaldulensis*				*				
Myrtaceae	*Eucalyptus*	*carnei*		*						
Myrtaceae	*Eucalyptus*	*lucasii*					*			
Myrtaceae	*Thryptomene*	*decussata*	*							
Myrtaceae	*Thryptomene*	sp. (sterile)	*	*						
Nyctaginaceae	*Boerhavia*	*coccinea*			*	*	*			
Pittosporaceae	*Pittosporum*	*angustifolium*							*	
Poaceae	*Aristida*	*contorta (A)*	*	*	*		*	*		
Poaceae	*Cenchrus*	*ciliaris (W)*						*		
Poaceae	*Cymbopogon*	*ambiguus*	*					*		
Poaceae	*Enneapogon*	*caerulescens*		*				*		
Poaceae	*Enteropogon*	*ramosus*	*	*						
Poaceae	*Eriachne*	*mucronata*		*						
Proteaceae	*Hakea*	*lorea* subsp. *lorea*				*				
Proteaceae	*Hakea*	*preissii*		*					*	*
Proteaceae	*Hakea*	*recurva* subsp. *recurva*			*	*	*			
Pteridaceae	*Cheilanthes*	*sieberi* subsp. *sieberi*	*		*		*			*
Rubiaceae	*Psydrax*	*latifolia*	*							
Rubiaceae	*Psydrax*	*rigidula*			*	*	*	*		*
Rutaceae	*Philotheca*	*brucei* subsp. *brucei*		*						
Santalaceae	*Exocarpos*	*aphyllus*		*					*	

Family	Genus	Taxon	B-AFW1	B-MWS1	OD-AFW1	OD-EW1	OD-MWS1	RP-AFW1	RP-AOW1	RS-AFW1
Santalaceae	*Santalum*	*spicatum*				*		*		
Sapindaceae	*Dodonaea*	*adenophora*	*							
Sapindaceae	*Dodonaea*	*lobulata*		*						
Scrophulariaceae	*Eremophila*	*forrestii* subsp. *forrestii*						*		
Scrophulariaceae	*Eremophila*	*georgei*				*		*		
Scrophulariaceae	*Eremophila*	*lonantha*		*				*	*	
Scrophulariaceae	*Eremophila*	*latrobei* subsp. *glabra*			*		*			
Scrophulariaceae	*Eremophila*	*latrobei* subsp. *latrobei*	*	*	*		*	*		
Scrophulariaceae	*Eremophila*	*metallicorum*						*		
Scrophulariaceae	*Eremophila*	*oldfieldii* subsp. *angustifolia*							*	*
Scrophulariaceae	*Eremophila*	*oppositifolia*		*						
Scrophulariaceae	*Eremophila*	*pantonii*			*	*	*			*
Scrophulariaceae	*Eremophila*	*platycalyx* subsp. Leonora (J. Morrisey 252)	*		*	*	*	*		*
Solanaceae	*Solanum*	*lasiophyllum*	*	*	*		*	*	*	
Solanaceae	*Solanum*	*orbiculatum*			*		*			*

APPENDIX C:
VEGETATION CONDITION RATING

Vegetation Condition Rating	South West and Interzone Botanical Provinces	Eremaean and Northern Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor		Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e., areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX D:
NATUREMAP DESKTOP SEARCH (40KM)

Vascular Flora

Abutilon aff. leucopetalum
Abutilon cryptopetalum
Abutilon leucopetalum
Acacia ?coolgardiensis
Acacia acuminata
Acacia aneura
Acacia aptaneura
Acacia ayersiana
Acacia burkittii
Acacia caesaneura
Acacia colletioides
Acacia coolgardiensis
Acacia craspedocarpa
Acacia craspedocarpa hybrid
Acacia donaldsonii
Acacia effusifolia
Acacia grasbyi
Acacia incurvaneura
Acacia jamesiana
Acacia ligulata
Acacia macraneura
Acacia megacephala
Acacia minyura
Acacia mulganeura
Acacia oswaldii
Acacia oswaldii (Narrow phyllode variant)
Acacia papyrocarpa
Acacia pteraneura
Acacia quadrimarginea
Acacia ramulosa
Acacia ramulosa var. linophylla
Acacia ramulosa var. ramulosa
Acacia Sect. Juliflorae (Microneurae, flat)
Acacia sibirica
Acacia sp.
Acacia sp. Marshall Pool (G. Cockerton 3024)
Acacia sp.Juliflorae - terete Eremaean Region
Acacia sp.Juliflorae-flat, Eremaean region
Acacia tetragonophylla
Acacia victoriae
Actinobole oldfieldianum
Agave americana
Alyogyne pinoniana
Amyema fitzgeraldii
Amyema nestor

Androcalva luteiflora
Aristida contorta
Asteridea athrixioides
Atriplex codonocarpa
Atriplex holocarpa
Atriplex semilunaris
Austrostipa elegantissima
Austrostipa nodosa
Austrostipa scabra
Avena sp.
Bonamia erecta
Boronia purdieana subsp. purdieana
Bossiaea walkeri
Brachychiton gregorii
Brachyscome ciliaris
Brachyscome iberidifolia
Brunonia australis
Calandrinia balonensis
Calandrinia eremaea
Calandrinia polyandra
Calandrinia pumila
Calandrinia schistorhiza
Calandrinia translucens
Calocephalus knappii
Calocephalus multiflorus
Calotis hispidula
Calotis multicaulis
Calotis sp. Carnarvon Range (D.J. Edinger & K.F. Kenneally D 2708 K 12243)
Calytrix desolata
Calytrix erosipetala
Calytrix praecipua
Calytrix uncinata
Casuarina obesa
Cephalipterum drummondii
Chenopodium nitrariaceum
Chrysocephalum puteale
Chthonocephalus pseudevax
Crassula sp.
Cryptandra connata
Cuphonotus andraeanus
Cuscuta planiflora
Cylindropuntia fulgida var. mamillata
Cylindropuntia imbricata
Cymbopogon ambiguus
Cymbopogon obtectus
Dampiera ramosa
Dampiera roycei
Dianella revoluta
Dichanthium sericeum subsp. humilius

Dicrastylis brunnea
Dicrastylis sessilifolia
Dodonaea adenophora
Dodonaea petiolaris
Dodonaea rigida
Duma florulenta
Duperreya commixta
Dysphania glomulifera subsp. eremaea
Eleusine indica
Enchylaena tomentosa
Enchylaena tomentosa var. tomentosa
Enekbatus eremaeus
Enneapogon caerulescens
Eragrostis eriopoda
Eragrostis setifolia
Eremophila alternifolia
Eremophila clarkei
Eremophila conglomerata
Eremophila decipiens subsp. decipiens
Eremophila eriocalyx
Eremophila exilifolia
Eremophila foliosissima
Eremophila forrestii
Eremophila forrestii subsp. forrestii
Eremophila fraseri
Eremophila galeata
Eremophila georgei
Eremophila gilesii subsp. gilesii
Eremophila gilesii subsp. variabilis
Eremophila granitica
Eremophila homoplastica
Eremophila hughesii subsp. hughesii
Eremophila jucunda subsp. jucunda
Eremophila lanceolata
Eremophila latrobei
Eremophila latrobei subsp. glabra
Eremophila latrobei subsp. latrobei
Eremophila longifolia
Eremophila maculata subsp. brevifolia
Eremophila malacoides
Eremophila margarethae
Eremophila metallicorum
Eremophila oldfieldii subsp. angustifolia
Eremophila oppositifolia subsp. angustifolia
Eremophila pantonii
Eremophila platycalyx subsp. Leonora (J. Morrisey 252)
Eremophila platycalyx subsp. platycalyx
Eremophila platythamnos subsp. platythamnos
Eremophila ramiflora

Eremophila scoparia
Eremophila serrulata
Eremophila shonae subsp. shonae
Eremophila simulans subsp. megacalyx
Eremophila simulans subsp. simulans
Eremophila sp.
Eremophila spectabilis subsp. brevis
Eremophila spectabilis x ?
Eremophila spuria
Eremophila youngii subsp. youngii
Eriachne flaccida
Eriachne helmsii
Eriachne mucronata
Erodium aureum
Erodium cygnorum
Erymophyllum ramosum subsp. ramosum
Eucalyptus caesia
Eucalyptus camaldulensis subsp. arida
Eucalyptus camaldulensis subsp. obtusa
Eucalyptus carnei
Eucalyptus eremicola
Eucalyptus eremicola subsp. eremicola
Eucalyptus eremicola subsp. peeneri
Eucalyptus gongylocarpa
Eucalyptus gypsophila
Eucalyptus kingsmillii
Eucalyptus lucasii
Eucalyptus striaticalyx
Eucalyptus striaticalyx subsp. striaticalyx
Eucalyptus trichopoda
Eucalyptus youngiana
Euryomyrtus maidenii
Exocarpos aphyllus
Frankenia georgei
Frankenia laxiflora
Frankenia pauciflora var. pauciflora
Frankenia setosa
Glycine canescens
Gnephosis arachnoidea
Gnephosis brevifolia
Gnephosis tenuissima
Goodenia macroplectra
Goodenia mimuloides
Goodenia mueckeana
Goodenia scaevolina
Goodenia triodiophila
Grevillea extorris
Grevillea inconspicua
Grevillea juncifolia subsp. juncifolia

Grevillea obliquistigma subsp. obliquistigma
Grevillea sarissa subsp. sarissa
Grevillea stenobotrya
Hakea leucoptera subsp. sericipes
Hakea lorea subsp. lorea
Hakea preissii
Hakea recurva
Halgania cyanea
Haloragis trigonocarpa
Harnieria kempeana subsp. muelleri
Helipterum craspedioides
Hemigenia botryphylla
Hemigenia exilis
Hibiscus burtonii
Hibiscus solanifolius
Hibiscus sp. Gardneri (A.L. Payne PRP 1435)
Hibiscus sp. Gardneri (A.L.Payne PRP 1435)
Homalocalyx thryptomenoides
Hybanthus floribundus
Hybanthus floribundus subsp. curvifolius
Hybanthus floribundus subsp. floribundus
Hypolaena grandiuscula
Hysterobaeckea occlusa
Indigofera georgei
Indigofera sp. Indet
Isoetes sp.
Isoetopsis graminifolia
Isotoma petraea
Juncus aridicola
Kennedia prorepens
Keraudrenia velutina subsp. elliptica
Keraudrenia velutina subsp. elliptica ms
Korthalsella leucothrix
Lawrencella davenportii
Laxmannia arida
Leiocarpa semicalva subsp. semicalva
Lemooria burkittii
Lepidium oxytrichum
Lepidosperma sp.
Leptosema chambersii
Leucochrysum fitzgibbonii
Leucochrysum stipitatum
Lobelia sp. indet
Lobelia winfridae
Lysiana casuarinae
Lysiana murrayi
Lysimachia arvensis
Maireana aff. planifolia
Maireana carnosa

Maireana georgei
Maireana planifolia
Maireana pyramidata
Maireana sedifolia
Maireana thesioides
Maireana tomentosa subsp. tomentosa
Maireana trichoptera
Maireana triptera
Marsdenia australis
Melaleuca hamata
Melaleuca interioris
Melaleuca xerophila
Micromyrtus chrysodema
Micromyrtus flaviflora
Mirbelia microphylla
Mirbelia rhagodioides
Mirbelia spinosa
Monachather paradoxus
Myriocephalus guerinae
Myriocephalus oldfieldii
Myriocephalus pygmaeus
Myriocephalus rhizocephalus
Nicotiana rosulata
Nicotiana rosulata subsp. rosulata
Nicotiana stenocarpa
Olearia calcarea
Olearia humilis
Olearia stuartii
Ophioglossum lusitanicum
Opuntia elata
Opuntia sp.
Ozothamnus cassiope
Philotheca brucei subsp. brucei
Philotheca tubiflora
Phyllanthus baeckeoides
Phyllanthus calycinus
Phyllanthus sp.
Pimelea trichostachya
Pittosporum angustifolium
Plantago debilis
Plantago drummondii
Pluchea dentex
Podolepis aristata subsp. affinis
Podolepis canescens
Podolepis capillaris
Podolepis gardneri
Podolepis kendallii
Podolepis lessonii
Pogonolepis muelleriana

Pogonolepis stricta
Poranthera leiosperma
Poranthera microphylla
Prostanthera althoferi subsp. althoferi
Prostanthera wilkieana
Psydrax rigidula
Psydrax suaveolens
Ptilotus aervoides
Ptilotus divaricatus
Ptilotus gaudichaudii
Ptilotus helipteroides
Ptilotus macrocephalus
Ptilotus nobilis subsp. nobilis
Ptilotus obovatus
Ptilotus polystachyus
Ptilotus roei
Ptilotus schwartzii
Ptilotus schwartzii var. schwartzii
Rhagodia drummondii
Rhagodia eremaea
Rhodanthe battii
Rhodanthe charsleyae
Rhodanthe chlorocephala subsp. splendida
Rhodanthe citrina
Rhodanthe manglesii
Rhodanthe maryonii
Rhyncharrhena linearis
Roebuckiella ciliocarpa
Roebuckiella similis
Roycea sp.
Salsola australis
Samolus repens
Santalum acuminatum
Santalum spicatum
Sauropus ramosissimus
Sauropus rigens
Scaevola spinescens
Sclerolaena cuneata
Sclerolaena densiflora
Sclerolaena fusiformis
Sclerolaena gardneri
Senecio glossanthus
Senecio magnificus
Senna artemisioides subsp. filifolia
Senna artemisioides subsp. filifolia x glutinosa subsp. chatelainiana
Senna artemisioides subsp. helmsii
Senna artemisioides subsp. x artemisioides
Senna artemisioides subsp. x sturtii
Senna charlesiana

Senna glaucifolia
Senna glutinosa subsp. chatelainiana
Senna manicula
Senna sp.
Senna sp. Austin (A. Strid 20210)
Senna stowardii
Seringia elliptica
Setaria dielsii
Sida calyxhymenia
Sida sp. dark green fruits (S. van Leeuwen 2260)
Sida sp. Excedentifolia (J.L. Egan 1925)
Sida sp. Golden calyces glabrous (H.N. Foote 32)
Solanum ferocissimum
Solanum lasiophyllum
Solanum nigrum
Solanum nummularium
Solanum orbiculatum
Solanum terraneum
Sonchus oleraceus
Stackhousia muricata subsp. annual (W.R. Barker 2172)
Stenanthemum patens
Stenanthemum stipulosum
Stenopetalum filifolium
Stenopetalum nutans
Streptoglossa liatroides
Stylidium induratum
Stylidium longibracteatum
Swainsona beasleyana
Swainsona formosa
Swainsona oroboides
Synaptantha tillaeacea var. tillaeacea
Tecticornia disarticulata
Templetonia incrassata
Teucrium teucriiflorum
Threlkeldia diffusa
Thryptomene decussata
Thryptomene sp. Leinster (B.J. Lepschi & L.A. Craven 4362)
Thyridolepis multiculmis
Thysanotus patersonii
Tietkensia corrickiae
Trachymene ceratocarpa
Trachymene ornata
Triodia basedowii
Triptilodiscus pygmaeus
Velleia glabrata
Velleia rosea
Verticordia interioris
Vittadinia sp.
Vittadinia sulcata

Wahlenbergia capillaris
Wahlenbergia sp.
Waitzia acuminata
Waitzia acuminata var. acuminata
Wurmbea deserticola
Wurmbea tenella
Zygophyllum ammophilum
Zygophyllum eremaeum
Zygophyllum ovatum
Zygophyllum simile

Terrestrial Vertebrate Fauna

Acanthagenys rufogularis
Acanthiza (Acanthiza) apicalis subsp. apicalis
Acanthiza (Geobasileus) uropygialis
Acanthiza apicalis
Acanthiza chrysorrhoa
Acanthiza robustirostris
Acanthiza uropygialis
Accipiter cirrocephalus
Actitis hypoleucos
Aegotheles cristatus
Anas gracilis
Anas superciliosa
Anthus australis
Aphelocephala leucopsis
Aquila (Uroaetus) audax
Aquila audax
Ardea pacifica
Ardeotis australis
Artamus cinereus
Artamus minor
Artamus personatus
Aythya australis
Barnardius zonarius
Biziura lobata
Cacatua roseicapilla
Cacomantis pallidus
Caimanops amphiboluroides
Calidris canutus
Certhionyx variegatus
Chalinolobus gouldii
Charadrius ruficapillus
Chenonetta jubata
Cheramoeca leucosterna
Chroicocephalus novaehollandiae
Chrysococcyx basalis
Cincloramphus cruralis
Cincloramphus mathewsi
Cinclosoma castaneothorax
Cinclosoma marginatum
Circus assimilis
Cladorhynchus leucocephalus
Climacteris (Climacterobates) affinis subsp. affinis
Climacteris affinis
Climacteris rufa
Colluricincla harmonica
Coracina maxima
Coracina novaehollandiae

Corvus bennetti
Corvus coronoides
Corvus orru
Corvus orru subsp. orru
Cracticus nigrogularis
Cracticus tibicen
Cracticus torquatus
Cryptoblepharus beaucaneri
Ctenophorus caudicinctus subsp. infans
Ctenophorus caudicinctus subsp. mensarum
Ctenophorus isolepis subsp. gularis
Ctenophorus nuchalis
Ctenophorus reticulatus
Ctenotus leonhardii
Ctenotus uber
Cuculus pallidus
Cygnus atratus
Daphoenositta chrysoptera
Dicaeum hirundinaceum
Diplodactylus conspicillatus
Diplodactylus granariensis subsp. granariensis
Diplodactylus granariensis subsp. rex
Diplodactylus pulcher
Dromaius novaehollandiae
Egernia depressa
Egernia formosa
Egretta novaehollandiae
Elanus axillaris
Elseyornis melanops
Eolophus roseicapillus
Epthianura albifrons
Epthianura aurifrons
Epthianura tricolor
Eremiascincus richardsonii
Erythrogonys cinctus
Eurostopodus argus
Falco (Ieracidea) berigora subsp. berigora
Falco berigora
Falco cenchroides
Falco longipennis
Falco peregrinus
Fulica atra
Gavicalis virescens
Gehyra variegata
Gerygone fusca
Grallina cyanoleuca
Haliastur sphenurus
Heteronotia binoei
Hieraaetus (Hieraaetus) morphnoides

Hieraaetus morphnoides
Himantopus himantopus
Hirundo neoxena
Hirundo nigricans
Lalage tricolor
Leipoa ocellata
Lerista desertorum
Lerista rhodonoides
Lerista timeda
Lerista timida
Lichenostomus penicillatus
Lichenostomus plumulus
Lichenostomus virescens
Lichmera (Lichmera) indistincta
Lichmera indistincta
Litoria cyclorhyncha
Litoria rubella
Macropus robustus
Macropus rufus
Macrotis lagotis
Malacorhynchus membranaceus
Malurus leucopterus
Malurus splendens
Manorina (Myzantha) flavigula
Manorina flavigula
Melanodryas cucullata
Melopsittacus undulatus
Menetia greyii
Merops ornatus
Microcarbo melanoleucos
Microeca fascinans
Milvus migrans
Morethia butleri
Mormopterus sp. 3
Neophema bourkii
Neopsephotus bourkii
Nephrurus vertebralis
Nephrurus wheeleri subsp. wheeleri
Ningaui ridei
Ninox novaeseelandiae
Notaden nichollsi
Nycticorax caledonicus
Nyctophilus geoffroyi
Nymphicus hollandicus
Ocyphaps lophotes
Oreoica gutturalis
Oreoica gutturalis subsp. gutturalis
Oryctolagus cuniculus
Pachycephala (Alisterornis) rufiventris

Pachycephala rufiventris
Parasuta monachus
Pardalotus striatus
Pelecanus conspicillatus
Petrochelidon ariel
Petrochelidon nigricans
Petroica (Petroica) goodenovii
Petroica cucullata
Petroica goodenovii
Phalacrocorax (Phalacrocorax) carbo
Phalacrocorax carbo
Phalacrocorax melanoleucos
Phalacrocorax sulcirostris
Phaps chalcoptera
Phylidonyris albifrons
Platalea (Platibis) flavipes
Platalea flavipes
Platycercus varius
Platycercus zonarius
Podargus strigoides
Pogona minor subsp. minor
Poliocephalus poliocephalus
Pomatostomus superciliosus
Pseudantechinus woolleyae
Pseudomys hermannsburgensis
Pseudonaja modesta
Pseudophryne occidentalis
Psophodes occidentalis
Ptilonorhynchus guttatus
Ptilonorhynchus maculatus subsp. guttatus
Purnella albifrons
Pygopus nigriceps
Pyrrholaemus brunneus
Recurvirostra novaehollandiae
Rhipidura leucophrys
Rhynchoedura ornata
Scotorepens balstoni
Simoselaps bertholdi
Smicrornis brevirostris
Sminthopsis dolichura
Sminthopsis macroura
Strepera versicolor
Strophurus assimilis
Strophurus wellingtonae
Tachybaptus novaehollandiae
Tadarida australis
Tadorna tadornoides
Taeniopygia guttata
Taphozous hilli

Threskiornis spinicollis
Todiramphus pyrrhopygius
Tribonyx ventralis
Tringa glareola
Tringa nebularia
Turnix velox
Tympanocryptis pseudopsephos
Underwoodisaurus milii
Vanellus tricolor
Varanus caudolineatus
Varanus gouldii
Varanus panoptes
Varanus panoptes subsp. rubidus
Varanus tristis
Vespadelus baverstocki
Vespadelus finlaysoni

APPENDIX E:
EPBC PROTECTED MATTERS SEARCH (40KM BUFFER)

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 31-Mar-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	4
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	8
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	1
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.		
Scientific Name	Threatened Category	Presence Text
BIRD		
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
MAMMAL		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
[Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia](#)	2015/7522	Not Controlled Action	Completed

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX C – BUNDARRA SURFACE WATER ASSESSMENT

WONDER GOLD PROJECT

SURFACE WATER ASSESSMENT

REPORT FOR
NORTHERN STAR RESOURCES LTD

MAY 2023

Rockwater
HYDROGEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

Report No: 263-7/23/01

TABLE OF CONTENTS

Tables

Text-Figures

Figures

Appendices

1 INTRODUCTION

Northern Star Resources (NSR) is planning an underground mine beneath the existing pits at Wonder, and a new pit south-east of the existing pits, located about 60 km north of Leonora. This hydrological assessment is needed in planning the mine and infrastructure, and for obtaining regulatory approvals.

There are indicated to be portals to the underground workings in Wonder North pit; and the main infrastructure (offices, workshops etc.) are to be in an area immediately to the north of the south-eastern North Pit (Fig. 1). It is assumed that the existing pit abandonment bund will be retained.

The scope of work covered in this report includes the following:

- Identification of catchment areas and natural water courses that could impact the planned pit, mine portals, and infrastructure.
- Hydrological analyses to estimate peak flows for 1-in-2, 5, 10, 20, 50 and 100-year ARI rainfalls for the critical storm duration in the relevant catchment areas; and for a 1-in-2000-year rainfall, taken to be the Probable Maximum Precipitation (PMP) event;
- Surface water hydraulic analyses at critical locations and sections in order to examine the impact of the 1-in-100 year ARI peak flow and Probable Maximum Flood (PMF); and
- Concept designs and recommendations for any surface water control structures to prevent flooding of the mine portals, pit and infrastructure during a 1-in-100 year ARI flow event.

2 SURFACE WATER HYDROLOGY

The Wonder Gold Project area is situated on ground that generally slopes downwards to the south-east, about 8 km south of a drainage divide. There are several minor drainage lines within the mining area that could carry flood flows; and runoff within the abandonment bund is likely to report to the existing pits. Three local surface water catchments (Catchments A, B & C, Fig. 2) have the potential for peak flows to impact the pits or pit bunds. Catchments D and E are within the abandonment bund and so would drain into the existing pits. The boundary between them is uncertain, but runoff could be controlled by constructing a bund on the conceptual boundary as depicted in Fig. 2.

For this assessment, the flood-estimation methods described in the Australian Rainfall and Runoff 1987 (Pilgrim et. al., 1987) guideline for the Arid Region of Western Australia were used. It should be noted that a revision of the Australian Rainfall and Runoff (ARR 2019) was published and is planned to replace the 1987 version. However, the new publication uses the Regional Flood Frequency Estimation (RFFE) model which has been found to produce unrealistic and unreliable results for the Pilbara and Arid regions of WA. The results from the ARR 1987 guideline are therefore taken to be more appropriate for the purpose of this report.

2.1 CLIMATE

The Wonder project area is located in a semi-arid climatic region. There are no long-term rainfall stations located in the immediate vicinity of the project site. The nearest Bureau of Meteorology (BoM) station is Weebo (Stn. 012082), located 38 km north of the project. Annual Rainfall (1930 to 2022) averaged 241.8 mm at that station (Table 1).

Dam evaporation at Melrose Station, located about 45 km north of Wonder averages about 2,427 mm/yr (Luke, Burke and O'Brien, 1988). On average, evaporation exceeds rainfall in all months of the year, and by a factor of 10 overall.

Table 1: Average Monthly Rainfall (Weebo) and Dam Evaporation (mm) (Melrose)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	34.6	38.3	32.6	23.5	22.5	22.7	15.2	11.5	5.9	8.2	11.9	17.7	241.8
Dam Evap.	367	282	260	172	113	79	80	109	160	229	261	315	2,427

2.2 RAINFALL ANALYSIS

Intensity-Frequency-Duration (IFD) curves for the site were obtained from the Bureau of Meteorology (BoM) web-site, and are based on the statistical and meteorological analyses given in the ARR 1987 Guideline (Pilgrim et. al., 1987). The IFD tables and curves are included in Appendix A.

The Probable Maximum Flood (PMF), assumed to be equivalent to the 1-in-2000 year ARI peak flow, was calculated by applying the Probable Maximum Precipitation (PMP) depths derived using the 2016 BoM data for rare design rainfall events. The Probable Maximum Flood (PMF) would result from a PMP event and is used in assessing likely worst-case flows for mine protection and mine closure requirements. The design rainfall for this event is also included in Appendix A.

2.3 CATCHMENT CHARACTERISTICS

The relevant catchment areas were identified from the 2 m interval contour plan provided by NSR (Fig. 2). The characteristics of the catchments which could impact the project area are listed in Table 1.

Table 2: Catchment Characteristics

Catchment	Area (km^2)	Length (km)
A	0.195	0.91
B	0.091	0.86
C	0.909	1.62
D	0.193	0.59
E	0.342	0.83

2.4 TIME OF CONCENTRATION

The time of concentration is required to estimate the critical storm duration for peak flows in each catchment. This was estimated using Equation 1 for the Arid Region of Western Australia as recommended by ARR 1987 and later editions:

$$t_c = 0.56 \cdot A^{0.38} \qquad \textit{Equation 1}$$

Where:
t_c is the time of concentration (hours)
A is the catchment area (km^2)

2.5 RATIONAL METHOD

The Statistical Rational Method, used in peak-flow estimation, is presented in Equation 2.

$$Q_y = 0.278 \cdot C_y \cdot I_{tcy} \cdot A \qquad \textit{Equation 2}$$

Where:

Q_y	*is the peak flow for return period of y years (m^3/s)*
0.278	*is a dimensionless metric conversion factor*
C_y	*is the runoff coefficient for y years (dimensionless)*
I_{tcy}	*is rainfall intensity (mm/hr)*
A	*is catchment area (km^2)*

2.6 FLOOD INDEX METHOD

The Flood Index Method does not exist for the Arid Region, and so the ARR 1987 guideline recommends using the method for the Wheatbelt in peak-flow estimation, as presented in Equation 3. It is used as a check for the Rational Method results.

$$Q_5 = 2.77 \times 10^{-6} \cdot A^{0.52} \cdot P^{2.12} \qquad \textbf{Equation 3}$$

Where:

Q_5	*is the peak discharge for the 5-year ARI flow (m^3/s)*
A	*is the catchment area (km^2)*
P	*is the average annual rainfall (mm)*

2.7 PEAK FLOWS

A summary of the design peak flows for catchments A to C, as estimated by averaging results from the Rational and Flood Index Methods, is shown in Table 2. The detailed calculations for the main Rational method are presented in Appendix A.

Table 3: Estimated Peak Flows

Catchment A

ARI Years	2	5	10	20	50	100	PMF*
Rational	0.18	0.51	0.86	1.32	2.06	2.79	4.23
Index	0.16	0.33	0.62	1.08	2.04	3.60	
Adopted	0.18	0.51	0.86	1.32	2.06	2.79	4.23

Catchment B

ARI Years	2	5	10	20	50	100	PMF*
Rational	0.10	0.28	0.48	0.74	1.15	1.56	1.74
Index	0.11	0.21	0.37	0.65	1.20	2.11	
Adopted	0.10	0.28	0.48	0.74	1.15	1.56	1.74

Catchment C

ARI Years	2	5	10	20	50	100	PMF*
Rational	0.46	1.32	2.23	3.43	5.34	7.24	19.35
Index	0.42	0.84	1.48	2.57	4.76	8.38	
Adopted	0.46	1.32	2.23	3.43	5.34	7.24	19.35

*PMF (probable maximum flood) taken to be a 1-in-2000-year event, estimated using 2016 BoM data

3 HYDRAULIC ANALYSES

3.1 RUNOFF INTO EXISTING PITS

The runoff into the existing pits, where the underground portals are likely to be located (particularly Wonder North), was estimated by assuming a worst case that all of a 1-in-100 year rainfall for each catchment within the abandonment bund and the conceptual bund between the pits, will report to the pits. In reality, a portion of the rainfall outside of the pit perimeters will be lost by evaporation and infiltration to the soil.

The estimated volumes were then used to calculate the theoretical height of water-level rise above the March 2020 pit lake levels (prior to pumping from Wonder North pit) so that the underground portals can be planned with a factor of safety. It was further assumed that there will be negligible flow from the pit lakes back into the surrounding groundwater. The calculations are summarised in Table 4.

Table 4: Predicted Pit Water Levels with Runoff from a 1-in-100 Year Rainfall

Wonder Pit	Catchment	Mar-20 WL	Catchment Area	100-Y Depth	Mar-20 vol.	Water Vol.	Tot. Vol.	Predicted RLWL
		(m AHD)	(m^2)	(72-hour, m)		100-y Rain.		(m AHD)
West	D	443.6	192,600	0.184	30,964	35,438	66,402	450.8
North	E	456.2	342,100	0.184	173,110	62,946	236,056	461.0

The results indicate that the rainfall runoff in a 1-in-100 year event could raise the pit lake levels by 5 m (Wonder North) to 7 m (Wonder West) above the march 2020 levels.

3.2 IMPACT OF FLOOD FLOWS ON THE PROJECT AREA

Peak flows in each of Catchments A to C were analysed to assess whether they could adversely impact the proposed infrastructure, and also to provide data for the conceptual design of flood protection structures, should they be required.

The locations of the flow paths that could impact the project were identified from aerial photography (Google Earth) and the contour plan (Fig. 2). The lateral extent, depth and velocity of flows along these flow paths were then determined at selected cross-sections where stage-discharge and stage-velocity relationships were calculated using Manning's equation.

The results of the hydraulic analyses are presented below. Cross-sections in the figures are presented looking upstream of the natural creeks. Details of the hydraulic calculations are given in Appendix B.

3.2.1 FLOOD IMPACT ON WORKSHOPS, OFFICES ETC

The planned mining infrastructure (buildings, parking areas etc.) will be located within the existing abandonment bunds and so will not be susceptible to flooding from minor drainage lines in the surrounding area (Fig. 1). Local runoff will flow into the Wonder North or West pit, and should have no impact on the infrastructure.

3.2.2 FLOOD IMPACT ON BUND NORTH AND WEST OF WONDER WEST PIT

Flows from Catchment A will be diverted by, and around the existing abandonment bund north and west of Wonder West pit. The stage and velocity of peak flows were analysed at Cross-Section 1 (Fig. 2) to assess the extent to which the 1-in-100 year ARI and PMF flows could impact the bund.

In a 1-in-100-year flood, the natural peak flow from Catchment A, west of the abandonment bund, would be contained by elevated ground 20 m to 30 m to the west and would have an elevation of about 503.79 m AHD and a width of about 32 m (Text-Figure 1). The maximum depth of the flood would be about 0.39 m and its maximum velocity in the order of 0.5 m/s (Table 5). The peak flow would be 0.1 m deeper in a PMF event. These flood levels and velocity would be of short duration and would not impact the bund, and so no additional protective measures are required.

If the higher ground west of the bund is not continuous, flood water would move further to the west as sheet flow and flood levels and velocities at Cross-Section 1 would be smaller than predicted.

Text-Figure 1: Cross Section 1 with 100 year ARI flood level, and PMF

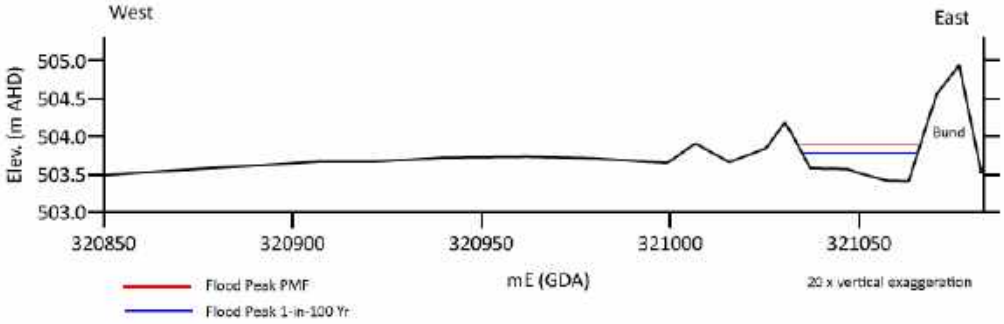


Table 5: Cross-section 1 - Flood Analysis Summary

Flood Analysis	Flow (m^3/s)	Flood Level Elevation (m AHD)	Maximum Depth (m)	Velocity (m/s)	Extent of Flood Level (m)
100-yr	2.8	503.79	0.39	0.46	30
PMF	4.2	503.89	0.49	0.53	32

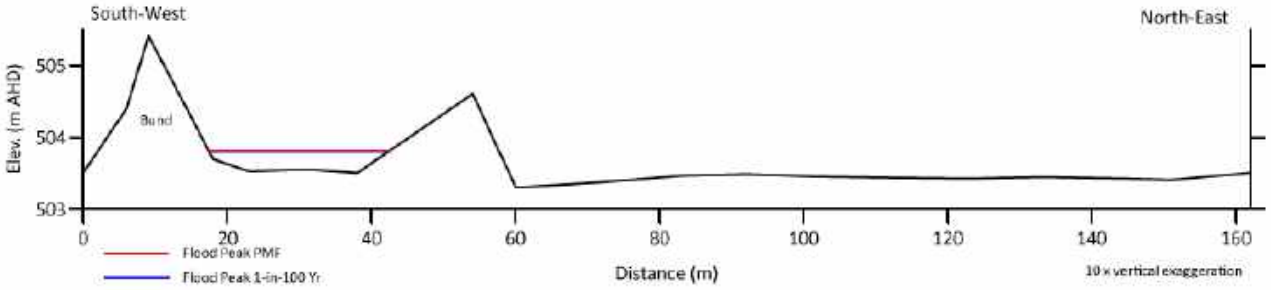
3.2.3 FLOOD IMPACT ON BUND EAST OF WONDER NORTH PIT

Flows from the small catchment B (Fig. 2) would be diverted along the abandonment bund which locally is along or close to a natural drainage line. Peak flood flows are calculated at Cross-Section 2, to determine whether they could impact the bund.

In a 1-in-100-year flood, the natural peak flow from Catchment B, north and east the abandonment bund, would be contained by elevated ground about 25 m to the east and would have an elevation of about 503.80 m AHD and a width of about 25 m (Text-Figure 1). The maximum depth of the flood would be about 0.30 m and its maximum velocity in the order of 0.4 m/s (Table 6). The peak flow would be only 0.01 m deeper in a PMF event. These flood levels and velocity would be of short duration and would not impact the bund, and so no additional protective measures are required.

If the higher ground east of the bund is not continuous, flood water would move to the east over a wider zone and flood levels and velocities at Cross-Section 2 would be smaller than predicted.

Text-Figure 2: Cross-Section 2 with 100 year ARI flood level and PMF



Consideration should be given to constructing another bund around North Pit, close to the pit edge, to minimise surface-water runoff into the pit, and consequently reduce the volumes of seepage into the underground workings.

Table 6: Cross-section 2 - Flood Analysis Summary

Flood Analysis	100 Year ARI Flow (m^3/s)	Flood Level Elevation (m AHD)	Max. Depth (m)	Velocity (m/s)	Extent of Flood Level (m)
100-yr	1.56	503.80	0.30	0.43	25.0
PMF	1.74	503.81	0.31	0.44	25.3

3.2.4 FLOOD IMPACT ON GOLDEN WONDER PIT

Two small drainage lines in Catchment C flow towards the planned Golden Wonder pit (Fig. 2), and so have the potential to impact the pit. The largest flows would occur at Cross-Section 3, at the southern edge of the pit.

The analyses indicate that in a 1-in-100-year flood event, the peak flood levels at cross-section 3 would be at about 491.55 m AHD and have a width of about 187 m (Table 7). The level would be about 0.15 m higher in a PMF (Text-Figure 3). Most of the flow would be contained within a drainage line that from the topographic contours is centred about 330 m south-west of the planned pit. Only in a PMF would low velocity flows of shallow depth be likely to reach the pit bund.

Text-Figure 3: Cross-Section 3 with 100 year ARI flood level and PMF

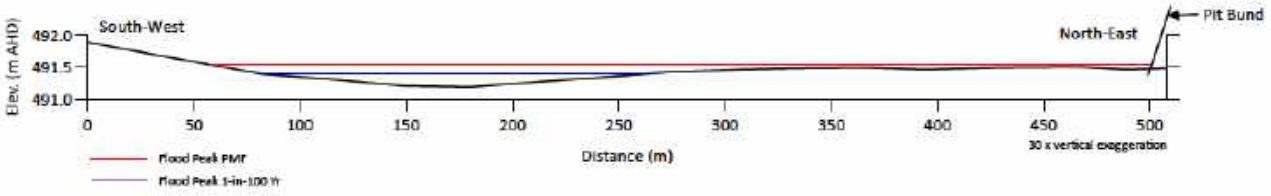


Table 7: Cross-section 3 - Flood Analysis Summary

Flood Analysis	100 Year ARI Flow (m^3/s)	Flood Level Elevation (m AHD)	Max. Depth (m)	Velocity (m/s)	Extent of Flood Level (m)
100-yr	7.24	491.40	0.21	0.26	187
PMF	19.35	491.55	0.36	0.38	443

Flow in the minor drainage line which will intersect the pit bund at its north-western end would move a short distance along the bund before flowing south into the main drainage line. A normal safety bund around the pit should be sufficient to control the flood flows described above, and any other minor local surface water flows.

4 CONCLUSIONS & RECOMMENDATIONS

The Wonder Gold Project area is situated on ground that generally slopes downwards to the south-east, about 8 km south of a drainage divide. There are several minor drainage lines within the mining area that could carry flood flows; and runoff within the existing abandonment bund is likely to report to the Wonder West and North pits.

The assessment of peak flows indicate that the rainfall runoff in a 1-in-100 year event could raise the pit lake levels by 5 m (Wonder North) to 7 m (Wonder West) above the March 2020 levels (assuming the runoff is divided by a bund between the pits). These lake-level rises should be taken into account when planning portals to the underground workings, and underground pumping requirements. Consideration should be given to constructing another bund around the Wonder North pit, close to the pit edge, to minimise surface-water runoff into the pit and consequently reduce seepage into the underground workings.

The planned mining infrastructure (buildings, parking areas etc.) will be located within the existing abandonment bund and so will not be susceptible to flooding from minor drainage lines in the surrounding area; and local drainage will be into the pits.

The existing abandonment bunds should prevent any flood flows outside of the bunds from entering the existing pits, and the flows would be shallow and of low velocity and so are unlikely to impact the bunds. Similarly, a usual safety bund around the planned Golden Wonder pit should protect the pit from runoff during flood events.

REFERENCES

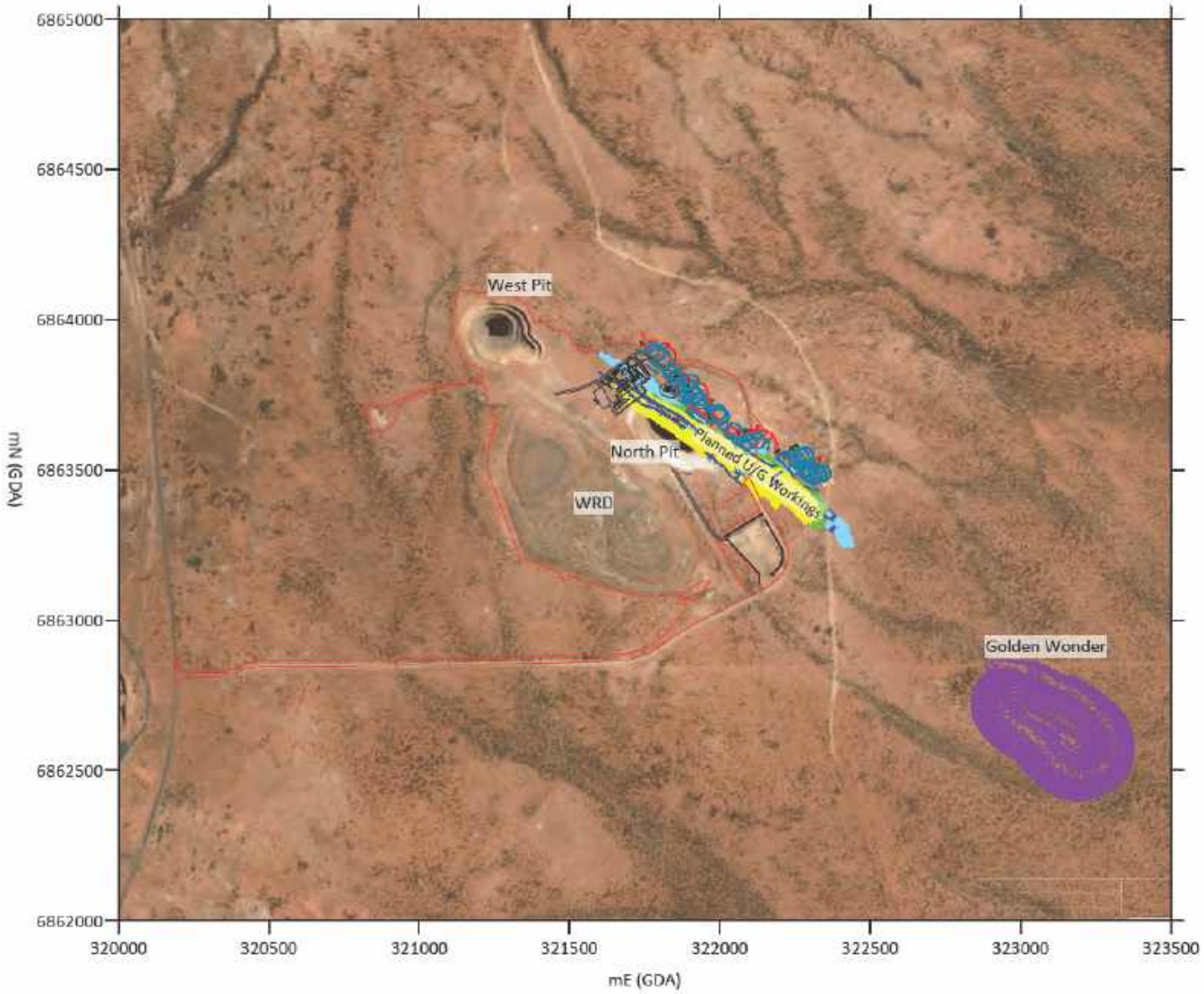
ARR, 1987, Australian Rainfall and Runoff, 1987, The Institution of Engineers, Australia.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, The Institution of Engineers Canberra.

Luke, G.J., Burke, K.L., and O'Brien, T.M., 1988, Evaporation data for Western Australia. Tech. Report No. 65 (2nd Ed), W.A. Dept. of Agriculture.

FIGURES

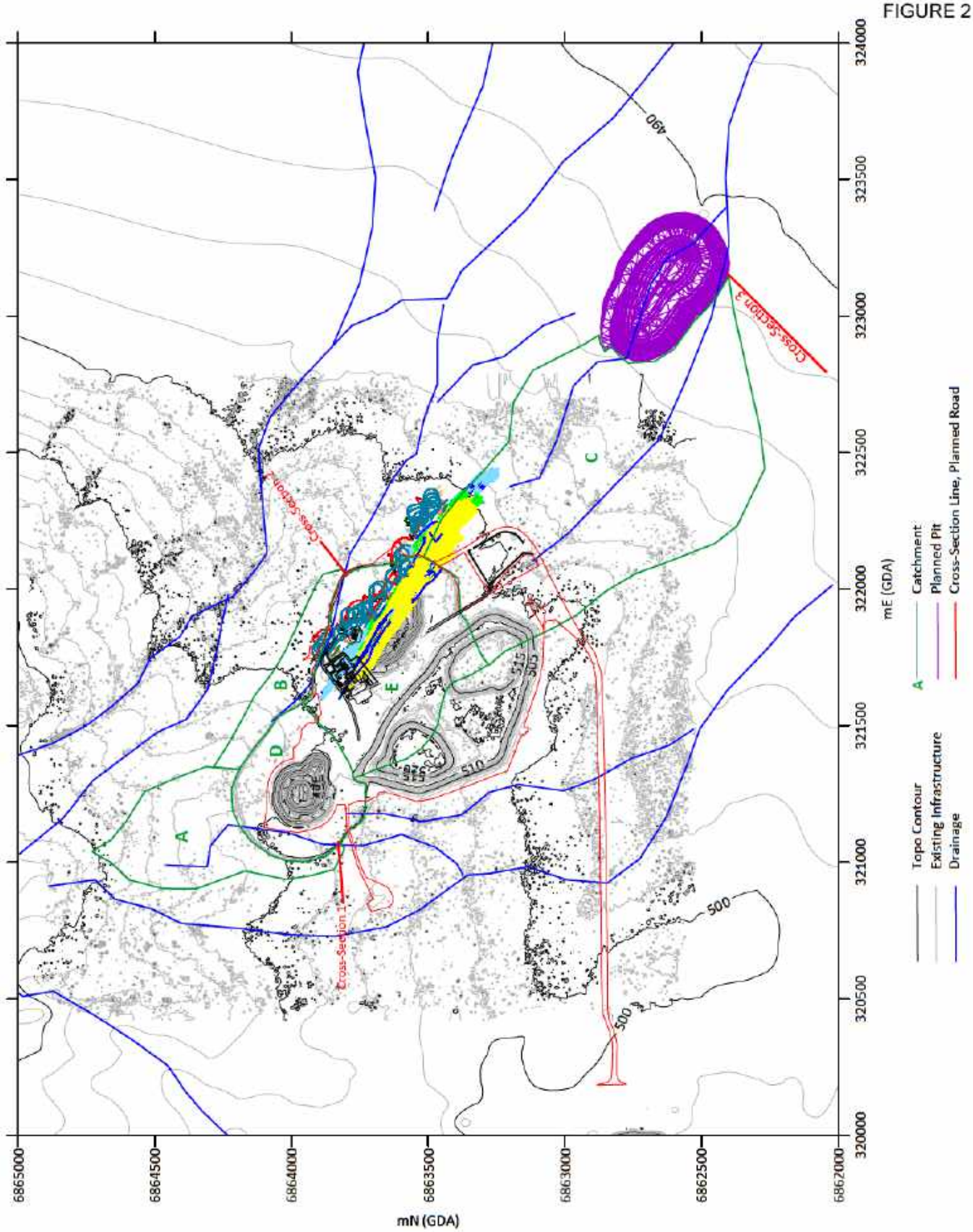
FIGURE 1



location plan.srf

CLIENT: Northern Star Resources	LOCATION PLAN
PROJECT: Wonder Surface Water	
DATE: April 2023	
Dwg No: 263-7/23/1-1	Rockwater Pty Ltd

FIGURE 2



topo contours detailed.srf

CLIENT: Northern Star Resources

PROJECT: Wonder Surface Water

DATE: April 2023

Dwg No: 263-7/23/1-2

TOPOGRAPHIC CONTOURS, CATCHMENTS, DRAINAGE, & SECTION LINES

Rockwater Pty Ltd

APPENDIX A

HYDROLOGY CHARTS AND CALCULATIONS

LOCATION 28.350 S 121.175 E * NEAR.Wonder

LIST OF COEFFICIENTS TO EQUATIONS OF THE FORM

$$ln(I) = A + B \times (ln(T)) + C \times (ln(T))^2 + D \times (ln(T))^3 + E \times (ln(T))^4 + F \times (ln(T))^5 + G \times (ln(T))^6$$

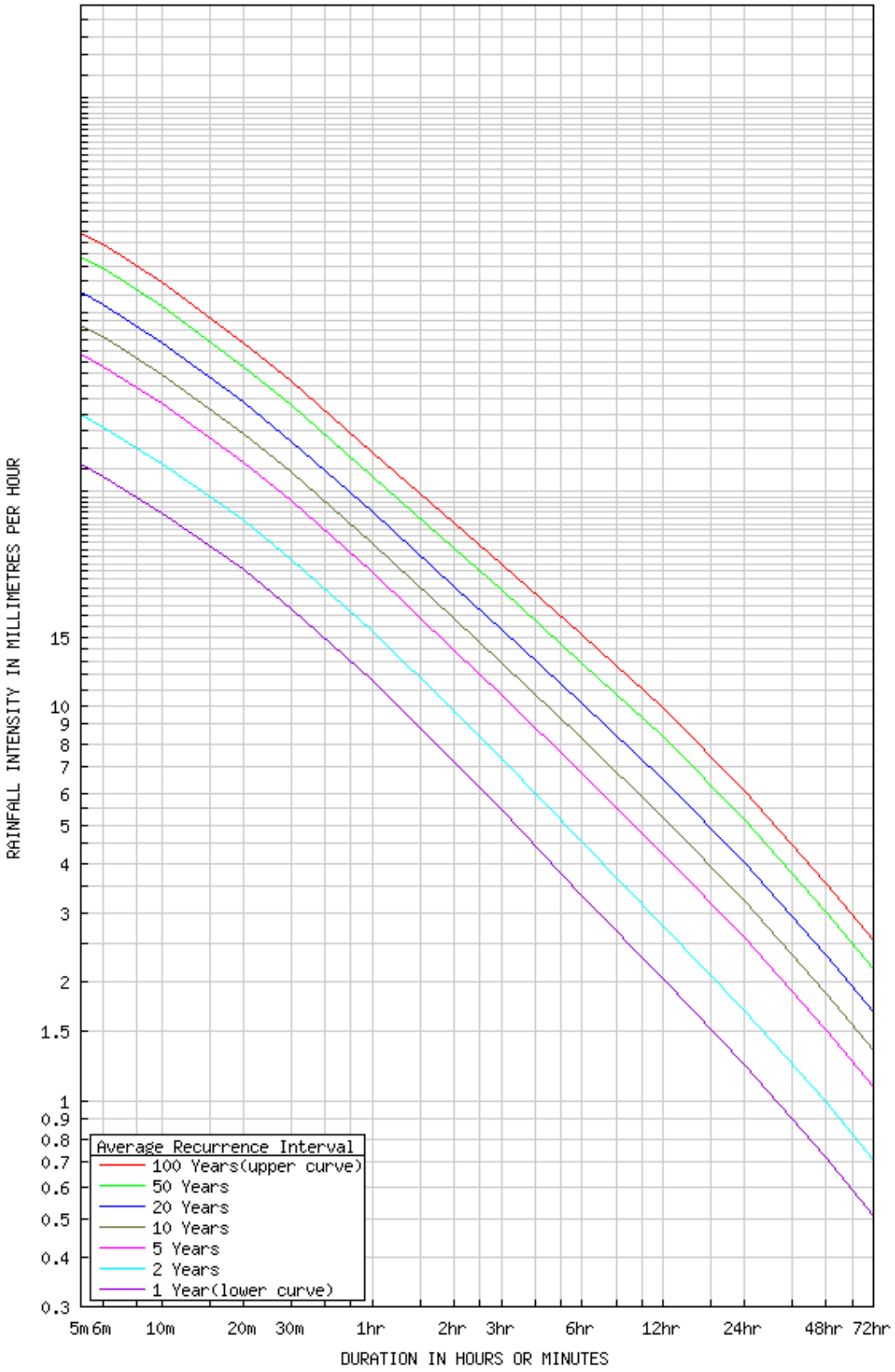
T = TIME IN HOURS AND I = INTENSITY IN MILLIMETRES PER HOUR

RETURN PERIOD	A	B	C	D	E	F	G
1	2.451223	-0.64926E+0	-0.45730E-1	0.10104E-1	0.10790E-2	-0.51090E-3	0.10935E-4
2	2.738683	-0.64524E+0	-0.39876E-1	0.11000E-1	0.29173E-3	-0.62038E-3	0.54926E-4
5	3.080984	-0.62929E+0	-0.26671E-1	0.10167E-1	-0.83973E-3	-0.52069E-3	0.66421E-4
10	3.252518	-0.62214E+0	-0.19045E-1	0.10818E-1	-0.17159E-2	-0.59880E-3	0.10366E-3
20	3.436622	-0.61490E+0	-0.13479E-1	0.10395E-1	-0.21778E-2	-0.54746E-3	0.10653E-3
50	3.645214	-0.60754E+0	-0.63887E-2	0.10399E-1	-0.29021E-2	-0.54845E-3	0.12721E-3
100	3.785305	-0.60235E+0	-0.16076E-2	0.10439E-1	-0.33997E-2	-0.55588E-3	0.14219E-3

RAINFALL INTENSITY IN mm/h FOR VARIOUS DURATIONS AND RETURN PERIODS

RETURN PERIOD (YEARS)

DURATION	1	2	5	10	20	50	100
5 mins	41.2	55.1	78.0	92.8	112.	138.	159.
6 mins	38.3	51.2	72.6	86.3	104.	129.	148.
10 mins	30.9	41.3	58.4	69.5	83.6	103.	119.
20 mins	22.2	29.6	41.5	49.3	59.1	72.8	83.7
30 mins	17.7	23.6	33.1	39.3	47.1	57.9	66.5
1 hour	11.6	15.5	21.8	25.9	31.1	38.3	44.0
2 hours	7.26	9.74	13.9	16.7	20.2	25.1	29.1
3 hours	5.46	7.36	10.7	12.9	15.7	19.7	22.9
6 hours	3.32	4.53	6.75	8.28	10.2	12.9	15.2
12 hours	2.03	2.78	4.23	5.24	6.52	8.36	9.87
24 hours	1.23	1.69	2.59	3.22	4.02	5.16	6.11
48 hours	.722	.992	1.52	1.88	2.34	3.01	3.55
72 hours	.509	.709	1.08	1.34	1.67	2.15	2.5


RAINFALL INTENSITY IN MILLIMETRES PER HOUR
15
10
9
8
7
6
5
4
3
2
1.5
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Average Recurrence Interval
100 Years(upper curve)
50 Years
20 Years
10 Years
5 Years
2 Years
1 Year(lower curve)
5m 6m 10m 20m 30m 1hr 2hr 3hr 6hr 12hr 24hr 48hr 72hr
DURATION IN HOURS OR MINUTES

	Annual Exceedance Probability (1 in x)				
Duration	**1 in 100**	**1 in 200**	**1 in 500**	**1 in 1000**	**1 in 2000**
1 min	5.15	5.88	7.01	7.95	8.96
2 min	9.20	10.6	12.8	14.7	16.7
3 min	12.4	14.3	17.2	19.7	22.3
4 min	15.1	17.4	20.8	23.7	26.8
5 min	17.5	20.0	23.9	27.2	30.7
10 min	26.1	29.7	35.4	40.0	45.0
15 min	32.0	36.4	43.3	49.0	55.1
20 min	36.5	41.5	49.5	56.0	63.1
25 min	40.1	45.7	54.5	61.8	69.6
30 min	43.1	49.2	58.8	66.6	75.1
45 min	50.2	57.3	68.6	77.9	87.9
1 hour	55.3	63.3	75.7	86.1	97.2
1.5 hour	62.8	71.9	86.0	97.8	110
2 hour	68.3	78.1	93.5	106	120
3 hour	76.5	87.3	104	118	133
4.5 hour	85.4	97.1	116	131	147
6 hour	92.2	105	124	141	158
9 hour	103	117	138	156	175
12 hour	111	126	150	169	189
18 hour	125	142	169	191	214
24 hour	136	155	184	209	236
30 hour	144	165	197	224	253
36 hour	152	175	210	239	271
48 hour	164	191	232	266	303
72 hour	181	214	264	307	355
96 hour	191	228	284	333	388
120 hour	196	236	295	348	408
144 hour	199	239	300	354	417
168 hour	200	240	301	354	419

AUSTRALIAN RAINFALL AND RUNOFF VOLUME 1 & 2 (1987)

RATIONAL METHOD - WESTERN AUSTRALIA

REGION:	**ARID INTERIOR**
LOCATION:	**WONDER**
CATCHMENT:	**A**

Arid Interior Region

Catchment	A (km^2)	L (km)	P (mm)
Characteristics	0.195	0.91	241.8

RATIONAL METHOD:

Care needs to be taken when catchment characteristics fall outside the following:

A =	59.0	km^2
L =	11.5	km
Se =	5.71	m/km
P =	255	mm

$Q_Y = 0.278 C_Y . I_{tc,Y} . A$ ..... **(1.1)**

$t_c = 0.76 A^{0.38}$ ..... **(1.2)**

t_c = 0.408 Hrs

$C_{10} = 3.46 \times 10^{-1} L^{-0.42}$ ..... **(1.3)**

C_{10} = 0.36

Frequency Factors (C_Y/C_{10})

	ARI (YEARS)					
	2	*5*	*10*	20	*50*	*100*
C_Y/C_{10}	0.34	0.70	1.00	1.28	1.62	*1.91*

100 year ARI extrapolated using the logarithmic trend-line

Therefore:

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	*100*
C_Y	0.12	0.25	0.36	0.46	0.58	0.69

DETERMINE AVERAGE RAINFALL INTENSITY FOR DESIGN DURATION

t_C = 0.408 hours

Use IFD curves

	ARI (YEARS) [mm/hr]					
Duration (hours)	*2*	*5*	10	20	*50*	100
0.408	26.52	37.19	44.10	52.91	65.09	74.79

Calculate peak discharge using equation (1.1)

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	100
Q	**0.18**	**0.51**	**0.86**	**1.32**	**2.06**	**2.79**

PMF 4.23 m^3/s

AUSTRALIAN RAINFALL AND RUNOFF VOLUME 1 & 2 (1987)

RATIONAL METHOD - WESTERN AUSTRALIA

REGION: **ARID INTERIOR**

LOCATION: **WONDER**

CATCHMENT: **B**

Arid Interior Region

Catchment	A (km^2)	L (km)	P (mm)
Characteristics	0.091	0.86	241.8

RATIONAL METHOD:

Care needs to be taken when catchment characteristics fall outside the following:

A = 59.0 km^2

L = 11.5 km

Se = 5.71 m/km

P = 255 mm

$Q_Y = 0.278 C_Y . I_{tc,Y} . A$ ……. **(1.1)**

$t_c = 0.76 A^{0.38}$ ……. **(1.2)**

t_c = 0.306 Hrs

$C_{10} = 3.46 \times 10^{-1} L^{-0.42}$ ……. **(1.3)**

C_{10} = 0.369

Frequency Factors (C_Y/C_{10})

	ARI (YEARS)					
	2	*5*	*10*	20	*50*	*100*
C_Y/C_{10}	0.34	0.70	1.00	1.28	1.62	*1.91*

100 year ARI extrapolated using the logarithmic trend-line

Therefore:

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	*100*
C_Y	0.13	0.26	0.37	0.47	0.60	0.70

DETERMINE AVERAGE RAINFALL INTENSITY FOR DESIGN DURATION

t_C = 0.306 hours

Use IFD curves

	ARI (YEARS) [mm/hr)					
Duration (hours)	2	5	10	20	50	100
0.306	30.9	43.45	51.57	61.92	76.27	87.71

Calculate peak discharge using equation (1.1)

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	*100*
Q	**0.10**	**0.28**	**0.48**	**0.74**	**1.15**	**1.56**

PMF 1.74 m^3/s

AUSTRALIAN RAINFALL AND RUNOFF VOLUME 1 & 2 (1987)

RATIONAL METHOD - WESTERN AUSTRALIA

REGION: **ARID INTERIOR**

LOCATION: **WONDER**

CATCHMENT: **C**

Arid Interior Region

Catchment	A (km^2)	L (km)	P (mm)
Characteristics	0.91	1.62	241.8

RATIONAL METHOD:

Care needs to be taken when catchment characteristics fall outside the following:

A =	59.0	km^2
L =	11.5	km
Se =	5.71	m/km
P =	255	mm

$Q_Y = 0.278 C_Y . I_{tc,Y} . A$ ……. **(1.1)**

$t_c = 0.76 A^{0.38}$ ……. **(1.2)**

t_c = 0.73 Hrs

$C_{10} = 3.46 \times 10^{-1} L^{-0.42}$ ……. **(1.3)**

C_{10} = 0.283

Frequency Factors (C_Y/C_{10})

	ARI (YEARS)					
	2	*5*	*10*	20	*50*	*100*
C_Y/C_{10}	0.34	0.70	1.00	1.28	1.62	*1.91*

100 year ARI extrapolated using the logarithmic trend-line

Therefore:

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	*100*
C_Y	0.10	0.20	0.28	0.36	0.46	0.54

DETERMINE AVERAGE RAINFALL INTENSITY FOR DESIGN DURATION

t_C = 0.73 hours

Use IFD curves

	ARI (YEARS) [mm/hr)					
Duration (hours)	2	5	10	20	50	100
0.73	18.82	26.41	31.30	37.56	46.20	53.08

Calculate peak discharge using equation (1.1)

	ARI (YEARS)					
Discharge (m^3/s)	*2*	*5*	*10*	20	*50*	*100*
Q	**0.46**	**1.32**	**2.23**	**3.43**	**5.34**	**7.24**

PMF 19.35 m^3/s

APPENDIX B

HYDRAULIC ANALYSES

Manning's Formula: $$Q = \frac{1}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Cross-Section 1 (Catchment A)

Stage	Top Length	A	P	Manning's n	Slope	V	Q
	(m)	(m^2)	(m)		(m/m)	(m/s)	(m^3/s)
503.4	0	0	0	0.06	0.007	0.00	0.0
503.6	18	1.8	18.4	0.06	0.007	0.30	0.5
503.8	31	6.2	31.8	0.06	0.007	0.47	2.9
504.0	34	10.2	35.2	0.06	0.007	0.61	6.2
504.2	38	15.2	39.6	0.06	0.007	0.74	11.2

Cross-Section 2 (Catchment B)

Stage	Top Length	A	P	Manning's n	Slope	V	Q
	(m)	(m^2)	(m)		(m/m)	(m/s)	(m^3/s)
503.5	0	0	0	0.06	0.0087	0.00	0.0
503.7	22.9	2.3	23.3	0.06	0.0087	0.33	0.8
503.9	27	5.3	27.4	0.06	0.0087	0.52	2.8
504.1	31	9.3	32.3	0.06	0.0087	0.68	6.3

Cross-Section 3 (Catchment C)

Stage	Top Length	A	P	Manning's n	Slope	V	Q
	(m)	(m^2)	(m)		(m/m)	(m/s)	(m^3/s)
491.2	0	0	0	0.06	0.0052	0.00	0.0
491.4	191.2	20.1	191.6	0.06	0.0052	0.27	5.4
491.6	305	62.5	305.8	0.06	0.0052	0.42	26.1
491.8	454	138.5	455.2	0.06	0.0052	0.54	75.3

APPENDIX D– BUNDARRA HYDROGEOLOGICAL ASSESSMENT

WONDER GOLD PROJECT

HYDROGEOLOGICAL ASSESSMENT

REPORT FOR
NORTHERN STAR RESOURCES LTD

MAY 2023

Rockwater
HYDROGEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

Report No: 263-7/23/02

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Appendix

1 INTRODUCTION

Northern Star Resources (NSR) is planning an underground mine beneath the existing North pit at Wonder, and in future a new pit (Golden Wonder) south-east of the existing pits, located about 60 km north of Leonora.

Three pits were mined in 2002 and 2003 by Sons of Gwalia: Wonder, Wonder West, and Wonder North (the south-eastern pit). Wonder pit was backfilled. Wonder West and Wonder North extend to depths of about 80 m. The underground workings beneath the latter will be about 600 m deep. The existing and planned workings are shown in Figure 1.

This hydrogeological desktop assessment was prepared using existing data, and is needed by NSR in planning the mine and infrastructure, and for obtaining regulatory approvals.

1.1 CLIMATE

The Wonder project area is located in a semi-arid climatic region. There are no long-term rainfall stations located in the immediate vicinity of the project site. The nearest Bureau of Meteorology (BoM) station is Weebo (Stn. 012082), located 38 km north of the project. Annual Rainfall (1930 to 2022) averaged 241.8 mm at that station (Table 1).

Dam evaporation at Melrose Station, located about 45 km north of Wonder averages about 2,427 mm/yr (Luke, Burke and O'Brien, 1988). On average, evaporation exceeds rainfall in all months of the year, and by a factor of 10 overall.

Table 1: Average Monthly Rainfall (Weebo) and Dam Evaporation (mm) (Melrose)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	34.6	38.3	32.6	23.5	22.5	22.7	15.2	11.5	5.9	8.2	11.9	17.7	241.8
Dam Evap.	367	282	260	172	113	79	80	109	160	229	261	315	2,427

2 GEOLOGICAL SETTING

The Wonder project is situated in granitic rocks that have intruded the north-north-west trending Norseman-Wiluna greenstone belt of Archaean age. A geological description by Sons of Gwalia (2003) indicates that the area is dominated by granite with frequent lensoidal mafic xenoliths (rafts) trending parallel to west-north-west shear zones, including the Wonder Shear. The granites have been mapped as tonalite/granodiorite/quartz diorite at Wonder North and in the Golden Wonder area; and there are similar rocks in the northern part of Wonder West, with porphyritic tonalite in the southern part of the pit and a hybrid, partly granitised mafic in the centre of the pit (Jeffrey, 2008).

There are numerous narrow east-west porphyry and lamprophyre dykes, and north-easterly trending structures containing aplite, pegmatite and dolerite dykes.

Mineralisation at Wonder North is in granitic rocks within a brecciated shear zone striking at 300 degrees, and dipping between vertical and 65^{o} to the north-east. There are also cross-cutting faults trending 330^{o} to 350^{o}.

The depth of weathering is variable, and up to about 70 m at Wonder West and 80 m at Wonder North.

3 HYDROGEOLOGICAL ASSESSMENT

3.1 GROUNDWATER OCCURRENCE

The Wonder Project area lies in an elevated area near the catchment divide between the Raeside and Carey palaeodrainages.

There are some major north-westerly trending faults that cut both the granitic and greenstone rocks; these structures include the Garden Well Shear, the Craig Fault, the Black Cat Shear, the Wonder Shear, and the Celtic Shear. The mineralisation is associated with these. Strong air-photograph lineaments are common and trend in various directions including north-south, east-west and north-east south-west; these probably follow fracture zones or geological contacts.

The results of previous investigations including one by Rockwater (2009) indicate that rocks in the area are generally of low permeability, and groundwater inflows to bores are small. The most prospective targets for groundwater supplies are fractured greenstone rocks, particularly felsic volcanics, close to drainage lines where there is the maximum potential for recharge during rainfall events. Granitic rocks are generally less prospective except where fractured or near contact zones where they intrude greenstones. There can also be some groundwater flows in the transition zone between weathered and fresh rocks.

Recharge rates are low, probably around one percent of average annual rainfall, or less.

Palaeochannel aquifers are the principal source of water supplies in the north-eastern goldfields, but these aquifers are unlikely to extend to anywhere near the Wonder Project tenements. The Sullivan Creek palaeochannel extends as far north as Wendys Bore, but probably becomes thin and unsaturated north of that borefield. There could be a tributary palaeochannel extending further north to the east: passing near Deadhorse Well and towards Christmas Well, although this potential channel has not been tested. If it exists, it would be about 15 km from Wonder.

Sons of Gwalia (2003) reported that all RC holes drilled at Wonder from 1995 to 1998 were dry; and in a Notice of Intent (NOI) to mine Wonder by Tarmoola Australia Pty Ltd (2001) it was stated that “exploration drilling in excess of 155 metres failed to encounter any significant volumes of groundwater” and “water flow testing of several of these holes revealed insufficient flow for v-notch measurement”.

A number of drillholes recorded in the NSR database have comments that indicate where significant groundwater inflows were intersected, often at depth in fresh granite. Details of these are summarised in Table 2, and the locations of the tops of the flow zones and the downhole extents, are shown in Fig. 2. These indicate that the groundwater intersections are associated with the mineralised Wonder Shear and possibly cross-cutting faults. There may have been other drillholes that intersected groundwater inflows but the information was unrecorded. For several other holes, there are records of the depths at which groundwater was intersected (“water table”) – these are also shown in Fig. 2, with the depths shown as elevations (m AHD).

Details of bores in the area recorded in the Department of Water and Environmental Regulation (DWER) Water Information Reporting (WIR) database are summarised in Table 3. The bore yields of more than 100 m^3/d are all at least 8 km to the south-south-west, around theTeutonic mine. No significant aquifers are recorded in the Wonder area.

Table 2: Groundwater Air-lift Flows Recorded in Wonder Drillholes (NSR Database)

Hole	mE	mN	RLGL	Dip	Azimuth	Wet Interval (m)	Summary of Comments
BNRC088	322813	6862837	494.38	60	225	94-100	Water throughout hole. Significant at base
BNRC106	323118	6862626	491.94	60	220	155-180	Hit water in shear zone
BNRC107	323147	6862652	491.43	60	225	186-196	Water from 169 m. Most from 186 to 196 m
BNRC108	323173	6862677	491.62	60	225	137-178	Water at various levels from 137 m to EOH
BNRC119	323339	6862558	489.44	60	225	137-160	Water 137-160
BNRC120	323357	6862576	489.48	60	225	155-220	Lots of water (filled sump) from 155m to EOH
BNRC122	323364	6862525	489.40	60	225	118-160	Water from 118m to EOH
BNRC123	323385	6862547	489.98	60	225	140-208	Filled sump. High flows from 140 m to EOH.
BNRC128	323436	6862434	490.14	60	225	120-166	Minimal water 120 to 166 m
BNRC129	323452	6862448	490.02	60	225	185-202	Hit high flows at 185m.
BNRC135	323546	6862379	489.16	60	225	190-196	high flows of water 190 to 196 m
BRC021	321805	6861852	495.31	60	220	256-262	Lots of water 256 m
BRC022	321843	6861624	495.50	60	220	244-247	Strong water flow from 244 m
BRCD003	322177	6863703	502.50	53	210	262-264	Abandoned hole: lots of water.
GWRC052	321622	6866278	514.46	60	0	48-49	Waterlogged
GWRC054	321623	6866241	514.67	67	0	54-162	High water flow. Head of water restricted EOH to 162 m
WNRD1014	321745	6863862	503.67	60	220	204-205	Driller reported a large water flow
WWRD029A	321293	6864090	506.60	56	220	107-216	High flows 107 to 108 m and 216 to 216 m. Filled two sumps
WNRD1028	322174	6863579	501.83	60	225	200-225	Hole stopped due to high flows
WNRD1104	322354	6863343	499.77	60	220	200-220	Hole stopped due to wet samples

3.2 GROUNDWATER LEVELS AND FLOW DIRECTIONS

Groundwater levels recorded in the WIR database at various times were reduced to m AHD using recorded ground levels or the Geoscience Australia SRTM DEM-H topographic contours, to prepare the groundwater level contour plan shown in Fig. 3. These should be taken as approximate, as some would have been pumping-affected; they were measured in various years over a long period, and there is some uncertainty in the measurements and the topographic levels.

The contours show that the natural groundwater flow-direction is southwards under a fairly even hydraulic gradient, with low levels around the Teutonic workings and bores. Pre-mining groundwater levels at Wonder were about 468 m AHD, and these have been lowered in Wonder West by evaporation, to about 444 m AHD,

3.3 GROUNDWATER QUALITY

Groundwater salinity measurements given in the WIR database, and made at various times, are shown in Fig. 4. They indicate brackish groundwater of salinity generally in the range 1,100 to 1,700 mg/L TDS around Wonder; with some lower and higher salinities (up to 8,400 mg/L TDS) in the south-west near Teutonic.

Water analyses were made on five samples from Wonder drillholes in July 2001, and have been reported in the NOI. There are also analyses of six samples from Wonder North pit, taken from January 2020 to July 2021 (Saprolite Environmental, 2021). The results of the analyses are included herein as Appendix A. The 2001 (pre-mining) analyses show the groundwater was brackish (salinity 1,600 to 2,100 mg/L TDS), of sodium chloride type with high sulphate concentrations, alkaline (pH 7.9 to 8.4), with low metal concentrations and high nitrate (27 to 95 mg/L nitrate-N).

Table 3: Summary of Bore Details, WIR Database

Site Ref	Name	Easting (m)	Northing (m)	Depth (m)	SWL (m bgl)	Aquifer	Yield (m^3/d)	Salinity (mg/L TDS)
120412491	Wandery Well	329369	6869834		26.67			4150
120412498	Wilsons Patch Well	322494	6867320	39.62	30.48			1300
120412499	Homestead	320835	6865775	74.37				
120412500	Garden Well	317142	6867773	18.3	18.75			1200
120412501	Pickaway Well	327942	6862549		22.56			1680
120412506	Wilsons	313073	6862086		23.16			
120412509	Ten Mile Well	327033	6857374		18			1300
120412510	Ptb Wb 105 Prod	317512	6858974	70	54.57	Porph. Fel. Volc	35	450
120412511	Ptb Wb 94 Prod	318120	6856511	78	38.24	dolertie + Qtz	38	750
120412512	Ptb Wb 104 Prod	318120	6856518	70	39.28	Basalt	371	466
120412513	Ptb Wb 95 Prod	317165	6856028	73	26.9	Basalt + Qtz	432	5608
120412514	Ptb Wb 107 Prod	319613	6855657	64	26.32	Porph. Fel. Volc	86	985
120412515	Ptb Wb 108 Prod	318114	6855774	80	36		330	540
120415438	Bore	322306	6866325	15.24				
120415439	Ptb Wb 85	317427	6860067	60		Granite	0	
120415440	Rd 4A	320525	6860317	42		rock	0	
120415441	Rd 4B	319431	6861435	37		Granite	0	
120415442	4C	320695	6863358	37		Granite	0	
120415443	4D	318684	6866327	21		rock	0	
120415444	4E	317685	6868177	31			0	
120415445	Teutonic	319569	6857310		32.8			300
120415453	Ptb Wb 76	317524	6858974	88	55.23		35	480
120415454	Ptb Wb 77	317518	6858974	80				
120415455	Ptb Wb 83	317518	6858974	80	44.4		43	1152
120415456	Ptb Wb 106 Prod	317512	6858974	70	44.41	Porph. Granite	22	1100
120415457	Ptb Wb 78	318120	6856511	96	38.15		112	720
120415458	Ptb Wb 79	317165	6856028	76	27.3		850	5880
120415459	Ptb Wb 81	317165	6856028	80	26.5		670	7150
120415460	Ptb Wb 80	316980	6857108	80			69	8352
120415461	Ptb Wb 84	316677	6859337	80			0	
120415462	3C	320783	6852060	50		clay	0	
120415463	Ptb Wb 82	315925	6857844	80			0	
120419220	Solar	320436	6865782					
120470080	07TBWB002	317547	6856186	75				
120470204	OSTBRC031	318651	6856337	165	87		2160	

Water from the pumped Wonder North pit in 2020-21 was saline (salinity 9,700 to 10,000 mg/L TDS), of sodium chloride type with high sulphate concentrations, alkaline (pH 8.1 to 8.7), with low metal concentrations and low nitrate (0.2 to 0.4 mg/L nitrate-N).

3.4 PIT WATER BALANCES AND HYDRAULIC CONDUCTIVITY

As indicated in Section 3.1 above, groundwater inflows to drillholes from zones of significant permeability (hydraulic conductivity) are probably limited to the mineralised Wonder Shear, and there could also be some permeable zones in cross-cutting faults and in the transition zone between weathered and fresh rocks.

Water balances for the existing pits give an indication of groundwater flows to the pits from both the mineralised zone and the base of weathering – there are few drillholes with weathering data in and around the existing pits but those available indicate that the pits extend down into fresh rock.

3.4.1 WEST PIT

West pit extends down to a base elevation of about 427 m AHD, 78 m below the ground level of 505 m AHD. In March 2020, before there had been any significant pumpage from North pit (and none from West pit), the water level in West pit was at 443.6 m AHD – about 25 m below the pre-mining groundwater level interpolated from Fig. 3. Assuming that the pit water level in March 2020 was at or near-equilibrium (i.e. groundwater inflows plus rainfall accumulation balanced evaporation losses), the pit water balance would be as given in Table 4, with the following assumptions:

- 80 percent of average rainfall (Table 1) within the pit perimeter reports to the pit lake; and
- Evaporation from the pit lake was at the annual rate given in Table 1.

Table 4: West Pit Water Balance

Pit Area (m^2)	Pit Lake Area (m^2)	Av. Rainfall (m/yr)	Av. Evap. (m/yr)	GW Inflows (m^3/d)
48,300	4,200	0.2418	2.427	-2

The small negative value in the last column of Table 4 suggests minor groundwater outflow (but this is unlikely). In reality, some of the assumptions are probably inexact, for example the lake level is probably still recovering, but the results do indicate that any groundwater inflows are very small, probably less than 10 m^3/d.

3.4.2 NORTH PIT

North pit extends down to a base elevation of about 422 m AHD, 80 m below ground level at 502 m AHD. The pit has been pumped as a water source since about April 2020, with records available of pumping volumes and pit lake levels, although there is some uncertainty in the data. Prior to pumping, the pit lake level was 456.2 m AHD, about 12 m below the pre-mining groundwater level (Fig. 3).

The stress applied to the groundwater flow system does provide more data for determining the pit water balance, and groundwater flows. The water balance is given in Table 5.

Table 5: North Pit Water Balance

Date	WL	Vol Pumped	Lake Area	Del Lake Vol	Evap Loss	RR Accum.	GW Inflow	
	(m AHD)	(m^3)	(m^2)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3/d)
15-Apr-20	456.15		17,840					
15-Jul-20	455.48	13464	17,300	-8,410	5,565	0	10,619	117
15-Oct-20	452.70	13802	15,080	-30,090	6,848	0	-9,440	-104
15-Jan-21	453.40	13534	15,680	6,800	13,403	711	33,026	359
15-Apr-21	451.90	16855	14,540	-14,500	12,165	4,347	10,173	113
15-Jul-21	451.70	13233	14,290	-2,500	4,579	1,630	13,682	150
15-Nov-21	451.30	9564	13,980	-3,900	9,419	1,128	13,954	114
28-Feb-22	449.40	4741	12,550	-17,950	14,441	4,263	-3,031	-29
30-Jun-22	446.90	4071	10,960	-17,190	7,363	1,588	-7,344	-60

For this water balance, actual rainfalls were used in calculating rainfall (RR) accumulation.

The irregularity of the calculated groundwater inflows, particularly the negative values, indicates that some of the pumpage data are unreliable. However, overall groundwater inflows averaged about 80 m^3/d with pit lake levels 12 m to 21 m below pre-mining levels.

4 ASSESSMENT OF MINE DEWATERING

A numerical groundwater model was constructed to make a first estimate of potential dewatering flow rates during the planned underground mining, and groundwater flows to the final mine void. The calculated values are based on limited data, and should be regarded as approximate only.

4.1 MODEL DESCRIPTION

The model consists of a rectangular grid of 100 columns, 74 rows and two layers covering an area of 5 km north-west to south-east and 3.7 km north-east to south-west. The grid is aligned with the geological strike at Wonder, 53 degrees west of north. Model cells are 50 m by 50 m in size.

Layer 1 includes the upper 100 m of rocks at Wonder; these are likely to be the most permeable in the model area, and have relatively high groundwater-storativity. Layer 2 extends down to 280 m AHD, below the water bearing zones intersected in the wet drillholes.

The model utilises Processing Modflow Pro version 8.0.47 which incorporates Modflow, finite difference groundwater flow modelling software designed by the U.S. Geological Survey (McDonald and Harbaugh, 1988), and utilises subsequent modifications.

The model was established with low values of hydraulic conductivity and storativity for the granitic wall (country) rocks, and low (Wonder West) to moderate (Wonder North) conductivity and storativity for the mineralised zone. Recharge was assumed to be negligible, and constant heads were assumed at distances of 1.6 km north-west of Wonder West, and 700 m south-east of Golden Wonder to simulate groundwater flows into the modelled area. The pre-mining water table was assumed to be flat at 468 m AHD.

Model parameters were adjusted in calibrating the model to calculated groundwater flows at Wonder West and Wonder North (Section 4.2). The adopted parameters are summarised in Table 6.

Table 6: Summary of Adopted Aquifer Parameters

	Horiz. Hyd. Conductivity (m/d)			Vert. Hyd. Conductivity (m/d)			Storage Coeff. (v/v)	Specific Yield (v/v)	
	Wall Rocks	Wonder W Min. Zone	Rest of Min. Zone	Wall Rocks	Wonder W Min. Zone	Rest of Min. Zone		Wall Rocks	Min. Zone
Layer 1	0.005-0.017	0.011	0.02-1	0.002	0.01	0.06-0.3	0.001	0.01	0.02
Layer 2	0.005	0.008	0.1-0.3	0.001	0.006	0.022	0.001	0.005	0.01

4.2 MODEL CALIBRATION

The model was calibrated by using Modflow's Drain package to simulate current groundwater flows to the Wonder West and North pits, and then adjusting parameters until the model-calculated flows were close to those calculated from the pit water balances: 91 m^3/d for North pit and 19 m^3/d for West pit.

The calibration should be taken as very approximate, as evaporative losses from the pits that induce groundwater inflows apply only a low degree of stress to the aquifer.

4.3 DEWATERING FLOW RATES

The numerical model was run, again using Modflow's Drain package, to estimate dewatering flow rates during development of the underground mine and subsequent drainage of groundwater to the workings over the mine life.

Mining is expected to commence late in 2023, with the decline extending down from a portal in Wonder North to about 340 m AHD by December 2024; to about 240 m AHD in December 2025; and then to about -75 m AHD by December 2029. In the final five years of mining there will mostly be driving and stoping from the decline, with the workings extending down to about -100 m AHD.

Based on the recorded water intersections in drillholes and experience at other sites, there is likely to be very little permeability below about 220 m depth, i.e. below about 280 m AHD. Consequently, the highest flow rates are expected to be in the first two years of mining.

Estimated average dewatering flows calculated using the groundwater model are given in Table 7. They do not include dewatering of the pond in North pit or any surface water flows to the pit.

Table 7: Estimated Average Dewatering Flow Rates, Wonder North Underground

Year	Model Stress Period	Calc. Total Flow Vol. (m^3)	Av. Flow (m^3/d)
1	1	448,400	1,230
2	2	427,700	1,170
3	3	323,400	890
4 to 10	4	1,646,500	640

4.4 SENSITIVITY ANALYSIS

Model parameters could be more or less than the assumed values, and so there is uncertainty in the estimated dewatering flow rates. The most sensitive parameters are horizontal hydraulic conductivity (KH), drainable porosity (specific yield, SY), and the nature of the model boundaries.

A sensitivity analysis was carried out to assess the potential ranges of dewatering flow rates for two cases:

1. Low flows, if values of KH and SY were only half those assumed, and the model boundaries were of no-flow type (rather than constant-head); and
2. High flows, if values of KH and SY were double those assumed (with constant-head boundaries).

The results are given in Table 8. They indicate that the highest average flows in Year 1 or two could possibly range from 680 to 2,300 m^3/d, compared to the best estimate of about 1,200 m^3/d.

Table 8: Results of Sensitivity Analysis

Year	Model Stress Period	Calc. Av. Dewatering Flows (m^3/d)	
		Low Flow Case	High Flow Case
1	1	680	2,260
2	2	580	2,300
3	3	450	1,720
4 to 10	4	320	1,260

4.5 POTENTIAL IMPACTS OF DEWATERING

Pumping from Wonder North pit has lowered the water level in the pit by 18 m, and has had a minor impact on Wonder West pit, lowering the water level by 1.4 m. It is unlikely that groundwater-level drawdowns during dewatering will extend more than 500 m west-north-west of Wonder West where geological mapping by Jeffery (2008) depicts that the Wonder Shear is truncated by basaltic rocks. Drawdowns could also extend about 1 km from the underground workings to the south-east along the Wonder Shear, and smaller distances across-strike to the north-east and south-west.

There are no known groundwater dependent ecosystems (GDE) at risk of being impacted by the dewatering.

The nearest bore or well recorded in the WIR database is Bundarra Homestead bore, located 2.4 km north-west of Wonder North and north of the Wonder Shear (Fig. 1). It is very unlikely that the bore would be impacted by water-level drawdown.

5 NATURE OF FINAL MINE VOID

The planned underground workings will be below Wonder North pit, and the water-balance calculation for that pit gives an estimate of the final pit lake level. Assuming the following: that 80 % of the average rainfall within the pit perimeter reaches the lake; evaporation from the lake at the dam evaporation is at the rate given in Luke, Burke and O'Brien (1988); and groundwater inflows are as determined by the numerical model: the calculated pit water balance values will be be those given in Table 9.

Table 9: Final Void Water Balance, Wonder North

Pit Lake Elev. (m AHD)	Pit Lake Area (m^2)	Rainfall Gain (m^3/d)	Evap. Loss (m^3/d)	GW Inflows (m^3/d)	Balance (m^3/d)
435	4,827	28	32	126	122
440	7,277	28	48	110	89
445	9,747	28	65	92	55
450	12,943	28	86	72	14
455	16,945	28	113	51	-34
460	20,840	28	139	29	-82

A zero value for the balance term - interpolated from the final column of Table 9 – is indicated to occur at a lake level of 451.4 m AHD; this would be 16.5 m below the pre-mining (static) groundwater level. The actual pre-pumping lake level in April 2020 was 456.2 m AHD (11.7 m below the static level) – the latter higher observed level may indicate there has been some runoff into the pit, or that evaporation rates are lower than those used in the final void balance.

In either case, the final void is indicated to be a permanent groundwater sink. Water in the pit lake will gradually increase in salinity, but there will be no seepage from the pit lakes back into the surrounding groundwater.

6 CONCLUSIONS

The Wonder project is in an area of generally low hydraulic conductivity, with low groundwater flows in any bores and wells.

Reports on the Wonder deposits in 2001 and 2003 stated that all drillholes were dry and that drilling to greater than 155 m depth had failed to intersect any significant volumes of groundwater. Also, there are no significant aquifers in the area indicated in the DWER WIR database. However, comments on some more-recent drillhole logs indicate some significant groundwater flows were intersected at depth in fresh granite along the mineralised Wonder shear zone.

Pit water balances indicate very low groundwater flows (less than 10 m^3/d) to Wonder West pit; and low to moderate flows averaging about 80 m^3/d to Wonder North pit. The groundwater flowing into the pits is brackish (salinity 1,600 to 2,100 mg/L TDS), of sodium chloride type with high sulphate concentrations, alkaline (pH 7.9 to 8.4), with low metal concentrations and high nitrate (27 to 95 mg/L nitrate-N).

A simple groundwater model was constructed of the Wonder area to estimate dewatering flows during the planned underground mining. It was approximately calibrated to the indicated groundwater flows to the pits. The results of the modelling suggest that dewatering flows could average about 1,200 m^3/d during the first two years of mining, and decreasing thereafter.

Groundwater-level drawdowns are expected to extend about 1 km from the workings along the Wonder Shear, and to smaller distances across-strike. There are no known GDEs that could be affected by the dewatering; and the nearest bore (Bundarra Homestead bore), 2.4 km north-west of Wonder North pit, is very unlikely to be impacted.

The final mine void will be a permanent groundwater sink. Water in the pit lake will gradually increase in salinity, but there will be no seepage from the pit lake into the surrounding groundwater.

REFERENCES

Jeffery, R.G., 2008, Bundarra Region, geological mapping. Report for Terrain Minerals Ltd.

Luke, G.J., Burke, K.L., and O'Brien, T.M., 1988, Evaporation data for Western Australia. Tech. Report No. 65 (2nd Ed), W.A. Dept. of Agriculture.

McDonald, M.G., and W.A. Harbaugh, 1988, MODFLOW, A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U.S. Geological Survey, Washington, DC. (A:3980), open file report 83–875, Chapter A1.

Rockwater, 2009, Bundarra Project, Initial assessment of potential groundwater sources. Report to Terrain Minerals Ltd.

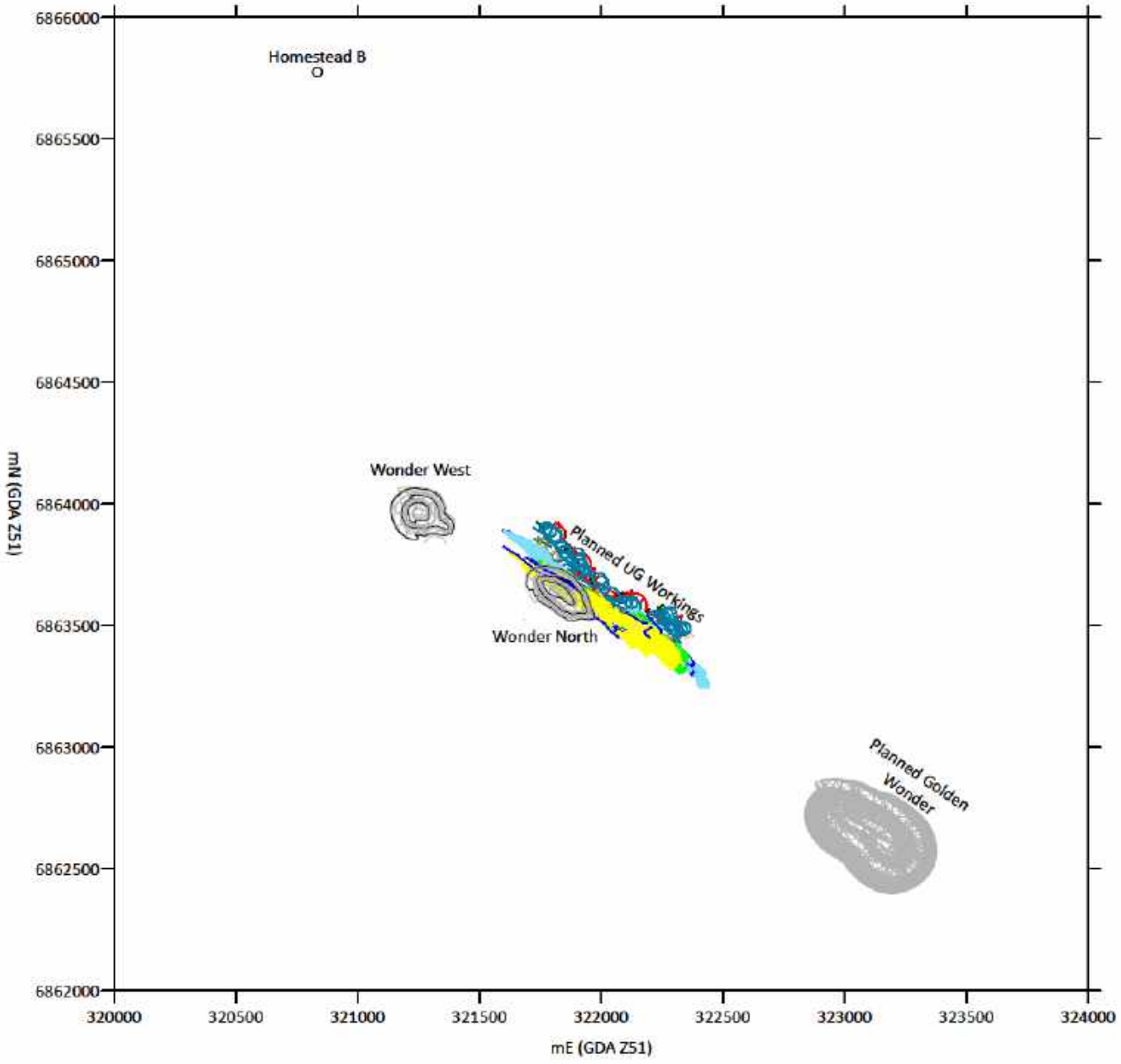
Saprolite Environmental, 2021, Thunderbox Operations, Annual groundwater monitoring review for groundwater well licences. Report to Northern Star Resources Ltd.

Sons of Gwalia, 2003, McEast/Robinsons Project, Annual report for the period 1 July 2002 to 30 June 2003. Report to Department of Industry & Resources.

Tarmoola Australia, 2001, Notice of Intent, Wonder gold project.

FIGURES

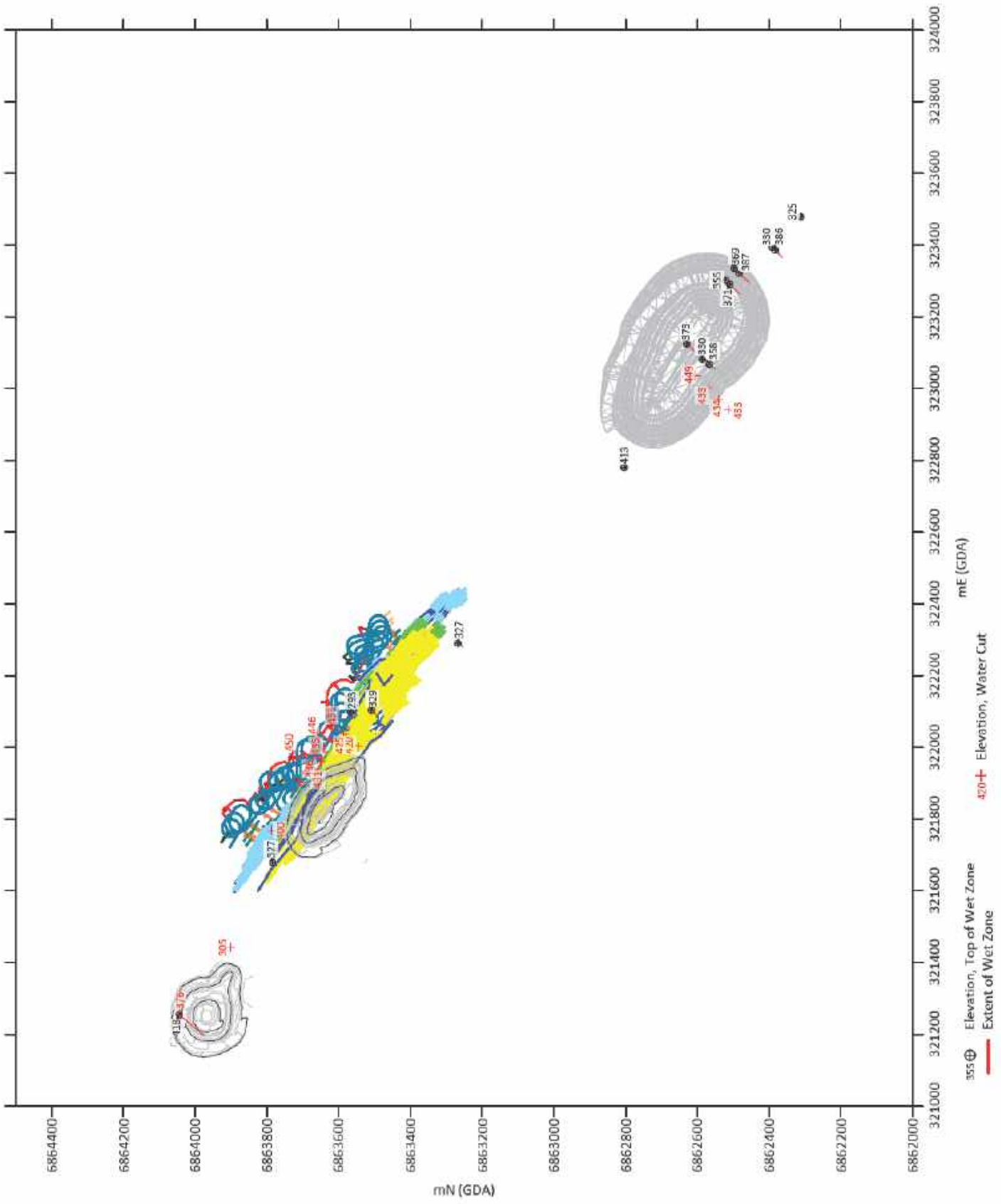
Figure 1



Location Plan.srf

CLIENT: Northern Star Resources	LOCATIONS OF PITS AND PLANNED WORKINGS
PROJECT: Wonder Hydrogeology	
DATE: May 2023	
Dwg No: 263-7/23/2-1	Rockwater Pty Ltd

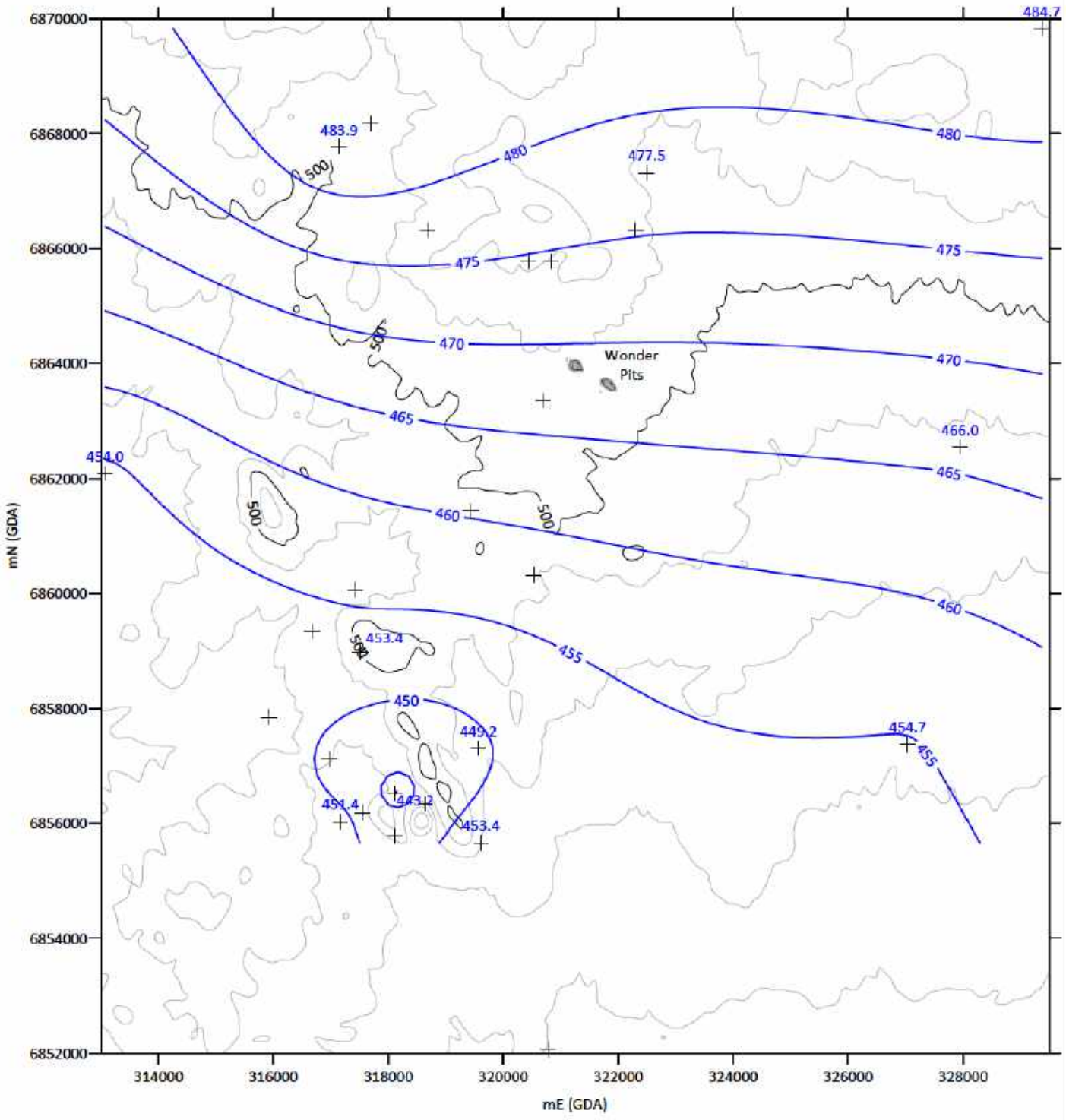
Figure 2



HiFlow Holes.srf

CLIENT: Northern Star Resources	GROUNDWATER INTERSECTIONS AND HIGH WATER FLOWS
PROJECT: Wonder Hydrogeology	
DATE: May 2023	
Dwg No: 263-7/23/2-2	Rockwater Pty Ltd

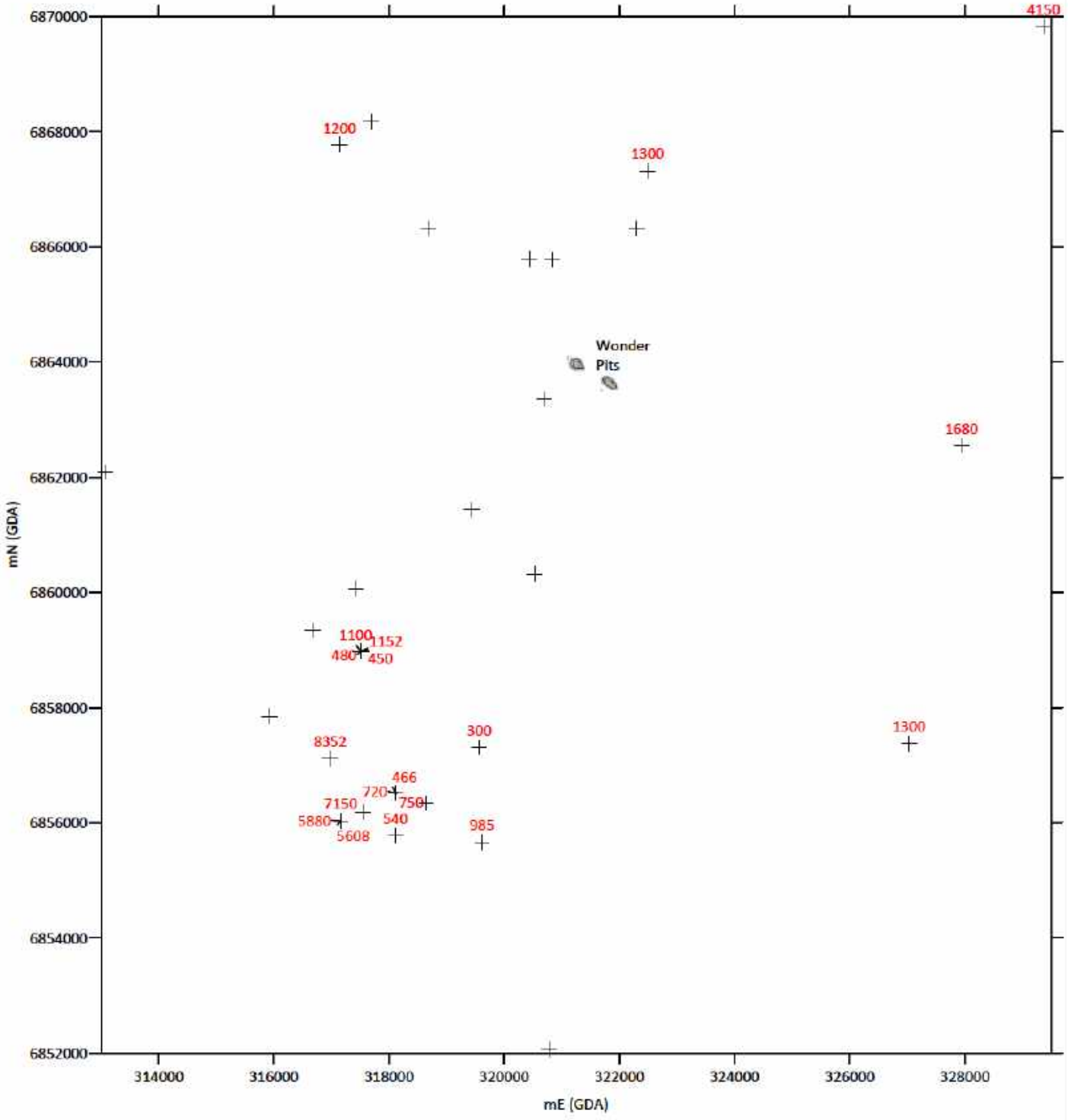
Figure 3



rlwls.srf

CLIENT: Northern Star Resources	GROUNDWATER LEVELS (m AHD)
PROJECT: Wonder Hydrogeology	WIR DATABASE
DATE: May 2023	
Dwg No: 263-7/23/2-3	Rockwater Pty Ltd

Figure 4



rlwls.srf

CLIENT: Northern Star Resources	GROUNDWATER SALINITY (mg/L TDS) WIR DATABASE
PROJECT: Wonder Hydrogeology	
DATE: May 2023	
Dwg No: 263-7/23/2-4	Rockwater Pty Ltd

APPENDIX A

RESULTS OF CHEMICAL ANALYSES

MPL Health, Safety and Environmental Solutions

MPL Group Pty Ltd
ABN: 36 083 014 388
16 - 18 Hayden Court, MYAREE WA 6154

Certificate of Analysis

TESTING FACILITY: PERTH
CHEMICAL WATER ANALYSIS

CLIENT : Tarmoola Operations Pty Ltd
ORDER NUMBER : S970041
DATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

TEST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

Lab No. : M005
Client ID : 0062
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	3300
TDS (Gravimetric)	1	mg/L	2100
pH			8.40
Carbonate	1	mg/L	3
BiCarbonate	1	mg/L	370
Tot Alk. (as CaCO3)	1	mg/L	300
Sodium	5	mg/L	650
Potassium	1	mg/L	10
Calcium	1	mg/L	34
Magnesium	1	mg/L	54
Iron	0.01	mg/L	0.22
Aluminium	0.2	mg/L	<0.2
Total Silica	5	mg/L	34
Manganese	0.01	mg/L	0.19
Hardness [CaCO3]	1	mg/L	310
Chloride	1	mg/L	700
Sulphate	1	mg/L	330
Nitrate (as NO3)	0.1	mg/L	27

Checked

Approved Signatory
23/07/01

MPL Health, Safety and Environmental Solutions

MPL Group Pty Ltd
ABN: 36 083 014 386
16 - 18 Hayden Court, MYAREE WA 6154

Certificate of Analysis

TESTING FACILITY: PERTH

CHEMICAL WATER ANALYSIS

CLIENT : Tarmoola Operations Pty Ltd
ORDER NUMBER : S970041
DATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

TEST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

Lab No. : M002
Client ID : 0106
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	2600
TDS (Gravimetric)	1	mg/L	1600
pH			8.30
Carbonate	1	mg/L	<1
BiCarbonate	1	mg/L	300
Tot Alk. (as CaCO3)	1	mg/L	230
Sodium	5	mg/L	540
Potassium	1	mg/L	13
Calcium	1	mg/L	27
Magnesium	1	mg/L	38
Iron	0.01	mg/L	0.45
Aluminium	0.2	mg/L	0.3
Total Silica	5	mg/L	19
Manganese	0.01	mg/L	0.16
Hardness [CaCO3]	1	mg/L	220
Chloride	1	mg/L	510
Sulphate	1	mg/L	260
Nitrate (as NO3)	0.1	mg/L	32

Checked

Approved Signatory
23/07/01

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16 - 18 Hayden Court, MYAREE WA 6154

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TESTING FACILITY: PERTH
CHEMICAL WATER ANALYSIS

CLIENT : Tarmoola Operations Pty Ltd
ORDER NUMBER : S970041
DATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

TEST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

Lab No. : M004
Client ID : 0116
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	2400
TDS (Gravimetric)	1	mg/L	1600
pH			8.00
Carbonate	1	mg/L	<1
BiCarbonate	1	mg/L	190
Tot Alk. (as CaCO3)	1	mg/L	150
Sodium	5	mg/L	480
Potassium	1	mg/L	8
Calcium	1	mg/L	17
Magnesium	1	mg/L	30
Iron	0.01	mg/L	0.25
Aluminium	0.2	mg/L	<0.2
Total Silica	5	mg/L	13
Manganese	0.01	mg/L	0.32
Hardness [CaCO3]	1	mg/L	170
Chloride	1	mg/L	390
Sulphate	1	mg/L	200
Nitrate (as NO3)	0.1	mg/L	95

[redacted]

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TESTING FACILITY: PERTH
CHEMICAL WATER ANALYSIS

CLIENT : Tarmoola Operations Pty Ltd
RDER NUMBER : S970041
ATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

EST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

. .b No. : M001
Client ID : 0127
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	2900
TDS (Gravimetric)	1	mg/L	1700
pH			7.85
Carbonate	1	mg/L	<1
BiCarbonate	1	mg/L	240
Tot Alk. (as CaCO3)	1	mg/L	200
Sodium	5	mg/L	540
Potassium	1	mg/L	9
Calcium	1	mg/L	26
Magnesium	1	mg/L	48
Iron	0.01	mg/L	0.11
Aluminium	0.2	mg/L	0.5
Total Silica	5	mg/L	36
Manganese	0.01	mg/L	0.09
Hardness [CaCO3]	1	mg/L	260
Chloride	1	mg/L	600
Sulphate	1	mg/L	290
Nitrate (as NO3)	0.1	mg/L	45

[redacted]

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Certificate of Analysis

TESTING FACILITY: PERTH
CHEMICAL WATER ANALYSIS

CLIENT : Tarmoola Operations Pty Ltd
ORDER NUMBER : S970041
DATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

TEST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

Lab No. : M003
Client ID : 0128
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	2900
TDS (Gravimetric)	1	mg/L	1600
pH			8.00
Carbonate	1	mg/L	<1
BiCarbonate	1	mg/L	240
Tot Alk. (as CaCO3)	1	mg/L	200
Sodium	5	mg/L	570
Potassium	1	mg/L	8
Calcium	1	mg/L	30
Magnesium	1	mg/L	45
Iron	0.01	mg/L	0.15
Aluminium	0.2	mg/L	0.4
Total Silica	2	mg/L	26
Manganese	0.01	mg/L	0.07
Hardness [CaCO3]	1	mg/L	260
Chloride	1	mg/L	620
Sulphate	1	mg/L	290
Nitrate (as NO3)	0.1	mg/L	40

[redacted]

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Certificate of Analysis

TESTING FACILITY: PERTH

CHEMICAL WATER ANALYSIS

CLIENT : Tarmocla Operations Pty Ltd
ORDER NUMBER : S970041
DATE RECEIVED: 12/07/01 JOB NO : 011826
SAMPLED BY : Client

TEST METHOD: Samples submitted by clients are analysed on an as received basis. Analysis performed in accordance with MPL Laboratories WILAB 5.0 and WILAB 6.0.

Lab No. : M006
Client ID : 0128
10/07/01

	Detect. Limit	Unit	ANALYTICAL RESULT
Conductivity	1	uS/cm	2600
TDS (Gravimetric)	1	mg/L	1400
pH			7.75
Carbonate	1	mg/L	<1
BiCarbonate	1	mg/L	280
Tot Alk. (as CaCO3)	1	mg/L	230
Sodium	5	mg/L	540
Potassium	1	mg/L	9
Calcium	1	mg/L	22
Magnesium	1	mg/L	39
Iron	0.01	mg/L	0.24
Aluminium	0.2	mg/L	0.2
Total Silica	5	mg/L	39
Manganese	0.01	mg/L	0.07
Hardness [CaCO3]	1	mg/L	220
Chloride	1	mg/L	530
Sulphate	1	mg/L	250
Nitrate (as NO3)	0.1	mg/L	42

This Laboratory is accredited by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of accreditation. This

[redacted]

SITE ID	DATE	pH	EC	TDS	TSS	Total Hardness as CaCO3	Carbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Cl	SO_4	Ca	Mg	Na	K	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Se	Zn	SiO_2	NO_3 (as N)	NO_2 (as N)	TN
		No Unit	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NWQMS 2000 (Livestock)		6.5-8.5		4,000								1000	1000				5	0.5	0.01	1	1	1			1	0.1	0.02	20				
Wonder Pit (North)	24/01/2020	8.60	14,500	9,750																												
Wonder Pit (North)	28/06/2020	8.31	15,000	9,700		1,910	3	<1	237	240	4580	1390	136	382	2610	47	0.31	0.001					0.77		0.002	<0.001				0.3	0.04	
Wonder Pit (North)	12/10/2020	8.66	14,400	9,630		1,890	52	<1	179	232	4540	1600	142	373	2640	48	<0.01	0.001					0.14		<0.001	<0.001				0.26	0.02	
Wonder Pit (North)	3/01/2021	8.08	14,300	10,000		2,100		<1	206	206	4480	1450	138	426	2820	54	<0.01	<0.001					0.39		<0.001	<0.001				0.17	0.03	
Wonder Pit (North)	12/04/2021	8.50	15,000	9,810		1,960		<1	172	198	3960	1450	144	388	2480	38	<0.01	<0.001					<0.05		<0.001	<0.001				0.21	0.01	
Wonder Pit (North)	10/07/2021	8.33	14,300	9,650	7	1,880		<1	232	238	4100	1450	140	373	2710	43	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	0.06	0.07	<0.001	<0.001	<0.01	0.006		0.4	0.07	
Leonora-Leinster Rd 4B																																
Leonora-Leinster Rd 4C																																