Bulk Test Sample
Mining Management Plan
Wonarah Phosphate Project

Authorisation Number: 1170-01

September 2023

DOCUMENT CONTROL RECORD

Job	EZ22273	680.30199
Document ID	222447-19	222447 Sept 2023
Author(s)	S. Barber	J. Woodworth
Date		

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Comments	Date
1	Avenira Ltd – Steve Harrison	Avenira Ltd – Steve Harrison	Department of Industry, Tourism and Trade (DITT)	First issue of MMP	25/01/2023
1.1	Avenira Ltd – Steve Harrison	Avenira Ltd – Steve Harrison	Department of Industry, Tourism and Trade (DITT)	Revision of MMP to meet DITT's RFI	17/04/2023
1.2	Avenira Ltd – Steve Harrison	Avenira Ltd – Steve Harrison	Department of Industry, Tourism and Trade (DITT)	Revision of MMP to include Trial Test Pit	04/05/2023
1.3	Avenira Ltd – Steve Harrison	Avenira Ltd – Steve Harrison	Department of Industry, Tourism and Trade (DITT)	Revision of MMP to include Trial Test Pit	29/05/23
1.4	Avenira Ltd – Steve Harrison	Avenira Ltd – Steve Harrison	Department of Industry, Tourism and Trade (DITT)	Revision of MMP to include redacted items, Surface Water Management Plan, Air Quality and Dust Management Plan	18/09/2023

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TABLE OF CONTENTS

Tables

Figures

Appendices

ACRONYMS

AAC	Arruwurra Aboriginal Corporation
AAPA	Aboriginal Areas Protection Authority
ABN and ACN	Australian Business Number and Australian Company Number
ANC	Acid Neutralising Capacity
APH	Arruwurra phosphorite geological domain (upper unit of mudstone phosphorite, present above the BPH unit)
ARD	Acid Rock Drainage
ABN and ACN	Australian Business Number and Australian Company Number
BPH	High-grade indurated mudstone phosphorite
CLC	Central Land Council
CPESC	Certified Practitioner Erosion and Sediment Control
DD	Diamond Drilling
DENR	Department of Environment and Natural Resources (now DEPWS)
DEPWS	Department of Environment, Parks and Water Security (formerly DENR)
DITT	Department of Industry, Tourism and Trade (formerly DPIR)
DPIR	Department of Primary Industry and Resources (now DITT)
DSO	Direct Shipping Ore
EIS	Environmental Impact Statement
EL	Exploration Licence
EMR	Environmental Mining Report
EPBC	*Environment Protection and Biodiversity Conservation Act*
ESCP	Erosion and Sediment Control Plan
ML	Mineral Lease
MMA	*Mining Management Act*
MMP	Mining Management Plan
MTA	*Mineral Titles Act*
NAF	Non-Acid Forming
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
RAB	Rotary Air Blast Drilling
RC	Reverse Circulation Drilling
ROM	Run of Mine
RWA	Restricted Work Area – only non-ground disturbing exploration activities allowed
SOBS	Site of Botanical Significance
SOCS	Site of Conservation Significance
TDS	Total Dissolved Solids
TPA	Thermal Phosphoric Acid
TPWC	*Territory Parks and Wildlife Conservation Act*
WCD	Water Control District
WoNS	Weeds of National Significance
WPP	Wonarah Phosphate Project

BACKGROUND

Avenira Limited (formerly known as Minemakers Limited) proposes to develop the Wonarah Phosphate Project (*here-in referred to as the Project*) located approximately 240 km east of Tenant Creek, Northern Territory and approximately 26 km directly south of the Barkly Highway. Avenira are seeking approval to undertake a bulk test sample within the existing Arruwurra test pit on the current Mineral Lease (ML) application ML33344, when the ML is granted.

Avenira are proposing bulk sample pits with a total material movement of 666kt to create 40 kt of high-grade indurated mudstone phosphorite (referred to as BPH). These bulk sample pits will enable shipping of 10-50 mm sized direct shipping ore (DSO) to a potential off-take partner overseas. The first phase is a trial test pit with a total volume of 87 kt to generate 5 kt of product to determine the lump to fines ratio. Should this prove successful then a further pit requiring 579kt of material movement will be completed to generate the remaining 35 kt of product within this MMP as an initial stage of a wider DSO project. If the test sample proves suitable, Avenira intend to commit to an off-take agreement and subsequent operational mining authorisation under the NT Mining Management Act 2001. This mining management plan (MMP) provides details of the proposed bulk test sample and ancillary activities, the environmental context, environmental and cultural identification of risks, risk assessment, environmental management, rehabilitation and closure of the Project. During 2010, the Project underwent assessment under the *Environmental Assessment Act 1982* (repealed, now the *Environmental Protection Act 2019)*. The Wonarah Phosphate Project Environmental Impact Statement (WPP EIS), encompassed mining of the two deposits, known as 'Wonarah' and 'Arruwurra'.

Upon NT EPA review of the WPP EIS, Assessment Report 64 was issued, stating:

> *"Based on its review of the draft EIS, Supplement and responses submitted to the assessment process, the Environment Heritage and Arts Division of the Department of Natural Resources, Environment, the Arts and Sport considers that the project can be managed without unacceptable environmental impacts. This is provided that the project as proposed, including all proposed management mechanisms, environmental commitments and recommendations detailed in the draft EIS, the Supplement, this Assessment Report and in the final management plans, are implemented and managed under the Mining Management Plan for the Project, and are subject to regular reporting and compliance auditing to the Department of Resources."*

The proposed bulk test sample and ancillary activities detailed here-in, are within the constraints of the approved WPP EIS, and no significant changes are identified.

A new MMP has been developed as the previously approved MMP was for historical tenements under previous operator "Minemakers". This new MMP has a focus on the Avenira mine plan for proposed bulk test sample (Stage 1.1) and grade control activities on ML33344 and ML33343 applications. If the bulk test sample is successful, Avenira will submit a larger scale DSO MMP for approval.

1 PROJECT DETAILS

Project Name	Wonarah Phosphate Project
Authorisation Number	1170-01 (See Appendix A Authorisation Certificate)
Operator Name	Avenira Limited
Operator ABN and ACN numbers	ABN: 48116296541 ACN: 116296541
Location and Access Details	The project is located in the Barkly Tableland of the Northern Territory directly south of the Barkly Highway, approximately 240 km east of Tenant Creek and approximately 960 km southeast of Darwin. The project area includes the Mineral Lease (ML) application ML33344, over the Arruwurra deposit, location of the proposed bulk test sample and ML33343 application, over the Wonarah main zone deposit, location of accommodation facilities. The site is accessed from Barkly Highway. The Wunara Community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 10 km to the east of ML33343 boundary. See Figure 1-1. Map of Project site location, mineral title and site access.
Target Commodity Details	Phosphate Used to generate Thermal Phosphoric Acid (TPA)
Mining Activities	The Mining Activities within this MMP comprises Stage 1.1 of the proposed future Direct Shipping Ore (DSO) Mining Management Plan and involves the bulk test sample of 40 kt of 10-50 mm BPH via extension of the existing Arruwurra test pit (broken into 5 kt (Bulk Test Sample) and 35 kt Stages (Initial DSO Operations)). <u>Bulk Test Sample:</u> The Bulk Test Sample requires 87kt of total movement to generate 5 kt of 10-50 mm BPH product via extension of the existing Arruwurra test pit. <u>Initial DSO Operations:</u> The initial DSO operation requires the movement of an additional 579kt of material to generate 35kt of BPH product via expansion of the Bulk Test Sample pit. In both the Bulk Test Sample and Initial DSO Operations activities the BPH horizon will be blasted and excavated via conventional open pit truck and excavator mining, then hauled from the pit for crushing at a mobile crushing unit on the existing stockpile area adjacent to the bulk test pit. Access will be via the existing Arruwurra test pit ramp. <u>Grade control:</u> Grade control drilling across ML33344. Planned total of 779 holes.
Proposed schedule	Bulk test sample operations to commence early quarter three 2023 and be ongoing for three months (June - August 2023). A total of 779 holes are proposed for grade control. Priority A – 450 holes - August 2023 Priority B – 329 holes - November 2023

1.1 Mining Interests and Land Ownership

Title Number	Title Holder	Application Date	Underlying Property Name or Land Holder	Proposed mining activities
ML33344 (Application)	Minemakers Australia Pty Ltd	23/09/2022	NT Portion 3753. Aboriginal land (NT enhanced freehold) Arruwurra Aboriginal Corporation (AAC).	Location of Arruwurra deposit. Activities include: • Bulk test sample from within existing Arruwurra test pit, waste dump, material stockpiling and haulage. • Grade control drilling
ML33343 (Application)	Minemakers Australia Pty Ltd	23/09/2022	NT Portion 3749. Aboriginal land (NT enhanced freehold) AAC.	Location of Wonarah Main Zone deposit. Activities include: • Camp / accommodation facilities in existing camp.

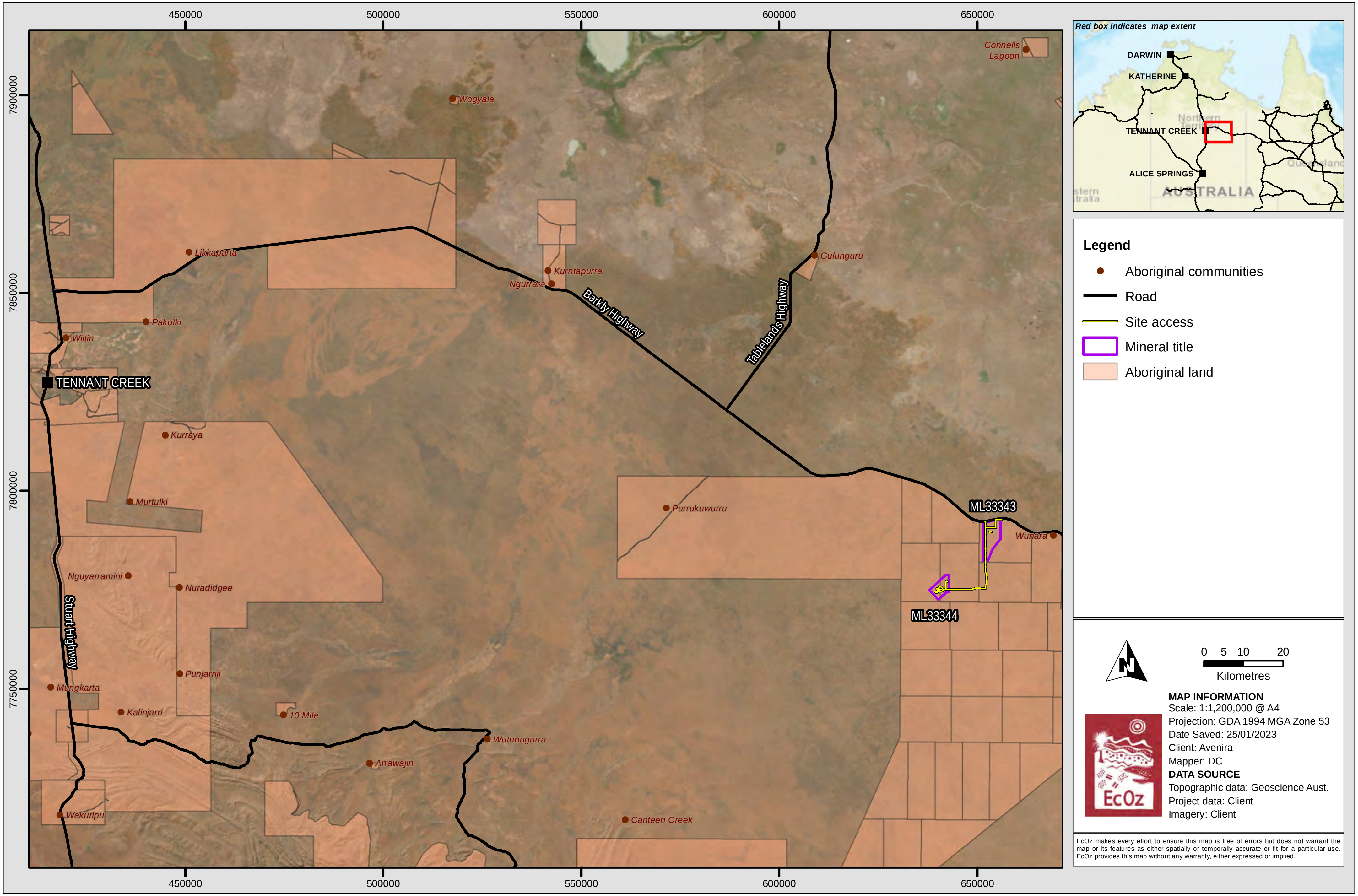

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Figure 1-1. Map of Project site location, mineral title and site access

1.2 Organisational Structure

Table 1-1. Key personnel, position titles and roles

Name	Position Title	Role
TBC	Registered Manager	Responsibility and oversight of operations and management of contractors
Steve Harrison	Chief Geologist	Oversight of Geological activities and stand-in for Senior Mine Geologist
TBC	Senior Mine Geologist	Responsibility for collection of grade control data and guidance of mining
TBC	Administrators x 2	Assist Registered Manager and Logistics Manager in administering and tracking contracts
Grant Williams	Logistics Manager (contract – offsite)	Setup and oversight of logistics process, procedures, and contracts
TBC	Mine Planning Engineer (contract – offsite)	Revision of mine plan as required from geological and mining related data
TBC	Mining Engineer	Oversight of daily mine operations
TBC	Field Assistant x 2	Assist Mine Geologist in sample collection and geological activities

Table 1-2. Key Contact

Key contact	Steve Harrison – Chief Geologist
Address	Unit 13, 6-10 Duoro Road, West Perth, WA, 6005
Phone	+61 438 100 350
Email	sharrison@avenira.com
Website	https://avenira.com/

There are several contracting companies who will be engaged to execute the mining, crushing, continuous miner and haulage activities.

2 LEGISLATION

Avenira are aware of the legislation and the requirements under each Act applicable to the Project as detailed in Table 2-1.

Table 2-1. Legislation

Northern Territory Legislation	Pertinent information	When
Mining Management Act 2001	Grant of mining authorisation	Prior to mining
Mineral Titles Act 2010	Granted mineral titles: ML33344 and ML33343	Prior to mining
Water Act 1992	A groundwater extraction licence application will be submitted for approval to extract water from bores.	Prior to water extraction
Environment Protection Act 2019	WPP EIS, Assessment Report 64 issued during 2010 under the then, *Environmental Assessment Act 1982 (now Environment Protection Act 2019).* The proposed bulk test sample and ancillary activities, are within the constraints of the approved WPP EIS, and no significant changes are identified.	Throughout life of mine, adhere to the relevant recommendations in the Wonarah Phosphate Project Assessment Report 64 (NRETAS 2010) See Section 7.1.2
Aboriginal Land Rights (Northern Territory) Act 1976	The Project is located on Aboriginal land (NT enhanced freehold) Arruwurra Aboriginal Corporation (AAC)	Land use agreements required prior to mining
NT Aboriginal Sacred Sites Act 1989	Historical AAPA Certificate (C2010/261) obtained by Minemakers Australia Pty Ltd for the Wonarah Phosphate Mine in 2010 did not identify any sacred sites within the subject land (ML27244). This certificate is no longer valid as the proposal did not commence within 24mths of the Certificate. Avenira are in the process of applying for a new AAPA Certificate to cover the Project area for the proposed activities.	Prior to mining
Bushfires Management Act 2016	The project area is located within the Barkley Fire Management Zone, permits and conditions apply.	NT permit to burn required prior to conducting prescribed burning activities
Dangerous Goods Act 1998	Bulk fuel storage onsite. All fuel storages must meet Australian Standard 1940: Storage and Handling of Flammable and Combustible Liquids	Construction phase
Heritage Act 2011	All sites on the NT Heritage Register and archaeological sites are protection under this Act. Archaeological survey (Hill, 2009) identified six sites of Aboriginal archaeological significance. Within and surrounding the MLs.	Planning / prior to disturbances
Territory Parks and Wildlife Conservation (TPWC) Act 1976	Eight flora species of conservation significance listed under the Territory Parks and Wildlife Conservation Act 1976 (TPWC Act) have been recorded inside the Wonarah Phosphate Project area during on-site investigations. Eight fauna species listed under the TPWC Act have been recorded within the project surrounds; two species (both listed as near threatened) have been recorded in the project area, *Rattus villosissimus* (long haired rat) and *Aspidites ramsayi* (woma). Two species of conservation significance were recorded during the field surveys, *Ardeotis Australia* (Australian bustard) (listed as vulnerable under the TPWC Act) and *Onychogalea unguifera* (northern nail-tailed wallaby) (listed as near threatened under the TPWC Act).	Prior to undertaking disturbance activities
Soils Conservation and Land Utilisation Act 1969	Erosion and Sediment Controls (ESCs) implemented by the Avenira, required to facilitate compliance with the general provisions of this Act.	Life of project

Northern Territory Legislation	Pertinent information	When
Waste Management and Pollution Control Act 1998	For wastes that are removed for off-site disposal, waste management contractors engaged by the project and facilities accepting listed wastes must be licensed under this Act.	When engaging waste management contractors
Weeds Management Act 2001	Landholders and occupiers have statutory obligations to manage declared weeds under the Act.	Life of project
Work Health and Safety (National Uniform Legislation) Act 2011	Mine sites in the NT must not permit any mining activity or a related mining activity to be carried out unless the mine operator has given to the regulator an RMP for the mine site that has been certified in accordance with regulation 614.	Life of project

3 EXISTING DISTURBANCE

A summary of the existing site disturbances is provided below and in Table 3-1. A total of 39.05 ha is the existing disturbance footprint of the Project.

Table 3-1. Existing site disturbances

Mining Interests	ML33344		ML33343
Infrastructure	**Volume (m^3)**	**Area (Ha)**	**Area (Ha)**
Access tracks (Barkley Hwy to camp)	-	-	2.5*
Access tracks (camp to Arruwurra office)	-	-	17.4*
Haul road (Arruwurra office to pit)	-	3.8*	
Arruwurra office / workshop	-	0.8*	
Open-cut pits (Existing Arruwurra test pit)	163,410*	2.8	-
Product stockpile pad	-	0.8	-
Waste dump	125,000*	2.0	-
Topsoil stockpile	39,000*	2.3	-
Camp	-		2.5
Minemakers exploration camp			1.13*
Borrow pits	-	1.52*	
Arruwurra bore dam	-	0.14	
Bore access roads		0.96	0.4
Total existing disturbance for each ML		**15.12**	**23.93**
Total existing area of mining disturbance (ha)		**39.05**	

*Source: Survey data Arruwurra bulk sample – final volumes 18 December 2009

Other data calculated form ArcGi and sourced from previous MMPs.

Note: exploration drilling disturbances and security accounted for in previous exploration MMPs and security held with DITT.

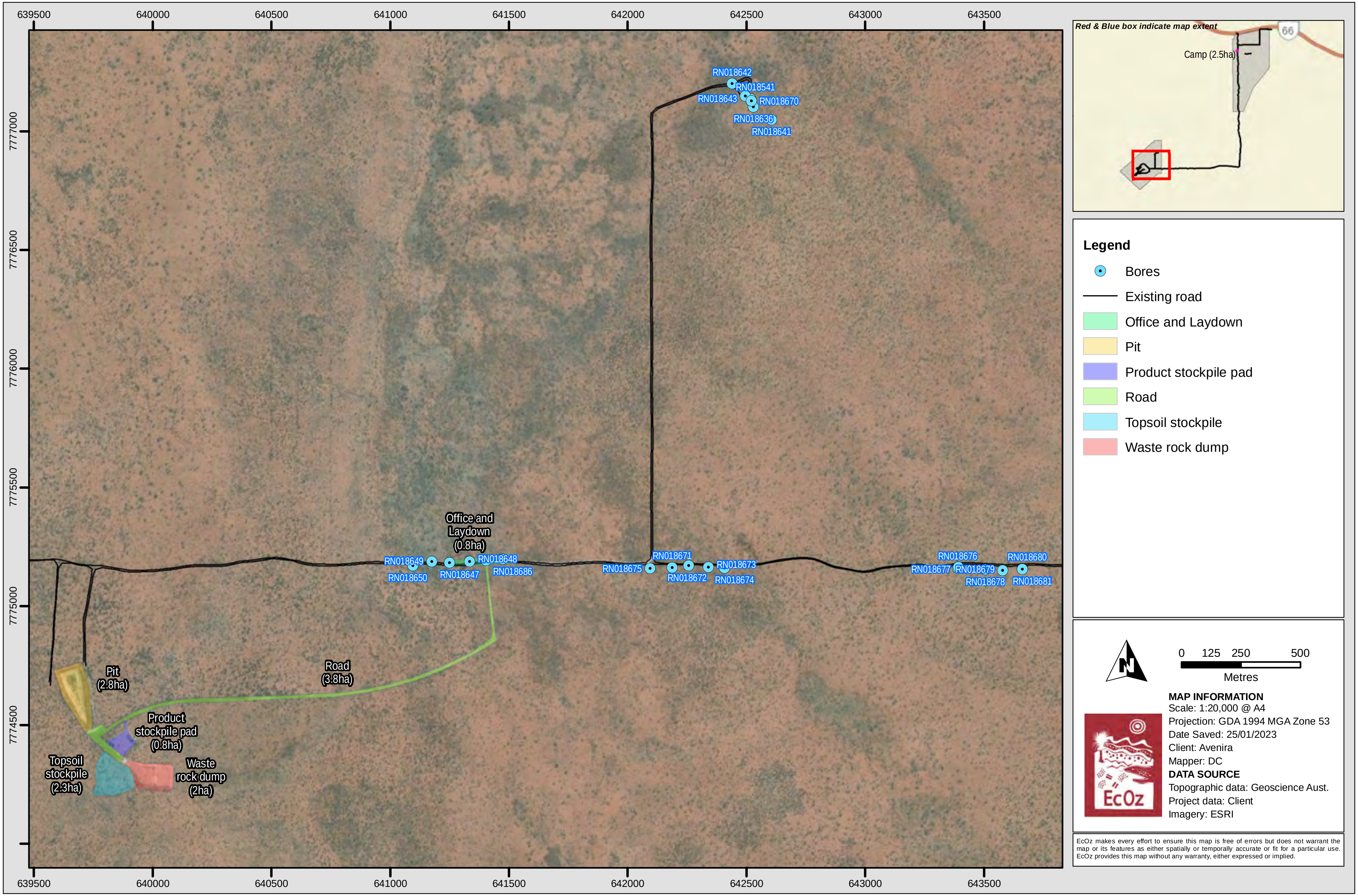

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Figure 3-1. Map of existing disturbances and bore locations at the Arruwurra deposit

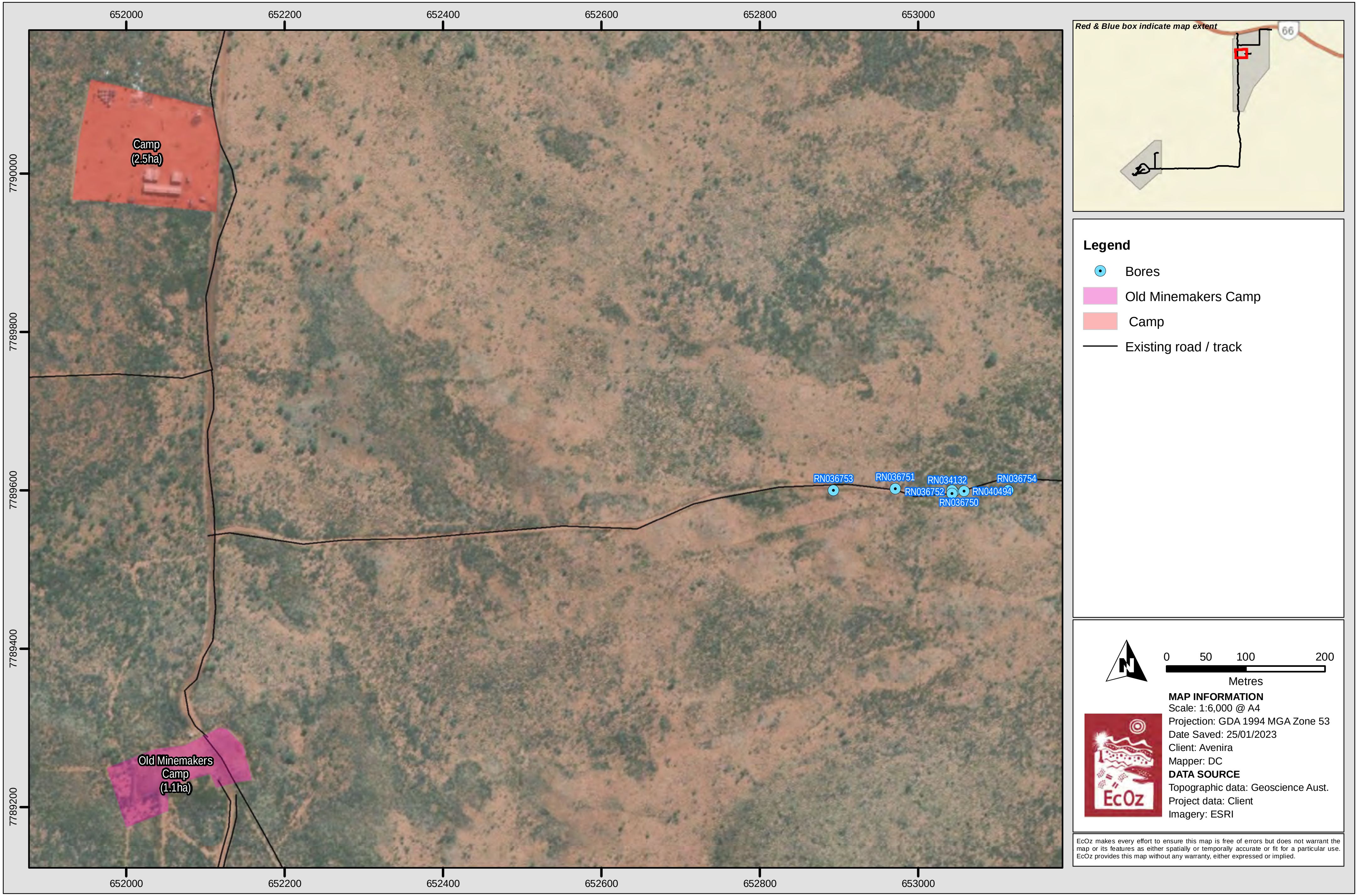

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Figure 3-2. Map of existing disturbance and bore locations at Wonarah Main Zone

4 ENVIRONMENTAL CONSIDERATIONS

4.1 Environmental Context

Item	Description	Reference
Climate	The climate of the south-central area of the Barkly region is semi-arid. The climate is monsoonal with well-defined wet and dry seasons, with nearly all the annual rainfall falling between November and March with the greatest incidence of rainfall events in January and February. Annual rainfall is between 300 and 400mm.	Hydrological Baseline Assessment – Wonarah Phosphate Project Groundwater Resources Management (GRM) 2009 (Appendix B)
Geology	Regional geology: the project is located in the Georgina Basin, a sedimentary basin containing lower and middle Palaeozoic sediments. Within the region of the Wonarah phosphate deposit two sub-basins occur, the Brunette and the Undilla, which are made up of Middle Cambrian sediments and volcanics. Arruwurra geology: the phosphate mineralisation occupies a broad northeast to southwest trending shelf that slopes to the southwest, before sharply dropping and the western end and south-eastern edge. The mineralisation outcrops in the north-east before petering out against the basement high to the north. The basement at Arruwurra is a weathered basalt layer of the Peaker Piker volcanics. Thorntonia Limestone equivalent dolomites and dolostones overlay the basalt along the south-eastern and southern margin of the deposit. An abrupt change in lithology and depth to basalt basement indicates a probable fault which has thrown the deposit side upwards. A karst surface is present on the dolomite. There appears to be some chert-rich domains within the deposit, but chert is generally sparsely and patchily distributed through the Arruwurra Phosphorite. The Phosphorite is white to yellow-brown in colour and ranges from friable to indurated or porcellinous. Chert averages 10% to15% of the Phosphorite unit. The Arruwurra Phosphorite is overlain by and, near surface, interdigitates with a limestone carbonate unit in the north-eastern part of the deposit. Outcropping high grade phosphorites occur in this area. To the south-west the Arruwurra Phosphorite is overlain by the Hanging wall Mudstone unit of the Wonarah Beds, which comprise siltstones and mudstones with variable but minor chert. Towards the south-west this unit thickens and becomes patchy but increasingly ferruginous. Aeolian sand covers much of the area and is underlain by ferricrete, silcrete, and, above the carbonate unit in the north-east, calcrete and black soil.	Hydrogeological and Water Supply Investigations – Wonarah Phosphate Project Groundwater Resources Management (GRM) 2009 (Appendix C)
Deposit Geochemistry	Geochemical characterisation has been carried out on representative samples of the waste rock for both the Arruwurra and Main Zone deposits and the non-DSO by Environmental Geochemistry International Pty Ltd (EGi). Overall, the geochemical characterisation showed that acid rock drainage (ARD) will not be a concern for the project. However, there are some elements that occur at elevated concentrations in waste rock and non-DSO. Although their solubilities are expected to be low, phosphate, fluorine and beryllium will be included in site water quality monitoring programs. All samples tested were classified as non-acid forming (NAF) and about 40% of the waste rock composites were also barren with respect to sulfur (S) and acid neutralising capacity (ANC), having a total sulfur content of less than or equal to 0.05% and ANC less than or equal to 5 kg sulfuric acid (H_2SO_4) per tonne. Elemental analysis of selected waste rock composites indicated that phosphorous (P) and beryllium (Be) were enriched in most samples from the Arruwurra and Main Zone deposits. Phosphorous enrichment is to be expected given the mineralogy of the deposit and although beryllium was enriched when compared against median soil concentrations, the actual concentrations were not enriched compared to mean crustal abundance. Other elements showing	Wonarah Phosphate Project – Acid Forming Characteristics of Waste Rock Composite Samples from the Arruwurra Prospect and Main Zone and Low Grade Ore. Environmental Geochemistry International Pty Ltd (EGi) 2009 (Appendix D)

Item	Description	Reference
	significant enrichment in some samples were silver (Ag), calcium (Ca), cadmium (Cd), copper (Cu), magnesium (Mg), lead (Pb), thallium (Tl), uranium (U) and zinc (Zn). Testing showed that all the non-DSO samples were highly enriched in phosphorous and beryllium and half of the samples were also significantly enriched in calcium and uranium. The actual concentration of U in the low grade ore is lower than typically observed in rock phosphate ore. In addition, silver, cobalt (Co), lead and strontium (Sr) were enriched in some samples. Water extractions carried out on waste rock and non-DSO samples indicated only low solubility of dissolved constituents and that the majority of the environmentally significant elements were either at low concentrations or below the detection limit. Phosphorous showed very low solubility. However, there was some solubility of fluorine (F) in the samples. Fluorine is typically associated with phosphate and leaching of fluorine would be expected in these samples.	Draft EIS Wonarah Phosphate Project https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register/completed-assessments/register/wonarah-phosphate-mine-barkly-tableland
Soils, land systems and topography	Soils type: soils within the project area have been classified into four major soil classifications: Kandosols, Vertosols, Calcarosols and Rudosols. Kandosols and Rudosols dominate the sand plains within the project area, while Vertosols and Calcarosols are restricted to areas subject to inundation such as ephemeral lakes and calcareous plains, respectively. Land units: The project area is dominated by the Yelvertoft land system with minor occurrences of the Wonarah land system. Topography: the physical setting of the project can be characterised as relatively flat, open grasslands / woodland which are common across the Barkly Tableland. The landform of the project area has a general low relief, although small rocky outcrops are locally common. Across the Barkly Tableland there is generally only a very gentle relief, which varies less than 50 m in elevation from the highest to lowest point.	Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E)
Bioregion and significant biodiversity areas	The project area is located entirely within the Davenport and Murchison Ranges Bioregion and is within the phosphate rich 'Wonarah Beds' Site of Botanical Significance (SOBS). Frew River floodout swamps Sites of Conservation Significance (SOCS) is located approximately 70 km west of the project area. See Figure 4-1. Map of Project surrounding waterways, SOBS and SOCS.	Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E).
Flora	The Arruwurra mine area is on the Wonarah land system and is characterised by gently undulating land with lateritic red earths with *Eucalyptus brevifolia* woodland or *Eucalyptus* spp. (low mallees) – *Acacia* spp. shrubland. At a finer scale the flora surveys identified that the Mineral Lease is dominated by sand plains and the associated vegetation (Acacia, Grevillea and Hakea over Aristida and Triodia), open woodlands and the associated vegetation (Acacia, Eucalyptus, Hakea, and Melaleuca over Triodia), and rocky rises and the associated vegetation (Acacia, Eucalyptus over Triodia). Field surveys identified five vegetation communities within the MLs: • Sand plains supporting Eucalyptus and Acacia open woodland over hummock grassland. • Black soil and clay pan supporting coolibah low open woodland over grassland. • Calcareous plains supporting supplejack low open woodland over open grassland. • Ephemeral lakes supporting coolibah low open woodland over grassland. • Rocky rises supporting Acacia and mallee shrubland over hummock grassland. These vegetation communities are widespread and common across the Davenport Murchinson Ranges bioregion. See Section 2.2 for significant flora and introduced species.	Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E).

Item	Description	Reference
Fauna	See Section 2.2 for native and threatened fauna. Five introduced animals were recorded within the project area during site surveys: • *Camelus dromedarius* (camel) • *Bos taurus* (cow) • *Equus asinus* (donkey) • *Felis catus* (cat) • *Vulpes vulpes* (fox)	Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E).
Hydrogeology	<u>Aquifers and depth:</u> The project occurs within the central portion of the Georgina Basin and the Barkly Tablelands. The main aquifers on the Barkly Tableland comprises cavernous zones that are commonly weathered and fractured, within calcareous units of the Wonarah Formation and Camooweal Dolomite. Groundwater offers the only source of reliable water within the region and is recharged predominantly from rainfall infiltration. Groundwater levels in the MLs are variable and range from around 3 m to 103 m below ground level. This variability in groundwater level suggests a heterogeneous groundwater system, with poor hydraulic connections between aquifers. Watertable levels are below the base of the ore across the deposits, with the exception of a few isolated locations that show evidence of minor or perched waterbodies. <u>Yield:</u> Minor groundwater supplies were found within the vicinity of the Arruwurra deposit. Test pumping carried out show a modest aquifer transmissivity at the Arruwurra zone of about 15 m^2/d. The combined yield from the five short-term Arruwurra production bores is estimated at about 12.5 L/s, using standard methods. Good groundwater supplies were identified north of the Barkley Hwy with maximum bore yields of about 20 L/s. <u>Groundwater users:</u> The main aquifers on the Barkly Tableland have been used to provide domestic and stock water across the tableland for nearly a century. Ten existing boreholes lie within the vicinity of the MLs, all located along the Barkly Highway. Seven of these boreholes were installed by the Northern Territory Government for construction and maintenance of the highway. An additional six existing boreholes lie within a 10 km radius of the northern borefield; these bores were installed by Dalmore Downs Station for stock watering purposes. <u>Groundwater quality:</u> Groundwater quality is fresh to brackish ranging from 500 to 4,000 mg/L Total Dissolved Solids (TDS), with elevated concentrations of iron and silica in the bores north of the Barkley Hwy and at Arruwurra; boron was also high in the camp bore.	Hydrogeological and Water Supply Investigations – Wonarah Phosphate Project Groundwater Resources Management (GRM) 2009 (Appendix C)
Hydrology	<u>Drainage:</u> No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit (Figure 4-1). All of the site drainage lines nearby to the project are minor and ephemeral in nature and are likely to only carry runoff for short periods following significant rainfall events. Seasonally flooded swamps occur in the southwest of the project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding. Although a lack of surface water flow data exists for the project area, modelling of surface water flows in the project area for a 100 year average recurrence interval (ARI) flood event was undertaken based on local meteorological and topographic conditions and catchment areas and using data from the Ranken and Georgina rivers and a potential flow rate of 480 m^3/s. Under these modelled	Hydrological Baseline Assessment – Wonarah Phosphate Project Groundwater Resources Management (GRM) 2009 (Appendix B)

Item	Description	Reference
	flood conditions, the local drainage line of most concern to the project, which flows in a north-westerly direction towards Arruwurra deposit, floods an area greater than 1 km in width. Contributing factors to such extensive flooding include the large upstream catchment area of the watercourse and the lack of discernible channel. <u>Water Management:</u> The Project is located within the Daly Roper Beetaloo Water Control District Declared Beneficial Use for Agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater. <u>Water uses:</u> There is no major water storage, diversion or supply infrastructure or current surface water licences within the vicinity of the Project area. Any water use is for stock watering, with groundwater resources providing the main water source in the region.	
Land use	• The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 34 km to the north-east of the Arruwurra deposit The community has four houses and associated buildings and an Indigenous population that fluctuates from 2 to 30 people according to the season (Figure 1-1). • The project is located wholly within enhanced freehold Aboriginal land owned by the Arruwurra Aboriginal Corporation. • Land use mapping for the region indicates that surrounding areas are predominantly utilised for traditional indigenous use, such as hunting and gathering and access to and use of sacred sites. Beside traditional Indigenous use, the other main land use that the area has been used for is mineral exploration. The Wonarah phosphate deposit was identified in 1967, and exploration for phosphate resources has been carried out intermittently at Wonarah over the past 50 years.	NR Maps Draft EIS Wonarah Phosphate Project https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register/completed-assessments/register/wonarah-phosphate-mine-barkly-tableland
Historical mining disturbances	• The Wonarah phosphate deposit was originally identified in 1967. Between 1967 and 1970, IMC conducted regional mapping, geophysical drilling and testing activities and described a resource of 307 Mt at 18.98% phosphorite (P_2O_5) (AKD, 2005). During the mid-1980s, CRA Exploration Pty Ltd carried out further exploration activities to the south of the Wonarah deposit, however, it withdrew its interest in the deposit due to low phosphate prices and lack of infrastructure in central Australia at the time. • The project was acquired by AKD Limited (currently Indo Mines Limited) in 1998 from Rare Earths and Minerals Pty Ltd and Pilbara Chemical Corporation NL who had applied for licences over the area in 1997. The exploration leases within which the Wonarah deposit lies were granted to Indo Mines Limited and to a joint venture between Indo Mines Limited and Rio Tinto in 1998 and 2000, respectively. During the joint venture, lasting from March 1999 to December 2002, Rio Tinto continued exploration activities as manager and operator of the tenements (AKD, 2005). The joint venture ended after a prefeasibility study in January 2000 recommended that Rio Tinto not proceed with development of the project (Hackman et al., 2000). • Minemakers purchased exploration licenses EL9976, EL22168, EL24562 and EL26394 from Indo Mines Limited in October 2006 and consolidated them into Substitute Exploration Lease SEL26452, which was registered in September 2007. Following this Minemakers were granted ML27244 covering the project area. Minemakers undertook numerous RC and DD exploration drilling from 2009 to 2013. Rehabilitation of the drill holes was conducted from 2014 to 2015. • Minemakers undertook a bulk sample/trial mining operation at the Arruwurra deposit in late 2009. Approximately 164,000 m^3 of overburden and 2,430 m^3 of high-grade DSO were removed. A shipment of phosphate rock from the trial pit	Previous Minemakers MMPs for the Wonarah Phosphate Project.

Item	Description	Reference
	was sent to Ballance in New Zealand in mid-2010 and was used successfully in the manufacture of a fertilizer product. • Feasibility study and WPP EIS undertaken by Minemakers during 2009-2010, with approval granted to undertake the proposed work.	

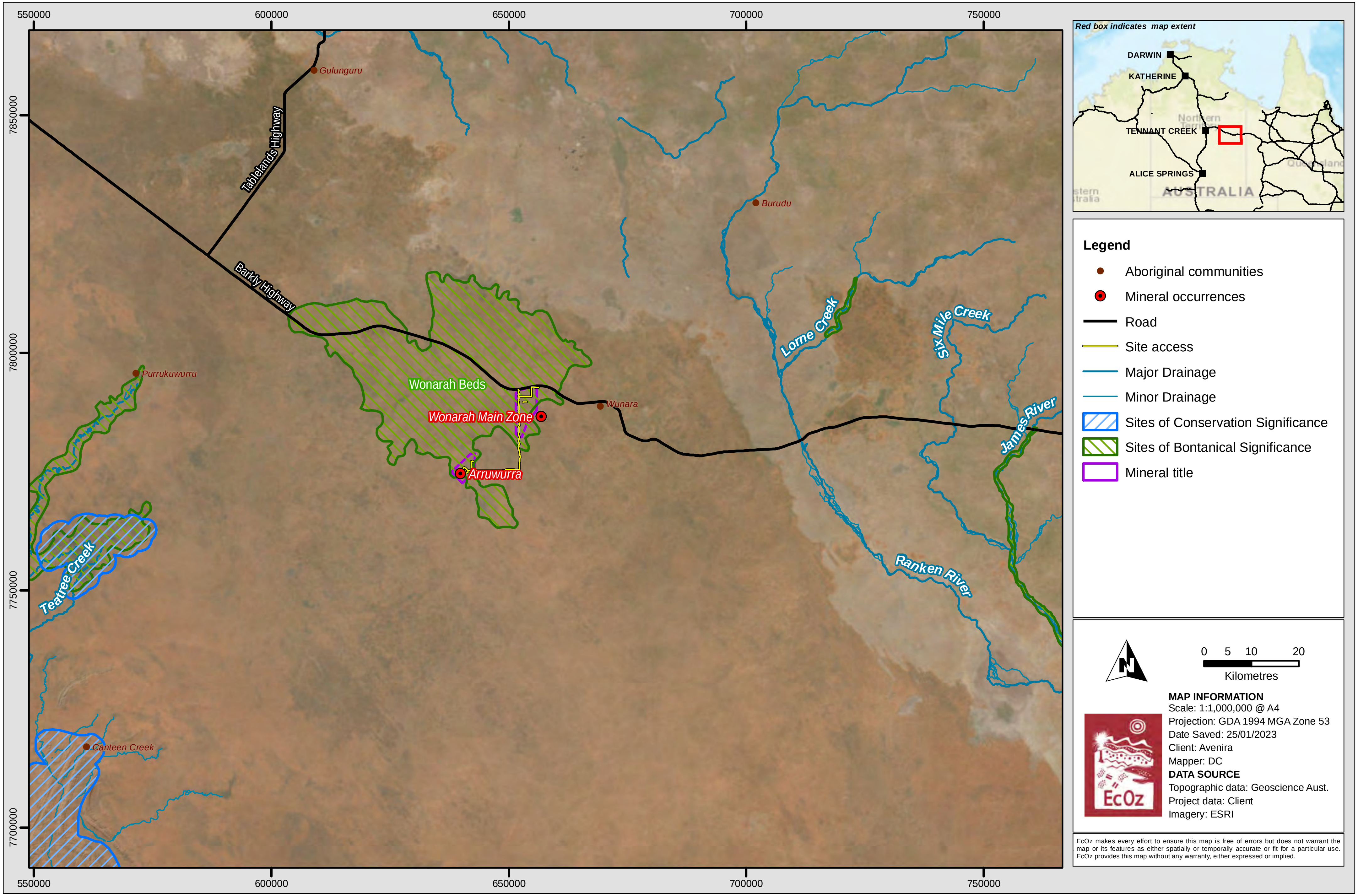

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Figure 4-1. Map of Project surrounding waterways, SOBS and SOCS

5 IDENTIFICATION OF ENVIRONMENTAL RISKS

5.1 Environmental and Cultural Risk Identification

<table>
<tr><th>Assessment Impact</th><th>Yes or No</th><th>Management Actions Required (if Yes)</th><th>Appended Information</th></tr>
<tr><td>Step 1:
Are there any threatened flora and fauna species or habitats of significance that may occur in the proposed work area?</td><td>Yes</td><td>No habitats of ecological significance were recorded during the field surveys undertaken by Low Ecological Services P/L (LES) 2009.

Flora species of conservation significance
No flora species of conservation significance listed under the EPBC Act were recorded in the project area, and none are considered likely to be present.
Eight flora species of conservation significance listed under the Territory Parks and Wildlife Conservation Act 1976 (TPWC Act) have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES 2009 field surveys and NT Flora & Fauna Atlas's) including;
Bergia barklyana. Listed as near threatened. B. barklyana plants were recorded at one survey site within low lying alluvial sand plain supporting open eucalypt woodland over hummock grassland. Dominant species were coolibah and bloodwood over spinifex. This area is within an Indigenous cultural exclusion zone.
Bonomia alatisemina. Listed as data deficient. A single plant has been recorded in the NT Parks and Wildlife Flora Atlas within Arruwurra deposit. No specimens were recorded during site surveys.
Distichostemon barklyanus. (now Dodonaea barklyanus) Listed as data deficient (now listed as least concern). A single specimen of D. barklyanus has been recorded 10 km south-east of the Arruwurra deposit prior to the current surveys. No specimens were recorded during site surveys.
Heliotropium ballii. Listed as data deficient. A search of the NT Parks and Wildlife Flora Atlas identified one record of H. ballii just inside of the main zone deposit, alongside the Barkly Highway. No specimens were recorded during site surveys.
Heliotropium pulvinum. Listed as data deficient. The NT Parks and Wildlife Flora Atlas records eight specimens of H. pulvinum in the project area surrounds. Records are scattered around the area with the closest record along the Barkly Highway. The March 2009 survey identified specimens within the Acacia shrubland.
Hibiscus brachychlaenus. Listed as near threatened. The March 2009 survey identified H. brachychleanus plants within the Arruwurra deposit. Specimens were found within the Acacia shrubland vegetation community. This species has not been recorded in the area before.
Sporobolus latzii. Listed as data deficient (now listed as vulnerable). One record of S. latzii is listed in the NT Parks and Wildlife Flora Atlas and this record is within an Indigenous cultural exclusion zone. This is the only known collection site of this species in Australia. Although targeted searches were performed as part of the surveys no specimens were identified.
Triumfetta deserticola. Listed as data deficient. A single record of T. deserticola has been recorded within the proposed Arruwurra pit; however, no plants were recorded as part of the June 2008 or March 2009 surveys.
A further six data deficient and one near threatened species were identified by the NT Parks and Wildlife Flora Atlas as falling within a 50 km radius of the project area; however, these species were not recorded during site surveys. The species were:
Acrachne racemosa (data deficient).
Crotalaria dissitiflora (data deficient).</td><td>Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E).</td></tr>
</table>

Assessment Impact	Yes or No	Management Actions Required (if Yes)	Appended Information
		• *Diplopeltis stuartii var. glandulosa* (data deficient). • *Gomphrena conica* (data deficient). • *Heliotropium concarpum* (data deficient). • *Najas marina* (near threatened). • *Synaptantha tillaeacea* (data deficient). Twenty-two species of regional or local significance were recorded during the site surveys, these species are all listed as of least concern under the TPWC Act. **Plant Species of Indigenous Value** Forty-four species of Indigenous utilitarian or cultural significance were recorded during the vegetation survey. Mature trees, especially coolibah and bloodwood, are culturally significant. The Central Land Council (CLC) classifies trees with a trunk diameter of greater than 12.5 cm and a height at least 1.5 m as significant; removal of trees meeting these criteria requires Traditional Owner approval, which will be sought as part of the Mining Agreement currently being negotiated with the Traditional Owners and Avenira. **Fauna** The protected matters report and search of the NT Parks and Wildlife Fauna Atlas identified 693 records of 163 species within the project surrounds. Twelve species were identified that are listed under the Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act*), including: • *Rostratula australis* (painted snipe), listed as vulnerable. • *Dasycercus cristicauda* (mulgara), listed as vulnerable. • *Macrotis lagotis* (bilby), listed as vulnerable. • *Epthianura crocea* (yellow chat), listed as vulnerable; however, it is the northern subspecies, *Epthianura crocea tunneyi*, which is listed. The inland species, *Epthianura crocea crocea*, recorded in the surrounding area, is not listed under the *EPBC Act* and is of least concern under the Territory Parks and Wildlife Conservation Act (*TPWC Act*). • Eight migratory bird species that are potentially present. None of these species were recorded during field surveys. A further eight species listed under the *TPWC Act* have been recorded within the project surrounds; two species (both listed as near threatened) have been recorded in the project area, *Rattus villosissimus* (long haired rat) and *Aspidites ramsayi* (woma). Field surveys identified no habitats of ecological importance. In general, the area does not exhibit any special features for biodiversity, however, two species of conservation significance were recorded during the field surveys, *Ardeotis Australia* (Australian bustard) (listed as vulnerable under the *TPWC Act*) and *Onychogalea unguifera* (northern nail-tailed wallaby) (listed as near threatened under the *TPWC Act*). Targeted surveys for species of conservation significance, especially bilby (*Macrotis lagotis*) and mulgara (*Dasycercus cristicauda or D.blythi*) where suitable habitat was identified, but no evidence was found. **Fauna of Indigenous Conservation Significance** Traditional Owners identified local fauna of cultural significance for their utilitarian values. Larger fauna species such as kangaroo, Australian bustard, sand goanna and other large dragons are still hunted by the Traditional Owners. The ephemeral lakes within the cultural exclusion zones (located outside of the MLs) are considered as an important hunting ground as they provide seasonal refuge to larger species. The Traditional Owners consulted during the March 2009 survey identified no species of mythical significance.	

Assessment Impact	Yes or No	Management Actions Required (if Yes)	Appended Information
Step 2: Are there any known declared weeds within the proposed work area?	No	Two environmental weed species were recorded in the project area, *Cenchrus ciliaris* (buffel grass) and *Aerva javanica* (kapok bush). Buffel grass was recorded in four isolated patches along the exploration track between the Main Zone and Arruwurra deposits, which were all low lying areas within the sand plains. Buffel grass occurs extensively outside the project area, especially along the Barkly Highway, where vehicles will be major vectors spreading seed into the project area. Buffel grass is regarded as a significant pastoral grass, a dominant land use in the Barkly Tableland, and continues to be sown for pastoral use today. Buffel grass has dramatically changed the vegetation structure and species composition of drainage systems in central Australia. As well as displacing native understorey species, Buffel grass increases the intensity of wildfires due to the high fuel loads it produces (Paltridge and McAlpin, 2002). An individual kapok bush was identified along the exploration track leading into the Arruwurra deposit in a shallow sand plain. Kapok bush is not considered a significant pest species on the Barkly Tablelands (Baker, 2005). Four declared weeds have been recorded within a 50 km radius of the project area. Several of these weeds are also a Weed of National Significance (WoNS) (bolded): • **Bellyache Bush (*Jatropha gossypifolia*)** • **Parkinsonia (*Parkinsonia aculeata*)** • Mossman River grass (*Cenchrus echinatus*) • Noogoora Burr (*Xanthium strumarium*) A weed management plan to restrict spread of these weeds into the project area is located in **Appendix J**. Declared weeds are to be managed in accordance with the *NT Weeds Management Act 2001 (WM Act).* In the NT, there are three classification types: • Class A - To be eradicated • Class B - Growth and spread to be controlled • Class C - Not to be introduced into the NT. All Class A and Class B weeds are also considered Class C. Weed management activities to prevent introduction and spread of declared weeds that will be implemented, as a minimum include: • All plant and equipment must be thoroughly cleaned prior to mobilisation to site and demobilisation from site at a designated wash-down area. Machinery used for clearing must be cleaned when moving between areas once on-site. • Undertake daily plant and equipment inspections, including weed inspections • No vehicles to drive off road • Undertake weed monitoring and control of high-risk sites (i.e. wash-down areas, disturbance areas, drainage lines) • Conduct weed control activities at suitable times of the year when the plant is actively growing and prior to seeding. Focus on outlier/isolated weeds and controlling the spread of declared weeds. • Inductions to include educational material such as weed alerts to efficiently detect and report declared weeds on-site. Avenira will refer to the following NTG resources for further weed spread prevention and weed control recommendations: • Weed Management Handbook Appendix A – Preventing Weed Spread (weed-management-handbook.pdf) • Vehicle Hygiene Brochure (vehicle-hygiene-brochure.pdf) • Preventing Weed Spread is everyone's business (preventing-weed-spread.pdf) Any sightings of new declared weed species in the Project area will be reported to the NTG Weeds Branch and steps taken to control and eradicate.	Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 (Appendix E). NRMaps Weed Records (accessed 5 Jan 2023)
Step 3:	Yes	It is estimated that 6 L/s, with a peak of 8 L/s will be required for construction of the bulk test sample and ancillary activities.	

Assessment Impact	Yes or No	Management Actions Required (if Yes)	Appended Information
Will you be using water from bores or other sources for the operation?		Thus, greater than 5 ML/yr groundwater extraction is required to be sourced from the nearby Arruwurra bore field on ML33344 for dust suppression and raw water for office ablutions. And from the Wonarah Main Zone area, ML33343 for camp supply. Bore locations for potential use are shown on Figure 3-1 and Figure 3-2. A groundwater extraction licence will be applied for under the *NT Water Act* and approved prior to extraction of >5 ML/yr per ML. The Pit will be dewatered to enable the bulk test sample to be extracted. This water will also be used for dust suppression activities and raw water for temporary mobile ablutions in the interim.	
Step 4: Is your project likely to have a significant impact on the environment?	No	NT EPA pre-referral screening assessment completed during January 2023. The proposed activities do not have potential to have a significant impact on the environment.	NT EPA Pre-referral Screening Report (EcOz 2023) (See Appendix F) Environmental Risk Assessment (Appendix G)
Step 5: Are there Aboriginal sacred sites in the Project area?	No	Sites of Indigenous and non-Indigenous cultural or archaeological significance have the potential to occur within the project area. [redacted] [redacted]	Draft EIS Wonarah Phosphate Project https://ntepa.nt.gov.au/your-business/public-registers/environmental-impact-assessments-register/completed-assessments/register/wonarah-phosphate-mine-barkly-tableland
Step 6: Are there archaeological and heritage sites in the Project area?	No	A search of the Australian Heritage Database and the NT Heritage Register identified no sites of non-Indigenous cultural heritage within the project area. Archaeological survey (Hill, 2009) identified [redacted] [redacted]	Proposed Minemakers Phosphate Mine (MLA 27244) Archaeological Survey Arruwurra Block-Barkly Highway NT (Hill 2009) (Appendix H)

5.2 Project Risk Assessment

A 'whole-of-project impact analysis and risk assessment' has been undertaken for the proposed bulk test sample and ancillary activities on mineral lease (ML) applications ML33344 and ML33343.

Risks have been largely identified based on the WPP EIS and supporting studies as the proposed disturbance activities are the same activities, but on a much smaller scale, intensity, duration and frequency for the proposed activities. The following environmental factors were identified as being potentially impacted:

- Flora
- Fauna
- Land use
- Air quality
- Groundwater
- Surface water
- Socioeconomic
- Noise and vibration
- Traffic and transport of ore
- Greenhouse gas emissions
- Landform, geology and soils
- Indigenous and non-indigenous cultural heritage.

For each environmental factor, activities that could cause impacts to environmental values (receptors) were identified. Potential direct and indirect impacts were then identified by considering cause and effect pathways for impacts to each environmental factor. The severity of each potential impact was assessed using the following criteria:

- Scale (extent)
- Intensity
- Duration and frequency.

The principles of qualitative risk management described in AS/NZS 31000:2009 Risk Management – Principles and Guidelines were used to set-up a framework for assessing which environmental impacts are potentially significant. The environmental risk assessment methodology that has been applied in this MMP is described below.

For each potential environmental impact identified, the risk assessment considered the likelihood of the impact occurring and then the worst-possible consequence to the environmental factors. The consequence assessment was informed both by the outcomes of the impact severity analysis, and the importance/sensitivity of environmental values.

Inherent risk

For each potential impact, an inherent risk rating was assigned by ranking the likelihood and consequence of the impact in the absence of any specific mitigation or management (i.e. it is a worst-case scenario). The inherent risk rating considered the project location and design, existing environmental conditions, impact sources and pathways, and the presence/absence of important and/or sensitive values and receptors.

Risk evaluation

Each inherent risk rating was evaluated with reference to the risk level and target action matrix to determine the level of mitigation and management attention required. Generally, the higher the inherent risk rating, the less tolerable/acceptable the risk is likely to be to stakeholders and regulators, and the greater the requirement for avoidance, mitigation and management.

Residual risk

Once all practicable mitigation and management measures were defined, each impact was re-assessed to assign a residual risk rating. The residual rating assigned to each impact reflects the level of risk that the project poses to the environment (assuming effective implementation of the mitigation and management measures).

Mitigation and management

Measures to avoid, mitigate and manage impacts were identified, focussing on impacts with an inherent risk level of medium or above. Impacts with a Low level of inherent risk were considered for further mitigation where routine controls would further contribute to risk minimisation. Suitable controls were generally identified with reference to mining best-practice guidelines, as well as from the past experience of the mining engineers and other technical experts engaged to work on the project.

Measures were applied with the goal of reducing all risks to 'as low as reasonably practicable' (ALARP). ALARP is considered to be the point at which the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.

Risk Registers

The risk registers compiled for each potential impact:

- Background information, existing environmental conditions and assumptions made in assessing the risk
- Inherent (unmitigated) risk
- Summary of controls
- Residual risk

A total of 47 risks were identified. Of these risks, there were four high inherent risks, 21 medium inherent risks and 22 low inherent risks. A summary of the high and medium inherent risks is outlined below. With controls implemented, all residual risks are reduced to low.

The four high inherent risks are associated with:

- Air quality – dust emissions causing a decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from vehicle movement on unsealed roads within the mineral lease.
- Flora - reduced habitat quality due to introduction and spread of weeds.
- Socio-economic - workforce influences on local community causing social disruption due to changes in population and demographics.
- Traffic and transport of ore - increased road traffic on major roads causing adverse effects on safety due to increased road traffic.

The 21 medium inherent risks identified are:

- Four risks associated with air quality from mining related activities.
- Six risks associated with flora and fauna impacts, from land clearing and mining related activities.
- One risk associated with groundwater contamination from hydrocarbon spills.
- Two risks associated with surface water; contamination from hydrocarbon spills and erosion and sedimentation as a result of land clearing.
- One risk associated with loss of heritage and impacts to culture sites of significance due to damage/disturbance of sacred sites and archaeology.
- Two risks associated with land use - restriction of AAC/Traditional Owner access to sites of cultural significance and for traditional hunting and gathering.
- Four risks associated with landform, geology and soils – reduction of soil quality due to inappropriate topsoil, waste dumps, stockpiles management, hydrocarbon spills, erosion and sedimentation and soil compaction.

- One risk associated with social-economic impact of increased availability and affordability of drugs and alcohol, with consequent negative social impacts.

The distribution of inherent and residual risk ratings for each phase of the project is summarised in Table 5-1. The residual risk ratings are show in bold and the inherent risk ratings are shown in (brackets) for reference. Management plans have been prepared to address the higher risk aspects.

Overall, the risk assessment indicates that the potential impacts associated with the project pose a low residual risk to environmental, social and cultural values.

Table 5-1. Environmental risk summary

Environmental Factor	Low	Medium	High	Very High	Total
Flora	**6** *(1)*	**0** *(4)*	**0** *(1)*	**0** *(0)*	6
Fauna	**5** *(3)*	**0** *(2)*	**0** *(0)*	**0** *(0)*	5
Land use	**2** *(0)*	**0** *(2)*	**0** *(0)*	**0** *(0)*	2
Air quality	**11** *(6)*	**0** *(4)*	**0** *(1)*	**0** *(0)*	11
Groundwater	**3** *(2)*	**0** *(1)*	**0** *(0)*	**0** *(0)*	3
Surface water	**3** *(1)*	**0** *(2)*	**0** *(0)*	**0** *(0)*	3
Socio-economic	**7** *(5)*	**0** *(1)*	**0** *(1)*	**0** *(0)*	7
Noise and vibration	**3** *(3)*	**0** *(0)*	**0** *(0)*	**0** *(0)*	3
Traffic and transport of ore	**1** *(0)*	**0** *(0)*	**0** *(1)*	**0** *(0)*	1
Greenhouse gas emissions	**1** *(1)*	**0** *(0)*	**0** *(0)*	**0** *(0)*	1
Landform, geology and soils	**4** *(0)*	**0** *(4)*	**0** *(0)*	**0** *(0)*	4
Indigenous and non-indigenous cultural heritage	**1** *(0)*	**0** *(2)*	**0** *(0)*	**0** *(0)*	1

The environmental risk register is in Appendix G. The register will be subject to review when there are substantial changes to proposed activities.

6 ACTIVITIES PROPOSED FOR THIS MMP

6.1 Bulk Test Sample

Mining Interests	ML33344
Location of bulk sample test pit	The sampling site will centre on the existing Arruwurra test pit area at 639700E 7774700N (MGA Zone 53)
Number of bulk sample pits	Existing: One – Existing Arruwurra Test Pit (approx. 2.8 Ha) • Total pit excavation 163,410 m^3 (survey data Arruwurra bulk sample – final volumes 18 December 2009). • Ore removed 2,430 m^3 (survey data Arruwurra bulk sample – final volumes 18 December 2009).
	Proposed: Initial small test pit for 5 kt of 10-50 mm product. Total additional disturbance is approx. **1.1 ha.** • Total pit excavation 87 kt o 5 kt DSO of 10-50 mm removed for test sample. o 8 kt BPH temporarily stockpiled. o 10 kt APH temporarily stockpiled. o 64 kt waste dump extension to existing facility.
Volume to backfill bulk sample pits (length x width x depth)(m)	87 kt and the existing test pit volume of 328 kt (164 kbcm with a specific gravity of 2) is a total of 415 kt to backfill the pit. Approximately 340 m L (north to south) x 130 m W (east to west) x 21m D
Bulk sample pits approved under Mineral Titles Act?	N/A – Mineral Titles were contacted in Q4 2022. Avenira were advised by Mineral Titles that approval is not required as Avenira propose to undertake the bulk test sample under an ML, not an EL.
Justification for sample type and size	A Thermal Phosphoric Acid (TPA) offtake partner is negotiating a DSO operation commencing in the second half of 2023. This will produce monthly product yields of 10-50 mm product totalling 25 kt per month in 2023 and 50 kt in 2024. Material required is high-grade indurated mudstone phosphorite (referred to as BPH). This is hard and more resistant than other phosphorite material, making it more suitable to retaining larger fragment size in the furnace used to create TPA. This test pit (**Figure 6-1**) was designed around the existing trial pit to reduce waste striping and utilises the existing ramp.
Details of split tonnage (if applicable)	The BPH horizon will be blasted, then hauled from the pit for crushing at a mobile crushing unit on the existing stockpile area adjacent to the bulk test pit. Crushing will be set at 50 mm with a 10 mm screen to remove undersize material. A product yield of ~70% of the BPH horizon is expected, which will be loaded into trucks and removed from site. The undersize will be stockpiled on the stockpile area adjacent to the crushing unit. This material will remain in place until either an offtake agreement is put in place to remove from site or the bulk test pit is successful, in which case it will be removed to the long-term storage area to the NW of the pit as will be detailed in the longer-term DSO MMP. It is expected there will be approximately 8 kt of this material. An upper unit of mudstone phosphorite (termed APH) is present above the BPH unit. This is softer and of lower grade. For the purpose of this bulk test pit the material also will be stockpiled on the stockpile area, being moved either when it is required for potential offtake testing or following approval of the DSO project. It is expected there will be approximately 10 kt of this material.
Detail of area to be cleared	For the purpose of this bulk sample test pit, the following disturbance footprint areas require clearing: <u>Pit:</u> Change to the batter angles to 60 degrees results in footprint within existing disturbance (see Figure 6-1) results in **no additional disturbance** (existing 2.8 ha).

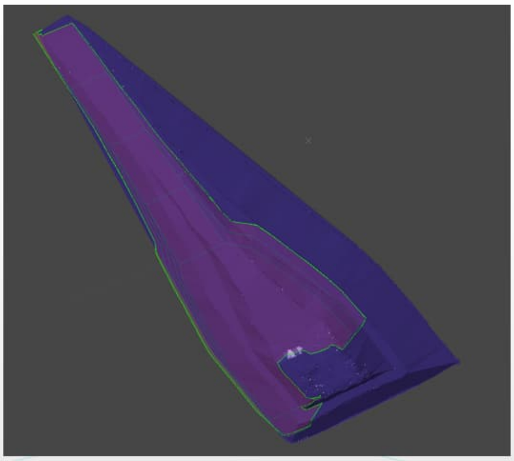
Mining Interests	ML33344
	Waste dump: For this stage the existing waste dump will be utilised Stockpile area and ROM pad: The stage 1.1 pit area being extracted in section 6.2 is to be cleared and used as a temporary stockpile/ROM area. Material on the existing stockpile area from the historic test pit will be used to surface the stockpile/ROM as a running surface and to avoid soil contamination of the product. Disturbance for this activity is **1.6 ha** Overflow will be temporarily stockpiled on the waste dump to minimise clearing requirements for the bulk test sample. BPH stockpile 8 kt of capacity is required APH stockpile 10 kt of capacity is required Pit Dewatering Storage area (Turkey's Nest): Due to the influx of water into the existing test pit during the recent wet season there is a need to extract water to allow operations to commence. This water is to be stored for use in dust suppression. The 0.8ha stockpile area from the historic bulk sample pit will be cleared, with ore stockpiles being moved onto areas of existing disturbance or to provide a surface to the proposed ROM/stockpile area to minimise product contamination. Office / laydown / fuel bay: Use of existing disturbance area previously used for office and workshop (0.8 ha). Haul road / access road: No haul road realignment is being undertaken for the test pit. Total disturbance footprint for bulk test pit area (additional to existing disturbance) and haul road realignment is approximately **1.6 Ha.**
Details of any associated ancillary works proposed	Existing access road is a total of 30.4 km in length and 23.7 ha (various width). During this trial test pit road repairs will be undertaken within the existing road corridor and fill taken from the footprint of existing borrow pits or from the waste dump. The road outside the MLs will be part of the AAC agreement and is subject to an access authority across Exploration Licences being held by Inca Minerals .
Description of excavation (blasting, method of extraction)	The excavation will utilise the existing bulk sample pit ramp plus an addition ramp to allow early and easier access to the ore face. Existing roads will be used from the previous bulk test pit. Extraction will commence with removal of topsoil from the pit, waste dump and stockpile areas, with material being used for building of bunds for safety and water inflow mitigation. Only minor drill and blast will be required for the caprock and the hard BPH ore horizon.
Details of any on-site beneficiation of processing proposed	Crushing will be set at 50 mm with a 10 mm screen to remove undersize material. Crushing and screening will occur in the existing stockpile disturbance area to minimise clearing required.
Details of any residue storage and/or disposal proposed	Existing WRD area will be utilised. The WRD height will be 20 m maximum.
Details of ore and waste rock characterisation and management	Overall, the geochemical characterisation showed that ARD will not be a concern for the project. However, there are some elements that occur at elevated concentrations in waste rock and non-DSO. Although their solubilities are expected to be low, phosphate, fluorine and beryllium will be included in site water quality monitoring programs (See Section 2.2 and Appendix D).
Radiation	As elevated radiation levels are sometimes associated with phosphate rock deposits, a suite of uranium assays have been undertaken on the lithologies of the deposit and routine radiometric logging has been undertaken, on a per metre basis, of every sample drilled. The results demonstrate that radiation levels are uniformly low for sediments in general and particularly so for sedimentary phosphates or phosphorites.

Mining Interests	ML33344
	While some uranium is present it is not in quantities above normal or 'safe' background levels; therefore, as no concentration or beneficiation of ore is proposed no specific management procedures are planned or warranted for the ore or waste materials. (See Section 5.3.4 Draft EIS WPP Project Description). https://ntepa.nt.gov.au/__data/assets/pdf_file/0010/286633/Ch_05_Project_Description.pdf
Details of any pending notifications for Referral or EIS	N/A. An EIS was undertaken during 2009 and approved in 2010 for the Wonarah Phosphate Project. This approval encompassed the two deposits, known as 'Wonarah' and 'Arruwurra'. See WPP Assessment Report 64 Minemakers Australia Pty Ltd (DNRETAS 2010).
Proposed production rate for final project	The mine plan being used for this bulk test pit is the first stage of extraction within this MMP It is expected that the 5kt component will take roughly 1 month to complete. The balance of this MMP is for a 35kt ore parcel which comprises the first part of a broader 300 ktpa DSO operation which is subject to broader operational DSO MMP approval.
Proposed timing of operation	Operations to commence mid-quarter two 2023 Duration 1 month for bulk test sample (June to July 2023)
Details for proposed transport of sample(s)	Final options are being considered for the trial test pit given the small volumes being extracted. The most likely option is currently to hauled along the site access road north to the Barkly Hwy then approximately 265 km west along the Barkly Hwy, to the Stuart Hwy T-junction, Then north 950 km to the Ostojic yard near East Arm in Darwin. Materials will be offloaded, containerised then transported 12 km to the Darwin Port at East Arm for shipping to Malaysia. Haulage will occur during daylight hours only.
Details of management of material	• 8 kt BPH (undersized material) and 10kt of APH will be temporarily stockpiled on the existing stockpile area and WRD area. This product will be rehandled to a new clearing to the main stockpile area when DSO MMP is approved pending success of bulk test sample. • Topsoil to be used as a bund surrounding the pit and any additional material will be stockpiled in the existing topsoil stockpile area.
Water demand and supply	• Water requirements are expected to be 6-8 L/s for the bulk test and ancillary activities. Water is required for dust suppression and potable/domestic use. Water from the pit sump and site bores will be used for dust suppression. Water from the camp bore will be used for potable/domestic use. • A groundwater extraction licence application will be completed for approval under the *Water Act*. • A groundwater level survey carried out at Arruwurra show levels mostly lie below the base of the ore. Dewatering requirements are therefore likely to be negligible, possibly limited to localized sump pumping to manage short-term seepage inflows.
Energy demand and supply	• Generators will be used to supply electricity for the operations. An existing generator in place for the existing 24-person camp.
Hazardous materials storage	• On-site fuel storage ~20,000 L self-bunded unit at the proposed office / laydown location. • No storage of explosives will be required for the bulk test sample, bring brought to site as required.
Domestic waste and sewage management	• Domestic waste will be buried at the previous onsite landfill located near the camp.
Accommodation facilities	There is an existing camp on the north end of main zone (Minadji) which was used by Jemena for the pipeline construction and is now owned by AAC. It currently houses 24 personnel and has offices and a dry mess. See **Figure 3-2** for camp location.
Number of Employees and Contractors required during bulk sample	It is estimated that 37 people will be required for the bulk test sample operations (staggered requirements): • Registered Manager x1 • Geologist x1 • Haulage Short Stay (for trucking cycle stoppage at Wonarah) x3 (after mining) • Contractor Medic / Trainer x1 • Mining Fleet A x 15 • Crushing x 6 (after mining) • Catering x 4 • Cleaning x 2 • Drill & Blast x 4

Mining Interests	ML33344
Rehabilitation	Rehabilitation of the access road areas outside of the realignment will be undertaken. This will involve ripping the areas to prevent access and seeding. Pending success of the bulk test sample, a larger scale DSO MMP will be proposed. This will involve backfilling a portion of the waste into the proposed pits. If the bulk test sample is unsuccessful and/or the proposed DSO operations do not proceed, Avenira Propose to leave the pit as a void, install a closure bund around the pit and rip and revegetate the disturbed areas. The waste dump and stockpiles will be recontoured, covered with 0.2 m of topsoil and revegetated with seed and supplemented with tubestock as required. See Section 8 for further details.
Other	N/A
Total proposed area of disturbance for bulk test sample and access road realignment	**1.6 ha**

Figure 6-1. Map of proposed Bulk Test Pit mining disturbances

Figure 6-2. Bulk Test Pit design - oblique view



	Tonnage (kt)
Waste	93.67
Ore	8.84
Total	102.51

Bench	APH	BPH	WST	TOTAL
260	-	-	795	795
255	-	-	9,609	9,609
250	-	-	19,836	19,836
245	10,000	-	24,965	34,965
240	28,462	8,839	-	37,301
Total	38,461	8,839	55,206	102,506

6.2 Initial DSO Operations

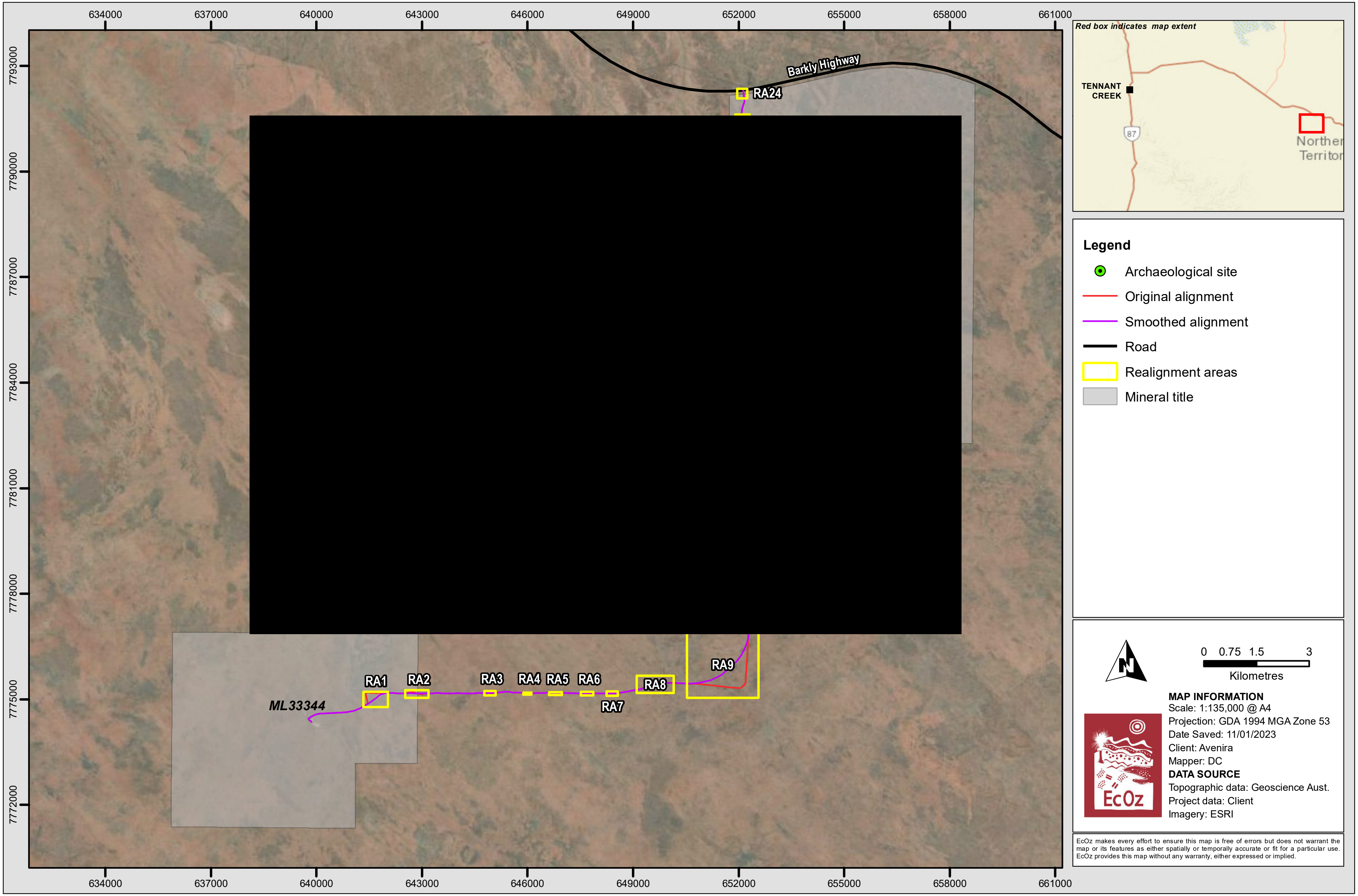
Mining Interests	ML33344
Location of bulk sample test pit	The sampling site will centre on the existing Arruwurra test pit area at 639700E 7774700N (MGA Zone 53)
Number of bulk sample pits	Existing: One – Existing Arruwurra 2009 Test Pit (approx. 2.8 ha) and 2023 Test Pit (1.1 ha) • 2009 Total pit excavation 163,410 m^3 (survey data Arruwurra bulk sample – final volumes 18 December 2009). • 2009 Ore removed 2,430 m^3 (survey data Arruwurra bulk sample – final volumes 18 December 2009).
	Proposed: Stage 1.1 Arruwurra Test Pit Extension. No additional disturbance due to use of footprint for ROM/stockpile area outlined in section 6.1 • Total pit excavation 579 kt o 35 kt DSO of 10-50 mm removed for test sample. o 38 kt BPH temporarily stockpiled. o 65 kt APH temporarily stockpiled. o 441 kt waste dump extension to new facility
Volume to backfill bulk sample pits (length x width x depth)(m)	579 kt (Stage 1.1 test pit) and the existing test pit volumes of 87 kt (2023 pit – see 6.1) and 328 kt (164 kbcm with a specific gravity of 2) is a total of 994 kt to backfill the pit. Approximately 340 m L (north to south) x 200 m W (east to west) x 21m D
Bulk sample pits approved under Mineral Titles Act?	N/A – Mineral Titles were contacted in Q4 2022. Avenira were advised by Mineral Titles that approval is not required as Avenira propose to undertake the bulk test sample under an ML, not an EL.
Justification for sample type and size	A Thermal Phosphoric Acid (TPA) offtake partner is negotiating a DSO operation commencing in the second half of 2023. This will produce 10-50 mm product at a monthly rate of 25 kt per month in 2023 and 50 kt in 2024. Material required is high-grade indurated mudstone phosphorite (referred to as BPH). This is hard and more resistant than other phosphorite material, making it more suitable to retaining larger fragment size in the furnace used to create TPA. Pit Stage 1.1 (**Figure 6-3**) was designed around the existing trial pits (2009 and section 6.1) to reduce waste striping and utilises the existing ramp, this pit will supply enough BPH ore for the first 35 kt shipment of product.
Details of split tonnage (if applicable)	The BPH horizon will be blasted, then hauled from the pit for crushing at a mobile crushing unit on the proposed waste dump area adjacent to the bulk test pit. Crushing will be set at 50 mm with a 10 mm screen to remove undersize material. A product yield of 70% of the BPH horizon is expected, which will be loaded into trucks and removed from site. The undersize will be stockpiled on the proposed DSO waste dump area adjacent to the crushing unit. This material will remain in place until either an offtake agreement is put in place to remove from site or the bulk test pit is successful, in which case it will be removed to the long-term storage area to the NW of the pit as will be detailed in the longer-term DSO MMP. It is expected there will be approximately 38 kt of this material. An upper unit of mudstone phosphorite (termed APH) is present above the BPH unit. This is softer and of lower grade. For the purpose of this bulk test pit the material also will be stockpiled on the DSO waste dump location, being moved either when it is required for potential offtake testing or following approval of the DSO project. It is expected there will be approximately 65 kt of this material.
Detail of area to be cleared	For the purpose of this stage 1.1 bulk sample test pit, the following disturbance footprint areas require clearing:

Mining Interests	ML33344
	Pit: No additional clearing is required due to the use of the existing test pit for access and the ROM/stockpile area from the bulk sample activities (section 6.1) being the pit footprint. Waste dump: A disturbance footprint of approximately **4.1 ha** will be required for the 441 kt of waste. This will be the northern half the proposed waste dump area . Stockpile area: The material to be stockpiled will be held temporarily in the waste dump area. This is to reduce additional clearing at this point in time and to allow for additional heritage surveys to be undertaken. This area will be adjacent to the waste dump area proposed above. BPH stockpile 38 kt of capacity is required APH stockpile 65 kt of capacity is required Office / laydown / fuel bay: Use of existing disturbance area previously used for office and workshop (0.8 ha). Haul road / access road: Haul road realignment was initially 23.7 km however has been significantly reduced in consultation with the haulage contractor. The haulage contractor believes the road will not require realignment from assessment of aerial photography, however for contingency 6km (25%) of the area has been retained in this MMP. This would comprise approx. **3.6 ha** of additional clearing required. Total disturbance footprint for bulk test pit area (additional to existing disturbance) and haul road realignment is approximately **7.7 Ha.**
Details of any associated ancillary works proposed	The realignment of existing site access road (see **Figure 6-4**) is proposed to smooth out bends to improve safety and reduce haulage costs and to mitigate against flooding. Existing access road is a total of 30.4 km in length and 23.7 ha (various width). Initially 23.7 km of the access road was identified as requiring potential realignment for heavy vehicle access. The haulage contractor has reviewed the aerial photography and stiulated that no realignment is definitely required, however checking during haulage for the bulk test pit (Section 6.1) will confirm this. Accordingly 6 km of the road has retained as being areas with tighter bends potentially requiring realignment. This is an additional approx. **3.6 ha** of disturbance required for a 6 m single lane width access road. Avenira has completed an additional Archaeological survey of the proposed realignment areas in preparation for this realignment. The previous archaeological survey (Hill, 2009) identified six sites of Aboriginal archaeological [redacted] Avenira will rehabilitate the existing access road that will no longer be part of the realignment. The road outside the MLs will be part of the AAC agreement and is subject to an access authority across Exploration Licences being held by Inca Minerals.
Description of excavation (blasting, method of extraction)	The excavation will utilise the existing bulk sample pit ramp to allow early and easier access to the ore face. Where possible existing roads will be used from the previous bulk test pits. Additional roads will be required to connect the pit to the waste dump and stockpiles which will take the shortest viable route. Extraction will commence with closing of the dewatering dam from section 6.1 and relocation of the stockpile/ROM from the bulk sample pit to the dewatering dam area. Removal of topsoil from the pit, waste dump and stockpile areas will be undertaken with material being used for building of bunds for safety and water inflow mitigation. Only minor drill and blast will be required for the caprock and hard BPH horizon.
Details of any on-site beneficiation of processing proposed	Crushing will be set at 50 mm with a 10 mm screen to remove undersize material. Crushing and screening will occur in the existing stockpile disturbance area to minimise clearing required.

Mining Interests	ML33344
Details of any residue storage and/or disposal proposed	Existing WRD area will be expanded to receive the additional 441 kt of waste material. The WRD height will be 20 m maximum.
Details of ore and waste rock characterisation and management	Overall, the geochemical characterisation showed that ARD will not be a concern for the project. However, there are some elements that occur at elevated concentrations in waste rock and non-DSO. Although their solubilities are expected to be low, phosphate, fluorine and beryllium will be included in site water quality monitoring programs (See Section 2.2 and Appendix D).
Radiation	As elevated radiation levels are sometimes associated with phosphate rock deposits, a suite of uranium assays have been undertaken on the lithologies of the deposit and routine radiometric logging has been undertaken, on a per metre basis, of every sample drilled. The results demonstrate that radiation levels are uniformly low for sediments in general and particularly so for sedimentary phosphates or phosphorites. While some uranium is present it is not in quantities above normal or 'safe' background levels; therefore, as no concentration or beneficiation of ore is proposed no specific management procedures are planned or warranted for the ore or waste materials. (See Section 5.3.4 Draft EIS WPP Project Description). https://ntepa.nt.gov.au/__data/assets/pdf_file/0010/286633/Ch_05_Project_Description.pdf
Details of any pending notifications for Referral or EIS	N/A. An EIS was undertaken during 2009 and approved in 2010 for the Wonarah Phosphate Project. This approval encompassed the two deposits, known as 'Wonarah' and 'Arruwurra'. See WPP Assessment Report 64 Minemakers Australia Pty Ltd (DNRETAS 2010).
Proposed production rate for final project	The mine plan being used for this bulk test pit is the Stage 1.1 pit outline from the broader 600 ktpa DSO operation which is subject to Mineral Licence and broader operational DSO MMP approval.
Proposed timing of operation	Operations to commence early quarter three 2023
Details for proposed transport of sample(s)	Ore will be hauled along the site access road north to the Barkly Hwy, approximately 265 km west along the Barkly Hwy, to the Stuart Hwy T-junction, and north along the Stuart Hwy for 105 km to the Bootu Creek Mine Railway Siding (pending approval). The ore will then go via rail to the Darwin Port for shipping to Malaysia. Haulage will occur during daylight hours only.
Details of management of material	• 38 kt of BPH and 65kt of APH will be temporarily stockpiled on the expanded WRD area. This product will be rehandled to a new clearing to the main stockpile area when DSO MMP is approved . • Topsoil to be used as a bund surrounding the pit and any additional material will be stockpiled in the existing topsoil stockpile area.
Water demand and supply	• Water requirements are expected to be 6-8 L/s for the bulk test sample Stage 1.1 and ancillary activities. Water is required for dust suppression and potable/domestic use. Water from the pit sump and site bores will be used for dust suppression. Water from the camp bore will be used for potable/domestic use. • A groundwater extraction licence application will be completed for approval under the *Water Act*. • A groundwater level survey carried out at Arruwurra show levels mostly lie below the base of the ore. Dewatering requirements are therefore likely to be negligible, possibly limited to localized sump pumping to manage short-term seepage inflows.
Energy demand and supply	• Generators will be used to supply electricity for the operations. An existing generator in place for the existing 24-person camp and will be upgraded to cater for a 52-person camp.
Hazardous materials storage	• On-site fuel storage ~20,000 L self-bunded unit at the proposed office / laydown location. • No storage of explosives will be required for the bulk test sample.
Domestic waste and sewage management	• Domestic waste will be buried at the previous onsite landfill located near the camp.
Accommodation facilities	There is an existing camp on the north end of main zone (Minadji) which was used by Jemena for the pipeline construction and is now owned by AAC. It currently houses 24 personnel and has

Mining Interests	ML33344
	offices and a dry mess. The planned expansion will upgrade to 52 people, so another 7 units (demountables) will be required for sleeping quarters and an additional laundry, an activities room and a wet mess, so an additional 10 units in total. There are existing septic and potable water setups on site which will be upgraded during the camp expansion. See Figure 3-2 for camp location.
Number of Employees and Contractors required during bulk sample	It is estimated that 46 people will be required for the bulk test sample operations: • Registered Manager x1 • Engineer x1 • Geologist x1 • Contractor Supervisor x1 • Contractor Admin x1 • Haulage Short Stay (for trucking cycle stoppage at Wonarah) x3 • Contractor Medic / Trainer x1 • Mining Fleet A x10 • Mining Fleet B x7 • Crushing x3 • Catering x8 • Cleaning x3 • Drill & Blast x4 • Admin x2
Rehabilitation	Rehabilitation of the access road areas outside of the realignment will be undertaken. This will involve ripping the areas to prevent access and seeding. Once the initial DSO operation has commenced, an MMP will be lodged for a broader 300ktpa DSO operation which will stipulate ongoing rehabilitation. This will involve backfilling a portion of the waste into the proposed pits. If the bulk test sample is unsuccessful and/or the proposed DSO operations do not proceed, Avenira Propose to leave the pit as a void, install a closure bund around the pit and rip and revegetate the disturbed areas. The waste dump and stockpiles will be recontoured, covered with 0.2 m of topsoil and revegetated with seed and supplemented with tubestock as required. See Section 8 for further details.
Other	N/A
Total proposed area of disturbance for bulk test sample and access road realignment	**7.7 ha**

Figure 6-3 Map of proposed stage 1.1 bulk test sample mining disturbances



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22138 - Wonarah MMP\1. Project Files\2. Report Maps\EZ22273\Proposed access road realignment.mxd

Figure 4-2. Map of proposed access road realignment and archaeological sites

Figure 6-5 Pit stage 1.1 - cross section east west

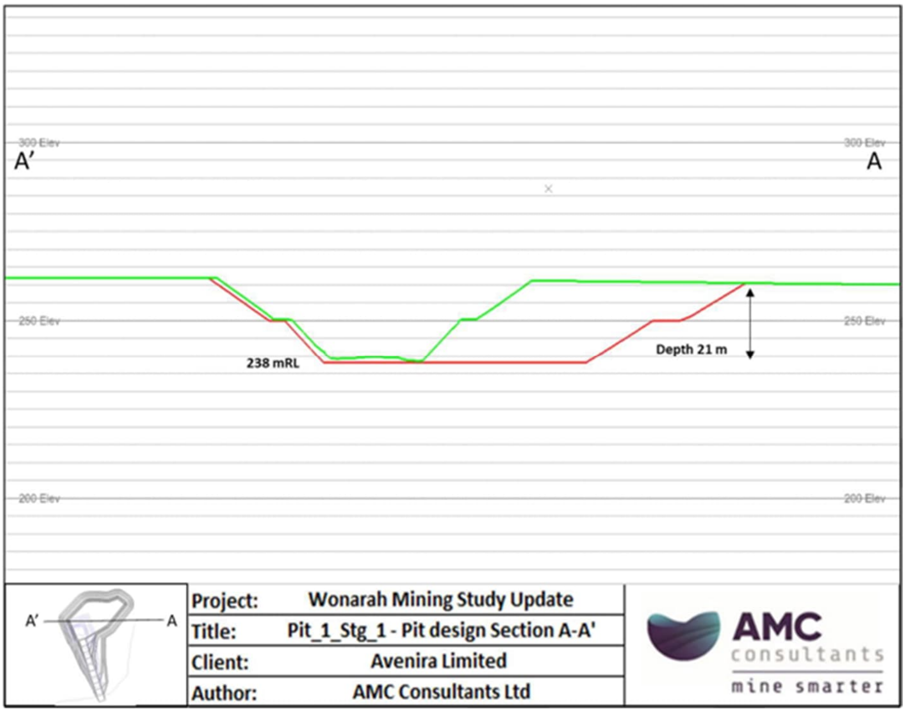


Figure 6-6 Waste dump 1 design - plan view

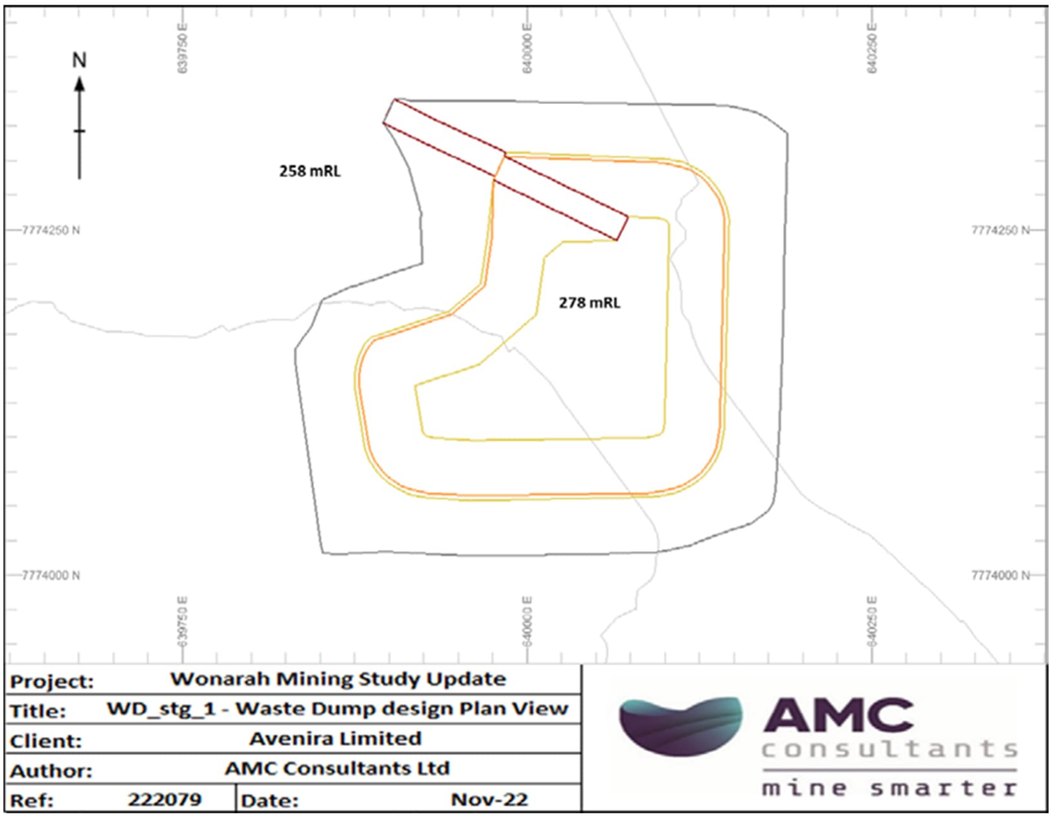
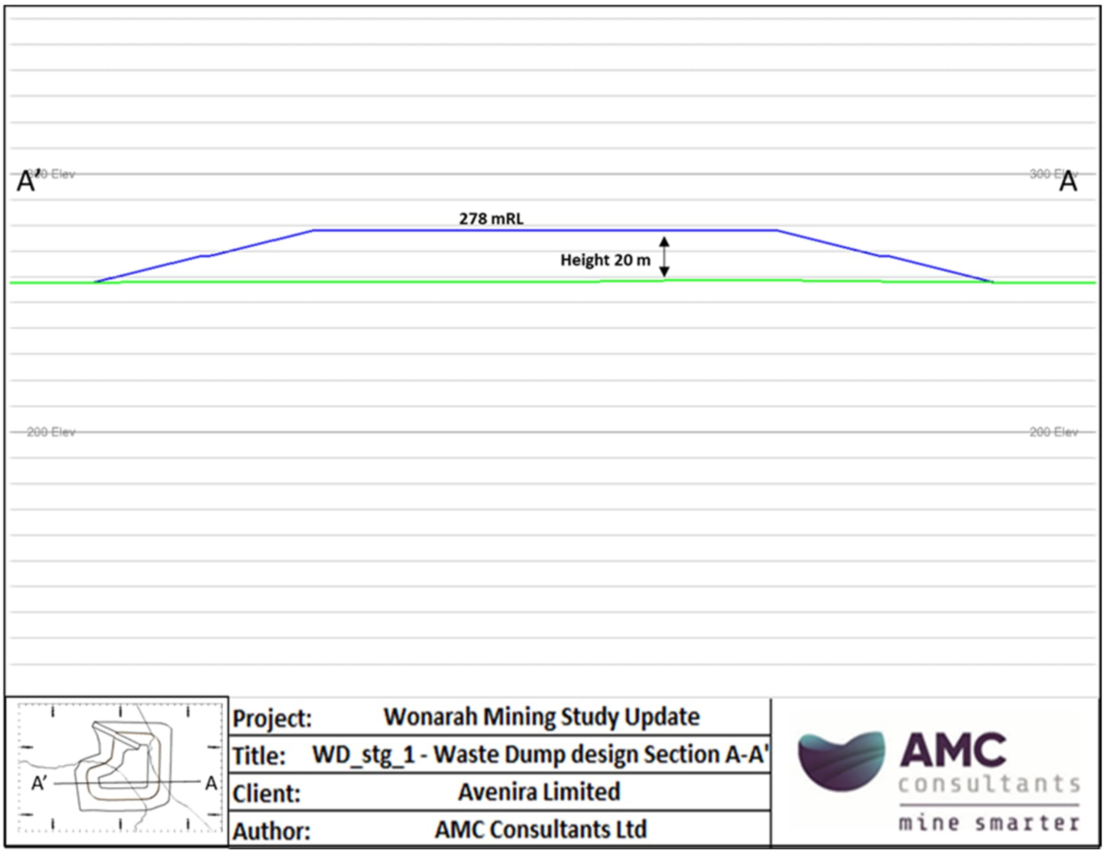


Figure 6-7 Waste dump 1 design – cross section east west



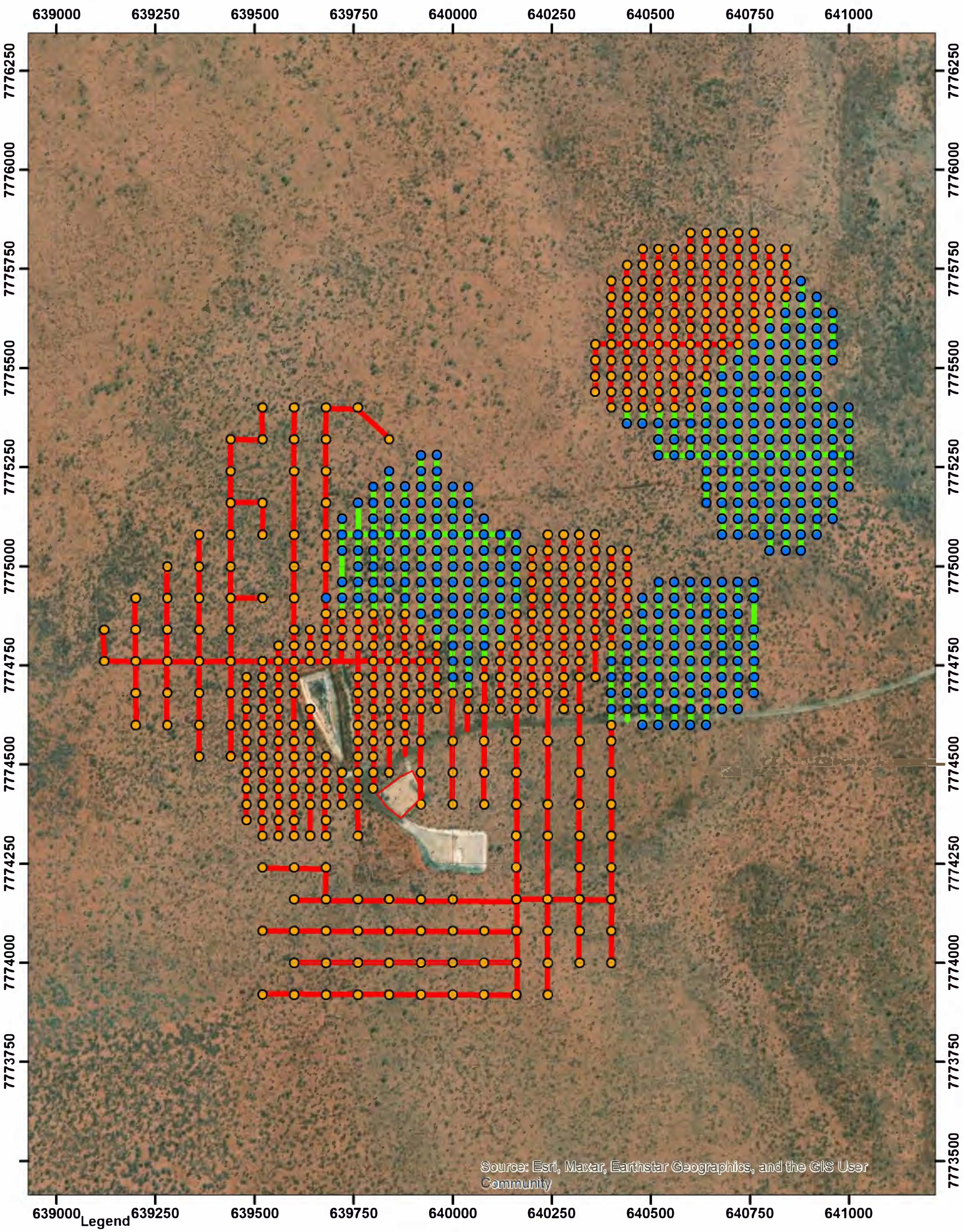
6.3 Grade Control Drilling

Mining Interests (i.e. titles)	ML33344	ML33343
Type of drilling (i.e. RAB, RC, Diamond, aircore)	Reverse Circulation – grade control	Nil
Number of proposed drill holes	Total 779 holes Priority A – 450 holes August 2023 Priority B – 329 holes November 2023	Nil
Maximum depth of holes	31m	-
Number of sumps (Length x Width x Depth m)	N/A	-
Number and size of drill pads to be cleared (Length x Width m)	Priority A – 450 x 20m x 6m = 5.4 ha Priority B – 329 x 20m x 6m = 3.95 ha	-
Total area of drill pads to be cleared (ha)	**Total 9.35 ha**	-
Number of proposed water bores	Nil	-
Is drilling likely to encounter groundwater in multiple or confined aquifers? (Y, N, unsure) If answering yes, please provide the number of exploration holes where this is likely to occur	No	-
Number of costeans (Length x Width x Depth m)	Nil	-
Volume to backfill costeans (Length x Width x Depth m)	N/A	-
Line/track clearing (Length kms x Width m)	Priority A – 24km x 4m = 9.6 ha Priority B – 14km x 4m = 5.6 ha	-
Area of proposed line/track clearing (ha)	**15.2 ha**	-
Camp area to be cleared (ha)	Nil	Nil – existing 2.5 ha disturbance sufficient for bulk test sample Stage 1.1
Camp Infrastructure (i.e. demountable, tents) Please provide a complete list with measurements as required in the security calculation	Nil	Total 10 demountable / units
Other:	Nil	Nil
Total proposed area of disturbance for grade control (ha)	**24.55 ha**	**-**

Proposed grade control drill hole details are provided in Table 6-1 and locations in Figure 6-8 and MMP excel attachment.

Table 6-1. Proposed grade control details

Depth	+1rod	Number of Holes	Number of Metres	Pit	Priority	Spacing
22	28	62	1736	1.1	A	40x40
22	28	21	588	1.2	A	40x40
25	31	53	1643	1.3	A	40x40
16	22	111	2442	2.1	A	40x40
20	26	75	1950	3	A	40x40
22	28	62	1736	1.4	B	40x40
22	28	45	1260	1.5	B	40x40
16	22	84	1848	2.2	B	40x40
23	29	84	2436	4	B	40x40
20	26	54	1404	5	B	40x40
24	30	52	1560	stockpiles	A	80x80
20	26	76	1976	waste dump	A	80x80
Total Priority A Holes		**450**	**11895**			
Total Priority B Holes		**329**	**8684**			



Legend

Grade Control Drilling

Priority

- A
- B

Grade Control Access

Priority

- A
- B

WONARAH GRADE CONTROL

0 0.1 0.2 0.4 0.6 0.8 km

N

AVENIRA LIMITED

AUTHOR: S. Harrison DATE: 19/12/22 SCALE: 1:12,500 MAP REF: Map Reference FIGURE: 6-7 A4

7 ENVIRONMENTAL MANAGEMENT SYSTEM

7.1.1 Overarching Environmental Objectives

Overarching factors and objectives applicable to project are adopted from the NT EPA Environmental impact assessment, general technical guidance - environmental factors and objectives (DEPWS 2021). These are applicable as identified in Section 5 – environmental risk identification and assessment and through the EIS process. The eight applicable environmental factors and objectives are:

Terrestrial environmental quality: Protect the quality and integrity of land and soils so that environmental values are supported and maintained.

Terrestrial ecosystems: Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

Hydrological processes: Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.

Inland water environmental quality: Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.

Air Quality: Protect air quality and minimise emissions and their impact so that environmental values are maintained.

Atmospheric Processes: Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.

Communities and economy: Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.

Culture and Heritage: Protect sacred sites, culture and heritage Cultural and heritage.

7.1.2 Environmental Commitments

The NT EPA Assessment Report 64 recommendations from the 2010 Minemakers WPP EIS are outlined in Table 7-1 below. Avenira will ensure that the recommendations relevant to the current proposed project activities are adhered to throughout the applicable phases of WPP. For this MMP, a number of these will not be applicable until the future DSO MMP is in operation following success of the bulk test sample.

Table 7-1. NT EPA Assessment Report 64 recommendations and status

Recommendation	Description	Status
1	Minemakers* shall ensure that the proposal is implemented in accordance with the proposed environmental management measures, environmental commitments and safeguards identified in the Wonarah Phosphate Project draft Environmental Impact Statement, Supplement (Coffey Environments, 2010b), and in the Assessment Report (No. 64) (DNRETAS, 2010). All safeguards, mitigation measures, and commitments outlined in the draft Environmental Impact Statement and Supplement are considered as commitments of Minemakers and will be incorporated into the Mining Management Plan.	When the WPP is developed in accordance with the proposed scale and activities outlined in the EIS, Avenira will commit to implementing all the relevant environmental management measures, environmental commitments and safeguards identified in the EIS and in the Assessment Report (No. 64) (DNRETAS, 2010).

Recommendation	Description	Status
2	Minemakers shall advise the Minister of any changes to the proposal in accordance with clause 14A of the *Administrative Procedures of the Environmental Assessment Act*, for determination of whether or not further assessment is required.	The proposed bulk test sample and ancillary activities are within the constraints of the approved WPP EIS, and no significant changes are identified. As part of this bulk test sample MMP, a NT EPA Pre-referral screening assessment was undertaken to identify any potential impacts to the environment that have not previously been addressed. No additional environmental impacts were identified (**Appendix F**).
3	Minemakers shall continue to refine the mine plan and sequencing over the mine life to identify potential increases in backfilling and commit to backfilling where possible. Minemakers shall demonstrate maximisation of backfilling by providing detail of developments of the mine plan and sequencing, to be reported into the Mining Management Plan for the Project.	Avenira will develop the DSO MMP and sequencing to ensure backfilling of pits is maximised. This will be pending the success of the bulk test sample and future DSO MMP approval.
4	Minemakers shall explore options to create natural profiles to the legacy waste rock storages and pits, to maximise visual amenity of legacy mine landscape. Consultation with a landscape designer is recommended. Creation of a 3-dimensional model of the proposed legacy landscape is recommended, to facilitate consultation discussions of legacy landscape profiles.	Avenira will continue to develop the mine closure and rehabilitation plan throughout the life of the mine. Initial rehabilitation and conceptual mine closure details are provided in Section 8 and 9.
5	Minemakers shall continue to consult with the Central Land Council and traditional owners to fully account for and minimise to the greatest extent possible all negative environmental legacies and loss of amenity from the Project to current and future generations of traditional owners. The results of consultations shall be incorporated into mine closure and rehabilitation planning, and the Mining Management Plan for the Project	Avenira will continue consultation with the AAC during the current MMP period.
6	Minemakers shall establish an on-site nursery, to optimise practical revegetation logistics and Project rehabilitation trials, and to facilitate Indigenous employment. Details shall be presented in the Mining Management Plan for the Project.	Pending success of the bulk test sample, details of a nursery established onsite, rehabilitation trials and facilitating indigenous employment will be included in the future DSO MMP approval.
7	Minemakers shall create an auditable plan and timeline for rehabilitation trials, including seed bank investigations and testing of seed viability, for inclusion into the Mining Management Plan for the Project.	Specific closure criteria will be further refined in consultation with relevant stakeholders throughout operations. Pending success of the bulk test sample, details of rehabilitation trials, including seed bank investigations and testing of seed viability will be included in the future DSO MMP approval.
8	Minemakers shall follow the Guidelines: • Native seed storage for revegetation (Florabank, 2010), with regard to storage of seed. • Weed Management on Mine Sites (DoR, 2010b) with regard to weed management planning.	The most relevant and up-to-date guidelines have been used for weed management and mine site rehabilitation and incorporated into future rehabilitation and mine closure plans for the DSO MMP. The Weed Management Plan is located in **Appendix J**

Recommendation	Description	Status
9	Minemakers shall establish Best Practice treatments to prevent erosion and control drainage of Waste Rock Storage slopes, appropriate to the semi arid environment. These shall be included in the Mining Management Plan for the DSO Project.	Avenira will implement Erosion and Sediment Controls in accordance with IECA (2008). *Best Practice Erosion and Sediment Control* - International Erosion Control Association (IECA) guidelines. The Erosion and Sediment Control Plan is located in **Appendix K.**
10	As a component of rehabilitation trials, Minemakers shall analyse whether topsoil seed banks to be applied to surfaces particularly vulnerable to erosion, such as Waste Rock Storage slopes, contain sufficient appropriate seed types to provide a quick stabilising role to protect topsoil and underlying soil profiles from erosion from the first heavy Wet season rains. Minemakers shall propose in the Mining Management Plan, contingency stabilising rehabilitation works to be applied in the absence of sufficient species being present within seed banks to stabilize soil profiles.	Avenira will undertake revegetation and rehabilitation trials on disturbed areas throughout the life of the mine to evaluate the most effective rehabilitation techniques. This will be included in the DSO MMP pending success of the bulk test sample. Avenira will commit to undertaking assessment of topsoil for seed content and viability. However, in the case of insufficient vital seeds, Avenira will commit to reseeding with native vegetation during rehabilitation.
11	Minemakers shall develop the Erosion and Sediment Control Plan (ESCP) for the Project in consultation with the Land Management Unit of DNRETAS (as per Section 4.7.4 of the Supplement), prior to inclusion of the ESCP into the Mining Management Plan.	Avenira will prepare an ESCP in consultation with the relevant NTG departments for the DSO MMP pending success of the bulk test sample. An ESCP for the Bulk Test Sample MMP is located in Appendix 44 of Appendix E of the MMP and further information been provided as **Appendix K**.
12	Minemakers shall be aware of potential necessity for a rehabilitation, revegetation and monitoring program spanning a number of decades to meet all post-closure outcomes agreed to in Minemakers consultations with traditional owners. Calculation of environmental securities should reflect potential long-term requirements for monitoring and maintenance.	Maintenance of the site will continue until all lease conditions and completion criteria have been met. A security calculation has been provided in **Appendix I** that includes costs for 10 years monitoring.
13	Minemakers shall present details of the proposed timing and frequency of routine surveys for near threatened and data deficient flora species in the Mining Management Plan.	Given the time since the EIS approval (12 years), Avenira will undertake an updated desktop ecological assessment of the proposed DSO disturbance footprint and provide updated recommendations for ecological surveys as required to address this item. Avenira commits to undertake a desktop ecological assessment prior to DSO works commencing. A Pre-clearance Checklist for the Bulk Test Sample is provided in **Appendix L**
14	Minemakers shall develop appropriate survey schedules for flora species of conservation significance, including data deficient species, in consultation with the threatened species officer and Herbarium DNRETAS. Details shall be provided in the Mining Management Plan for the Project.	Given the time since the EIS approval (12 years), Avenira will undertake an updated desktop ecological assessment of the proposed DSO disturbance footprint and provide updated

Recommendation	Description	Status
		recommendations for ecological surveys as required to address this item. Avenira commits to undertake a desktop ecological assessment prior to DSO works commencing. A Pre-clearance Checklist for the Bulk Test Sample is provided in **Appendix L**
15	Minemakers shall undertake regional and seasonal studies of data deficient flora species which may be present on-site, to better understand their regional / seasonal context within the Project Area. Survey results shall be included in the Mining Management Plan, and supplied to Biodiversity Conservation DNRETAS in appropriate digital format.	Given the time since the EIS approval (12 years), Avenira will undertake an updated desktop ecological assessment of the proposed DSO disturbance footprint and provide updated recommendations for ecological surveys as required to address this item. Avenira commits to undertake a desktop ecological assessment prior to DSO works commencing. This assessment will provide recommendations for the requirements for additional studies.
16	Minemakers shall explore potential for minimising (such as overlapping) statutory and non-statutory vegetation clearing corridors required for the various utilities to be placed beside proposed roads. Prompt revegetation of corridors shall occur where continued vegetation clearance is not required.	Avenira will minimise vegetation clearing associated with utility and road corridors wherever possible. Revegetation will be as per the rehabilitation and mine closure plan, which will be further developed for the DSO MMP.
17	Minemakers shall revise proposed standard operating procedures for management of fauna road-strikes to fully address animal-welfare and safety objectives, including: • Risk of leaving large animal carcasses on the road, which presents risks of causing further accidents for other road users, particularly at night, on un-lit highways. • Risk of attracting scavenger fauna, such as eagles, and kites onto the highways risking further fauna strikes, and further accidents for other road users. • Avoiding preventable fauna deaths by providing effective procedures for rescue of injured wildlife, and /or recovery and care of orphaned wildlife that may still be present in the pouch of a freshly killed or injured parent.	A Fauna Management Plan to address potential road risks is located in **Appendix M**.
18	Minemakers shall inspect all vehicles, equipment, goods and machinery transported from Northern Queensland on entry to the mine site to ensure no mosquito larvae are present in any open reservoirs or pockets containing water. Any mosquitoes found breeding in transported machinery etc. shall be sent to Medical Entomology, Department of Health and Families for identification. The water holding receptacle is to be subsequently treated with a 10% chlorine solution or residual insecticide such as lambda-cyhalothrin.	Avenira commit to inspecting vehicles equipment, goods and machinery transported from Northern Queensland for mosquito larvae.
19	Minemakers shall continue to seriously consider measures to reduce greenhouse gas emissions from the	As part of the future DSO MMP, Avenira will deliver a greenhouse

Recommendation	Description	Status
	Project through identification of further opportunities to improve energy efficiency and utilise alternative, lower emission energy options. Minemakers shall consult with DNRETAS on opportunities to offset greenhouse gas emissions in the Northern Territory.	gas emissions assessment report and identify opportunities to improve energy efficiency and utilise alternative, lower emission energy options.
20	Minemakers shall identify measurable auditable outcomes for the Industry Participation Plan (IPP), and include these in the Mining Management Plan for the Project.	Avenira will report on key metrics for the project, as per the Industry Participation Plan, to the Northern Territory Government in the future DSO MMP.
21	Minemakers shall formulate a traffic management plan, identifying risks, potential scenarios, monitoring and contingency management measures to be applied. Minemakers shall consult with Road Network Division, Department of Lands and Planning to resolve any road related issues associated with the Project. Consultation should clarify appropriate: • Procedures for responding to significant traffic incidents. • Procedures for reporting of significant incidents. • Detail for the Traffic Awareness Program, prior to its delivery to members of Indigenous communities. • Liability for repairs or preventative maintenance of road degradation. • Requirements for, and design of any upgrades of road infrastructure, such as lighting of intersections. • Safe interaction of the haul trucks with tourist traffic, such as slower vehicles towing caravans, or vehicles wishing to overtake. • Management of driver fatigue and distraction. Any other road or traffic related issues for the Project. Minemakers shall include the Traffic Management Plan in the Mining Management Plan for the Project.	Avenira has prepared a draft traffic management plan for the project to address these items for submission to DITT and DIPL prior to haulage operations commencing. This will be updated and finalised for the larger scale future DSO MMP. The draft Traffic Management Plan is provided in **Appendix P**.
22	Minemakers shall include a commitment to maintaining groundwater quality, and include details of the groundwater monitoring program in the Mining Management Plan for the Project. Minemakers shall commit to ongoing evaluation of groundwater quality and depth data, and verification/refinement of the existing groundwater model for the Project area	Avenira will conduct a site verification of the bore network for inclusion in the Water Management Plan (WMP) that will be developed for the DSO MMP. The WMP will include details of the water use, management and monitoring associated with groundwater. The Groundwater Monitoring Program is located in **Appendix Q**.
23	Minemakers shall prepare a formal biennial report and review the groundwater monitoring program every two years with particular consideration to the comparison of modelled and observed data. The report shall be included as part of the Mining Management Plan and forwarded to Water Resources DNRETAS. The report shall include as a minimum: monitoring data, data analysis and updates of model predictions of drawdown and recharge.	A requirement for biennial review and reporting of the groundwater monitoring program is included in the Groundwater Monitoring Program (**Appendix Q**).
24	If groundwater extraction impacts on other groundwater users, Minemakers shall provide another water supply by one or more of the following: • Deepening existing bores. • Providing additional bores. • Determining a new area suitable for groundwater extraction. • Trucking adequate water supplies to affected parties.	Mitigation and management measures for groundwater impacts are included in the Groundwater Monitoring Program (**Appendix Q**).

Recommendation	Description	Status
	• Piping adequate water from its bores to a location required by affected bore user.	
25	Minemakers shall investigate opportunities to maximise the efficient use of water on site including reusing treated effluent; minimising sources of dust generation to reduce requirements for dust suppression; and using any stored water in pits as a seasonal supplement. Proposed measures are to be included in the Mining Management Plan for the Project.	Avenira will continue to investigate and implement measures to maximise the efficient use of water on site. Details are provided in the Surface Water Management Plan (**Appendix Q**) Details are provided on dust and air quality in **Appendix R**.
26	Minemakers shall report to the Department of Resources all incidents of overtopping of sediment ponds and release of water. Water quality of discharge water shall be monitored, and reported. Discharges from water holding structures travelling off the Mining Lease may potentially require a waste discharge licence, and must be reported to Environmental Operations section of DNRETAS, and to the Department of Resources.	Noted – not relevant for the bulk test sample activities. However, the future DSO MMP will include commitments for Avenira will report any overtopping of sediment ponds and release of water to DEPWS and DITT. Details are provided in the Surface Water Management Plan (**Appendix Q**)

** Note the proponent for the project at the time of AR64 being published was Minemakers. Where Minemakers is referred to in the recommendations, it is taken to mean the person or company undertaking the action, therefore Avenira take on these recommendations.*

7.1.3 Environmental Management Plans

An environmental protection management system has been developed in Table 7-2 below for each of the relevant factors and potential risks of the proposed bulk test sample and ancillary mining activities. All environmental incidents will be reported to the Department in accordance with Section 29 of the *Mining Management Act.*

Table 7-2. Environmental protection management system

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
Terrestrial environmental quality:	Protect the quality and integrity of land and soils so that environmental values are supported and maintained.	Erosion and sediment	• Minimise erosion of cleared areas and constructed infrastructure (i.e WRD, topsoil, stockpiles)	• Vegetation clearing during, and immediately after rainfall events, will be avoided • Vegetation clearing will be kept to the minimum required to safely traverse vehicles and drill rigs along tracks and drill pads • Implementation of erosion and sediment controls (ESCs) in accordance with IECA (2008) • Restrict land clearing to the minimum required for the project • Progressive clearing of sections of the project footprint only when the area is required • Delineate area to be cleared prior to clearing	• Controls in place in accordance with ESCP • Effectiveness of controls is maintained • No signs of significant erosion of stockpiles or work area • No vegetation clearance or ground disturbance outside of the approved footprint	• End-of-Dry season inspection of all drainage and erosion and sediment controls to identify any issues or maintenance requirements • Inspection of erosion and sediment controls and infrastructure as soon as practicable following significant rainfall events (i.e. > 25 mm).	• Review ESC measures and develop site-specific Progressive ESCPs • Engage Certified Practitioner (CP)ESC advice for significant erosion • Review processes of land disturbance to assess system failures	• Site Inspection Register • Report to regulators in accordance with approval and licence conditions. • Incident register – documenting any unauthorised clearing • Monitoring results reported in annual environmental mining reports (EMR) to DITT

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				• Develop and adhere to a land clearing schedule • Blade-up approach for clearing will be used (i.e. no windrows, leave root stock and topsoil) • Where blade-up techniques cannot be employed, topsoil and vegetation will be stockpiled appropriately for rehabilitation purposes • Significant vegetation will be avoided during clearing (i.e. large trees, specimens providing habitat or food sources, riparian vegetation, and threatened species)				
		Waste (non-mineral)	• Reduce waste disposed of in landfill by implementing alternate waste management options to reduce , reuse and recycle. • Prevent wind-blown waste • Prevent occurrence of pest and vermin	• Waste kept in lidded bins and transferred to landfill at camp on a regular bases • Camp landfill regularly covered with soil • Management of pests and vermin • No disposal of hazardous materials in landfill, removal off-site to an approved and licenced waste management facility in Tennant Creek	• No visible wind-blown waste • No noticeable increase in the presence of pest or vermin surrounding the landfill and camp area • No contamination of water from waste leachates	• Monitoring of landfill and waste segregation areas – conduct audit on a monthly basis • Incidental observations of new pest species in the project area • Seepage monitoring of landfill	• Waste management included in site inductions and training • Incident register • Controlled landfill facility by restricted access i.e. locked gate • Review waste management measures	• Waste register • Incident register • Pest Monitoring & Control Log

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
			• Protect water quality from waste leakages	• Reduce, reuse and recycle measures to be adopted where possible • Designated and signed area for segregating waste	• Waste register indicated reduction of waste produced.		• Conduct pest and feral animal control programs • Fence establishment for pest animals	
		Hydrocarbon and hazardous materials	• No hydrocarbons contamination of soil or water	• Hazardous substances (including hydrocarbons) will be stored and handled in accordance with relevant Australian Standards • Hydrocarbons will be stored in lined and bunded areas • Surround storage areas for fuels and oils with an impervious bund that contains 120 % of the largest container stored in the bund, as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately sized to manage the volume of fuels that could be spilled • Hydrocarbon spills will be minimised using liners and drip trays under machinery, and	• No incidents of significate spills (volumes >200L or a spill that risks pollution of waterways) • Reporting of minor spill and corrective actions implemented to prevent reoccurrence	• Regular inspection of site for signs of spills • Weekly check that spill containment equipment kits are stocked • Recording of incidents and implementation of corrective actions	• Investigate cause of spill and update procedures as necessary • Remediate contaminated site	• Site Inspection Register • Incident register • Monitoring results reported in annual environmental mining reports (EMR) to DITT • Report to regulators in accordance with approval conditions.

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				appropriately sized spill-kits available in the event of a spill				
Terrestrial ecosystems	Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	Weeds	• Minimise the potential for introduction and spread of weeds	• Management of weeds in accordance with the NTG Weed Management Handbook • Source off-site materials from sites that have been declared weed-free • Survey disturbance area for weeds prior to commencement of clearing/construction and control/eradicate existing infestations. • Annual weed mapping to identify declared weed species location, abundance and distribution • Clean, check and certify all earth-moving equipment and vehicles as weed-free before entering site • Vehicle hygiene measures will be employed to prevent the introduction and spread of invasive species and pathogens when mobilising vehicles and equipment from one location to another	• No new declared weed species introduced into the project area • No increase in declared weed infestations from baseline conditions • No weed complaints	• Annual weed mapping • Establish photo monitoring locations and undertake quarterly monitoring • Quarterly surveying for the presence of weeds, focussing on: - Areas to be disturbed that are in the vicinity of any weed occurrence - Stockpiles - Areas that have soil, sand or gravel introduced - Access tracks - Drainages, particularly after floods	• Review weed hygiene measures • Implement weed controls appropriate to the species detected	• Weed Monitoring - photos & weed control register • Weed mapping data • New occurrences of Weeds of National Significance (WoNS) to be reported to the NT Weeds Branch.

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				• Install wash bay facilities near Hwy entrance • Weed identification and management included in site induction and training				
		Fire	• Minimise the impact of bushfires caused by project activities	• Mulch and/or burn stockpiled vegetation as soon as practicable with a NT Bushfires permit to burn. • Conduct prescribed burning at suitable times of the year in accordance with a NT Bushfires permit to burn. • Maintain spot fire response capability (i.e. water truck, and fire extinguishers fitted in all vehicles and machinery) to prevent fires from spreading. • Establish firebreaks around all laydown, stockpile and central work areas • Develop bushfire response procedures within site Emergency Management Plans	• No bushfires attributable to project activities other than prescribed / controlled burning • No uncontrolled burning • No unauthorised lighting of fires	• Weekly check that fire-fighting equipment is in order during dry season	• Investigate cause of fire and update procedures as necessary	• Report wild fires that cross ML boundary to Bushfires NT • Site Inspection Register • Register of prescribed burning activities
		Biodiversity	• Minimise the risk of Injury and/or death of fauna caused	• Implement weed, fire and rehabilitation management provisions	• No fauna injury and/or death related	• Fauna observation recorded - sightings,	• Review monitoring measures and effectiveness	• Annual Environmental Mining Report (EMR) to include

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
			by mining activities • Minimise land disturbance activities • Native vegetation reestablishment comparable to that of the surrounding ecosystems	• Site speed restrictions to minimise harm to fauna and dust on flora • Buffer zones around sensitive fauna and/or flora areas • Fauna spotter/catcher immediately prior to clearing • Undertake rehabilitation • Respread topsoil and felled vegetation • All employees and contractors will be trained and inducted in relation to the management of environmental risks in the work area, including threatened species • Vegetation clearing will be kept to the minimum required • Significant vegetation will be avoided during clearing (i.e. large trees, specimens providing habitat or food sources, riparian vegetation, and threatened species)	to mine activities • Regeneration of self-sustaining local native vegetation species similar to baseline habitat	injuries, deaths, scats, track, diggings. • Quarterly transect – photo monitoring of rehabilitation areas	of rehabilitation • Installation of additional erosion management structures • Supplement regeneration through tubestock plantings • Reseeding impacted areas • Rip and contour bare areas • Sourcing and spreading of additional topsoil • Direct planting • Implement treatment and prevention controls in the Weed Management Handbook (2018)	details of rehabilitation. • Fauna and flora sightings/ survey records
		Rehabilitation	• Domain is a safe, stable, non-polluting and erosion	• Undertake mitigation measures identified for weeds, fire,	• Landform (WRD, stockpiles, topsoil)	• Drone monitoring annually	• Earthworks and remediation	• Annual EMR to include details of rehabilitation.

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
			resistant landform • Native vegetation establishment comparable to that of the surrounding ecosystems.	biodiversity, erosion and sedimentation. • Stockpiling of sufficient volume of topsoil • Obtain native seed supply • Progressive rehabilitation of disturbance areas i.e drill pads immediately to encourage reestablishment of native vegetation • Progressive land clearing and minimise disturbances • Drill holes will be securely capped immediately after drilling	integrity and stability: • Successful native vegetation establishment	• Quarterly transect – photo monitoring of rehabilitation areas	or erosion areas • Installation of additional erosion management structures • Supplement regeneration through tubestock plantings • Reseeding impacted areas • Rip and contour bare areas • Sourcing and spreading of additional topsoil • Direct planting • Implement treatment and prevention controls in the Weed Management Handbook (2018)	• Photo monitoring records • Aerial imagery – drone monitoring
Hydrological processes	Protect the hydrological regimes of groundwater and surface water so that environmental values	Alteration of surface water flows	• Flood management - prevention of erosion and sedimentation caused by flooding	• Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse	• Mine constructed to design • No erosion and sedimentation issues caused by flooding or	• Monitoring of turbidity downstream water quality	• Review mine design and flood mitigation measures	• Water quality database • Annual EMR • Incident reporting – Internal and external to regulators

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
	including ecological health, land uses and the welfare and amenity of people are maintained.			impacts on water quality downstream of the Mineral Lease. • Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing drainage lines.	flood management infrastructure.			
		Groundwater extraction	• Prevent overextraction and /or reduced supply for other groundwater users	• Groundwater extraction licence for volumes >5ML/yr per parcel of land • Avenira groundwater monitoring program will monitor groundwater levels and quality.	• Only volumes extracted as per water extraction licence conditions	• Flow meters • Groundwater standing water level and quality	• Assess project water supply and demand and recycling / reuse options	• As per conditions of the water extraction licence • Water extraction and use register
Inland water environmental quality	Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	Water quality	• No contamination of surface water or groundwater	• Implement hydrocarbon and ESC management provisions listed above. • Mine constructed to design • WRD and ROM pad designs incorporating a low permeability base	• Toxicants = ANZG (2018) 95% species protection guideline values for freshwater • Hydrocarbons = below detection limits • Potable water quality analysis meets Australian Drinking Water Guidelines (ANZG 2018)	• Regular monitoring of potable water, surface water, seepage and groundwater bores • Visual monitoring of and seepage from the WRD and stockpile areas	• Investigate and implement water treatment systems • Cart in potable water • Investigative source of contamination and implement mitigation measures	• Water quality database • Annual EMR • Incident reporting – Internal and external to regulators

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
					• No incidents of potable water contamination			
Air Quality	Protect air quality and minimise emissions and their impact so that environmental values are maintained.	Dust	• No impact to air quality to surrounding sensitive receptors i.e Wunara community	• Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion. • Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion. • Watering areas to be disturbed immediately prior to clearing during windy conditions. • Undertake dust suppression • Using existing disturbance areas where possible to reduce land disturbance requirements • Manage waste rock, ore and topsoil storage, including such measures as: - Positioning the stockpiles lengthways to the predominant wind direction.	• No air quality complaints received	• Dust observations – visible plumes, on vegetation, buildings etc. • Onsite dust monitoring • Weather observations recorded	• Review dust management controls and processes • Dust depositional gauges located nearby sensitive receptors i.e. Wunura community	• Records of: - Operational hours of all water trucks. - Amount of water and dust suppressant used. - Numbers of water trucks in operation. - Complaints

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				- Minimising the slope of the upwind surfaces. - stockpiling coarser material on the outer slopes of stored material to prevent wind blown dust and protecting with cleared vegetation. - Watering stockpiles to prevent wind losses when required (e.g., during dry windy weather, when stockpiles have been recently formed, and have surface dust). • Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement offsite. • Cease mining and clearing operations during severe meteorological conditions (wind speeds above around				

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				40 km/h) causing extreme levels of dust. • Spray water and/or the dust suppressant agents on unsealed trafficked areas and other dust generating areas. • Reduce speed limit in sensitive areas • Progressive clearing of drill pads • Manage mine traffic, including such measures as: - Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use. - Prohibiting off road driving. - Restricting site access to necessary site vehicles only. - Limiting parking of vehicles to designated parking areas to minimise soil disturbance. - Speed limits will be imposed on roads used by mine traffic to				

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				reduce vehicle dust - Limiting load sizes of haul trucks on-site to ensure material is not above the level of the vehicle sidewalls				
Atmospheric Processes	Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.	GHG emissions	• No notable decrease in air quality due to GHG emissions	• Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. • Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently. • Conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and	• No notable increase in emissions gathered from emissions reporting	• Monitoring of fuel usage	• Undertake a GHG assessment and assess methods to reduce GHG emissions.	• Fuel usage register • Emissions reporting

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				consider any new technologies that may be available to reduce emissions. • Using existing disturbance areas where possible to reduce land disturbance requirements				
Communities and economy	Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.	Traffic and transport of ore	• No impact to safety and amenity or increased pressure on local emergency services	• Impose speed limits on ore trucks. • Ensure all vehicles are mechanically sound and serviced regularly • Liaise with the Barkly Shire Council and Northern Territory Government to assist future planning and development activities. • Develop a traffic management plan (TMP)	• No incidents or accidents caused by mining activities • No road/ transport complaints received	• Monitoring of road condition • Complaints monitoring	• Review TMP	• Haulage log / records • Road condition report • Complaints records
		Noise and vibration	• No noise or vibration impact to surrounding sensitive receptors i.e Wunara community	• Avoidance through design. • Service all plant, machinery and vehicles regularly. • Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles. • No unauthorised entry • No public access	• No noise or vibration complaints received	• Monitoring of plant and equipment noise levels prior to use and as part of general services	• Review of Company plans and procedures	• Plant and equipment service / testing register

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				• Turn off machinery when not in use • Monitor noise impacts by complaint, developing additional mitigation measures if necessary • Strictly manage blasting procedures to ensure the comfort of employees and to protect mine infrastructure. • Design each blast using a suitably qualified person, with initial blasts being conservatively designed. • Monitor blasting impacts by complaint, developing additional mitigation measures if necessary • Manage drilling impacts and restrict hours if necessary				
		Workforce influences local community	• Benefit to the local community by providing jobs and training	• Work with existing training providers to ensure that programs they deliver will provide appropriate training programs. • Inform local community of the types of jobs that will be required and the skills and qualifications people will require to fill them.	• Local employed and upskilled	• Annual internal assessment of Company benefits provided to local community -assess % of workforce sourced locally, and local services used.	• Review stakeholder consultation plan.	• Training register • Procurement register

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				• Use local businesses to fill contract positions where contractors are competitive and appropriately skilled. • Support the development of business opportunities within the local Indigenous community. • Implement stakeholder consultation plan.				
Culture and Heritage	Protect sacred sites, culture and heritage Cultural and heritage	Land use	• Ensure no restrictions to Traditional Owners (TOs) to sites of cultural significance • End-land use agreement – Arruwurra Aboriginal Corporation (AAC) / TOs consulted and agreement defined	• The immediate loss of land for traditional hunting and gathering will be compensated for, as agreed during discussions and negotiations with the AAC and TO's and Avenira will formalise in a Mining Agreement between the parties. • Avenira will develop alternative access routes to the sacred sites in consultation with the AAC / TOs • Rehabilitation of the project area post mining will assist in the project area being suitable for hunting and gathering use after mining has finished	• No complaints received by the AAC / TO's • End land use and access arrangements developed in consultation with all relevant parties.	• Monitor in accordance with land use agreements	• Review land use agreement • Consultation with AAC / TO's	• Land use agreement • Stakeholder consultation records

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
		Cultural heritage	• No damage or destruction to heritage or Aboriginal sites	• Set up cultural exclusion zones around sacred sites • AAPA authority certificate (AC) application in progress and involves relevant groups. Adhere to AC conditions. • Consultation with AAC / TOs early on in project development to identify exclusion zones. • Avenira will seek consent under the NT Heritage Act for all ground disturbing works within 30 metres of all silcrete outcrops. • Disturbance permit protocols and procedures to be adhered too • Minimise disturbance • No driving off designated tracks • All Avenira' employees will be made aware of the location of these cultural exclusion zones through project inductions and access (and therefore disturbance) to these areas will be prohibited.	• No unauthorised entry to areas of cultural significance • No complaints from AAC / TOs, regarding cultural sites • No damage to cultural heritage sites	• Monitor in accordance with AAPA Certificate conditions • Monitor cultural heritage sites to ensure no unauthorised access or disturbances have occurred	• Consultation with AAC / TO's	• AAPA Certificate • Cultural heritage sites database

Factor	Overarching objective	Environmental Risk	Risk specific objective	Management provisions (mitigation/controls)	Performance indicators	Monitoring	Corrective actions	Reporting & Record-keeping
				• Chance find / stop work procedures will be implemented				

8 REHABILITATION

The following rehabilitation will be undertaken across each of the disturbance domains:

The end-land use is to be determined in consultation with relevant stakeholders, including but not limited to the AAC / TO's and approved by DITT. Some suggestions have been provided in Table 7-3.

Drone aerial imagery (orthomosaic) will be captured for all proposed disturbance areas prior to any mining activities (baseline imagery), at completion of bulk test sample mining activities (capture disturbance footprint prior to rehabilitation activities), and at completion of rehabilitation activities (baseline for rehabilitation progress).

Table 7-3. Rehabilitation plan and schedule

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
Camp	2.5	AAC owner camp retained for AAC use	• In agreement with AAC - camp area and facilities to be retained for AAC use / Wunura community	• Suitable living area for Community use	• Remove all unwanted infrastructure from site, remove ant contaminants / waste ie. Sewage, cooking fat oils, non-mineral waste. • Cover, contour, rip and seed landfill facility. • Rip, contour and seed are larger disturbances surrounding the camp that are no longer used. • Revegetation species are to be native species endemic to the area, typical of that from the baseline flora surveys for each land unit.	• If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation activities to occur immediately.	• Establish photo monitoring locations of rehabilitated areas on completion of rehab and monitor biannually. • Drone flight (orthomosaics) of rehabilitation areas annually. • Biannual (wet season and dry season) site inspections to include monitoring of revegetation establishment success (transects), weed species, abundance and distribution, erosion, fire, pests and feral animal impacts, and evidence of fauna recolonisation.
Roads (haul road and access roads)	23.7 Existing 23.7 proposed realignment 1.36km bore access roads	Portion of access roads retained for AAC use (~4m width)	• Traditional cultural uses (hunting and gathering)	• Safe, stable and non-polluting • Reestablishment of vegetation that is comparable to the surrounding environment	• The section of the haul/access road that are no longer required with the realignment will be deep ripped, contoured for appropriate drainage. Felled vegetation from the	• The existing access/haul road that is no longer required (23.7ha) will be immediately rehabilitated as	

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
				• Fauna recolonisation comparable to that of the surrounding ecosystems	new alignment area will be spread over the rehab road areas, and also positioned to block access. The areas will be seeded during the rainfall months. Signage to prevent unauthorised access and identify rehab areas / no go zones will be installed along the length of the route.	part of the new road alignment construction works. • The haul road realignment will be rehabilitated If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation activities to occur immediately.	• Camp supply groundwater monitoring – biannually – quality to be suitable for potable use (Australian drinking water guidelines).
Pit	3.9	Pit void and abandonment bund to be constructed	• Open pit void – pit lake • Ecological habitat	• Pit void is stable and safe • Prevent unauthorised access to pit • Pit lake water quality will not present an unacceptable risk to beneficial uses	• Pit walls made safe and stable • Ramp access blocked / bunded • Pit abandonment bund constructed in accordance with Western Australia Department of Mines and Petroleum, Safety bund walls around abandoned open pit mines guidelines (DoIR 1997) with minimum dimensions of 2m height and 5m base width and using the zone of instability calculation. • Safety signage will be erected surrounding the bund wall	• If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation activities to occur immediately.	• Biannual water quality monitoring • Drone flight (orthomosaics) of rehabilitation areas annually. • Biannual (wet season and dry season) site inspections to include integrity of abandonment bund and pit safety, evidence of pit wall stability i.e wall slumping, erosion. Animal entrapment / access into the pit.
Waste dump	10.1	Elevated landform – waste dump retained on surface. Previous agreement with AAC stated backfilling the pit if	• Ecological habitat	• Safe, stable and non-polluting landform • Reestablishment of vegetation that is comparable to the	• Waste dump surface will be reshaped, contoured for appropriate surface drainage to prevent water pooling, ripped across slope, and seeded with native species endemic to	• If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation	• Establish photo monitoring locations of rehabilitated areas on completion of rehab and monitor biannually.

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
		viable. Aveira are currently in the process of executing an agreement with AAC, which will include closure options and end land use agreements. Avenira will undertake a feasibility study to backfilling the pit as part of the proposed DSO MMP. The current mine plan for the proposed DSO MMP, includes partial backfill of the pits during mining and will further assess the feasibility of further backfill options.		surrounding environment • Fauna recolonisation comparable to that of the surrounding ecosystems	the area, typical of that from the baseline flora surveys for each land unit.	activities to occur immediately.	• Drone flight (orthomosaics) of rehabilitation areas annually. • Biannual (wet season and dry season) site inspections to include monitoring of revegetation establishment success (transects), weed species, abundance and distribution, erosion, fire, pests and feral animal impacts, and evidence of fauna recolonisation, evidence. • Seepage monitoring, evidence of ARD.
Product stockpile area	0.8	Preferred option will be to sell the product stockpiles and remove from site. Second option would be to beneficiate then sell – remove from site. Least preferred option will be to retain stockpiles as landforms and rehabilitate.	• Ecological habitat	• Preferred options objective is to completely remove product stockpiles from site. • Least preferred option will be to ensure that the remaining stockpiles are safe, stable and non-polluting landform that sustains local native species	• Remove all crushing and screening infrastructure from site • Remove stockpiles from site, deep rip, and seed with native species endemic to the area, typical of that from the baseline flora surveys for each land unit, OR • Cover stockpile with 0.1m topsoil and seed with native species endemic to the area	• If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation activities to occur immediately.	
Topsoil	2.3	Nil - natural surface, congruent with	• Traditional cultural uses	• Topsoil suitable for rehabilitation of infrastructure	• Topsoil will be spread across all retained infrastructure including	• If bulk test sample unsuccessful or	• Establish photo monitoring locations of rehabilitated areas

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
		surrounding topography	(hunting and gathering) • Ecological habitat	provides suitable material for successful revegetation establishment	Waste dump and stockpiles. • Minimum thickness is 0.1m to 0.2m of topsoil. • Condition soil as required (to be determined by soil sampling at the time of rehabilitation to determine if soil conditioners such as fertiliser is required to promote plant growth). • Scarify and seed with native species endemic to the area, typical of that from the baseline flora surveys for each land unit.	in the event of unplanned closure – rehabilitation activities to occur immediately.	on completion of rehab and monitor biannually. • Drone flight (orthomosaics) of rehabilitation areas annually. • Biannual (wet season and dry season) site inspections to include monitoring of revegetation establishment success (transects), weed species, abundance and distribution, erosion, fire, pests and feral animal impacts, and evidence of fauna recolonisation.
Infrastructure (Office, workshop, laydown, fuel bay)	0.8	Nil - natural surface, congruent with surrounding topography	• Traditional cultural uses (hunting and gathering) • Ecological habitat	• Area returned to pre-mining topography, be stable, non-polluting • Reestablishment of vegetation that is comparable to the surrounding environment • Fauna recolonisation comparable to that of the surrounding ecosystems	• Disconnect services and removal of all infrastructure from site. • Remove all hydrocarbon contaminated material from fuel bay and workshop area and bioremediate on-site. • Contour and rip area • seed with native species endemic to the area, typical of that from the baseline flora surveys for each land unit.	• If bulk test sample unsuccessful or in the event of unplanned closure – rehabilitation activities to occur immediately.	
Grade control drill pads and holes	47	Nil - natural surface, congruent with surrounding topography	• Traditional cultural uses (hunting and gathering) • Ecological habitat	• Area returned to pre-mining topography, be stable, non-polluting • Reestablishment of vegetation that is comparable to the surrounding environment	• Total 779 holes to be rehabilitated – collar cut minimum 0.4m below ground and removed. Holes plugged and backfilled to surface (mounded). • All waste material removed.	• Progressive rehabilitation of drill holes and pads during the grade control program.	

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
				Fauna recolonisation comparable to that of the surrounding ecosystems	• Area stabilised and reshaped as required, rip along contour (across slope). • Topsoil and felled vegetation respread across the site • Allow natural reestablishment of flora through retained and reused topsoil. If natural reestablishment is not successful one year post rehabilitation, then bare areas are to be ripped and seeded.		
Grade control tracks	15.2	Nil - natural surface, congruent with surrounding topography	• Traditional cultural uses (hunting and gathering) • Ecological habitat	• Area returned to pre-mining topography, be stable, non-polluting • Reestablishment of vegetation that is comparable to the surrounding environment • Fauna recolonisation comparable to that of the surrounding ecosystems	• All waste material removed i.e pegs, flagging tape • Area stabilised and reshaped as required, rip along contour (across slope). • Topsoil and felled vegetation respread across the site • Allow natural reestablishment of flora through retained and reused topsoil. If natural reestablishment is not successful one year post rehabilitation, then bare areas are to be ripped and seeded.	• Progressive rehabilitation of tracks during the grade control program.	
Borrow pits	0.46	Nil - natural surface, congruent with surrounding topography	• Traditional cultural uses (hunting and gathering)	• Area returned to pre-mining topography, be stable, non-polluting	• Area stabilised and reshaped as required, rip along contour (across slope).	• Rehabilitation of remaining borrow pits on completion of the haul road	

Domain	Disturbance area (ha)	Remaining infrastructure	Proposed end land use options	Objective	Methods	Timeframe	Monitoring and frequency
			• Ecological habitat	• Reestablishment of vegetation that is comparable to the surrounding environment Fauna recolonisation comparable to that of the surrounding ecosystems	• Topsoil and felled vegetation respread across the site • Seed with native species endemic to the area, typical of that from the baseline flora surveys for each land unit.	realignment works	

9 CLOSURE PLANNING

9.1 Conceptual Closure Plan

Closure planning largely requires stakeholder consultation to continuously define the closure objectives and closure criteria based on the agreed final end-land use. Table 7-4 outlines the conceptual closure plan, which will be updated and further refined throughout operations. Avenira will develop a final landform design in agreement with the relevant stakeholders and to be approved by DITT as part of the future DSO MMP.

Table 7-4. Closure criteria and closure planning

Domain	Closure objectives	Completion criteria	Closure monitoring and frequency
Overall Project compliance	• Avenira will meet the conditions of all legally binding condition relevant to the rehabilitation and closure of the Project, including but not limited to the landowner agreements (yet to be formalised), MMP and environmental approval documents.	• All conditions and commitments relevant to rehabilitation and closure are met	• Annual audit of conditions of mining authorisation and commitments made in project assessment
Camp	• Suitable living area to return for Community use (Camp area currently AAC owned)	• Camp infrastructure handed back over to AAC in condition and terms as per agreement between Avenira and AAC. • Rehabilitation and monitoring completed as outlined in Table 7-3.	• Camp supply groundwater monitoring - quality to be suitable for potable use (Australian drinking water guidelines) on closure prior to return to AAC to resume responsibly. • Audit of camp areas post rehabilitation on closure prior to return to AAC to resume responsibly.
Roads (haul road and access roads)	• Area returned to pre-mining topography • Safe, stable, non-polluting • Support reestablishment of native flora and fauna species endemic to the surrounding area • Suitable for cultural uses such as hunting and gathering, access to culturally significant place and groundwater resources.	• Evidence of successful revegetation and habitat comparable to the surrounding environment. • No notable impacts of erosion, sedimentation, declared weed proliferation, feral animal or pest activity in comparison the surrounding unimpacted environment. • Evidence of available wildlife for hunting, availability of natural resources for bush tucker and access to culturally important sites. • Groundwater quality similar to baseline water quality pre-mining conditions.	• Annual audit to monitor completion of the rehabilitation and closure criteria to include: o Drone monitoring, weed mapping, rehabilitation transect monitoring (comparison to analogue sites), opportunistic fauna sightings, erosion monitoring and groundwater quality monitoring, culturally significant sites undisturbed. .
Pit	• Pit void is stable and safe • Pit lake water quality will not present an unacceptable risk to beneficial uses	• Pit wall stable • Water quality within acceptable for beneficial uses – non-polluting	• Annual audit to monitor completion of the rehabilitation and closure criteria to include: o Drone monitoring, pit water quality monitoring, pit wall stabilisation, weed

Domain	Closure objectives	Completion criteria	Closure monitoring and frequency
		• Abandonment bund constructed, safe, stable and non-polluting	mapping, rehabilitation transect monitoring (comparison to analogue sites), opportunistic fauna sightings, and erosion monitoring.
Waste dump Product stockpile area	• Safe, stable and non-polluting landform that supports the reestablishment of native flora and fauna species endemic to the area	• Evidence of successful revegetation and habitat comparable to the surrounding environment. • No notable impacts of erosion, sedimentation, declared weed proliferation, feral animal or pest activity in comparison the surrounding unimpacted environment.	• Annual audit to monitor completion of the rehabilitation and closure criteria to include: o Drone monitoring, weed mapping, rehabilitation transect monitoring (comparison to analogue sites), opportunistic fauna sightings, and erosion monitoring.
Topsoil Infrastructure (Office, workshop, laydown, fuel bay) Grade control drill pads and holes Grade control tracks Borrow pits	• Area returned to pre-mining topography • Safe, stable, non-polluting • Support reestablishment of native flora and fauna species endemic to the surrounding area • Suitable for cultural uses such as hunting and gathering and access to culturally significant places.	• Areas comparable to baseline topography • Evidence of successful revegetation and habitat comparable to the surrounding environment. • No notable impacts of erosion, sedimentation, declared weed proliferation, feral animal or pest activity in comparison the surrounding unimpacted environment. • Evidence of available wildlife for hunting, availability of resources for bush tucker and access to culturally important sites.	• Annual audit to monitor completion of the rehabilitation and closure criteria to include: o Drone monitoring, weed mapping, rehabilitation transect monitoring (comparison to analogue sites), opportunistic fauna sightings, erosion monitoring, available access to culturally significant sites and culturally significant sites remain undisturbed from mining and rehabilitation activity.

10 SECURITY

The departments ‘Security Calculation Tool’ was used to calculate the rehabilitation costs for disturbances proposed in this MMP and all existing disturbances. Post operation and rehabilitation monitoring and maintenance costs are included.

Table 7-5. Security

Security – Stage 1 Bulk Sample Security	
Total security amount (amended amount)	$82,158
Document reference for the security calculation	Existing disturbance data sources from: • Arc Gis • Survey data Arruwurra bulk sample – final volumes 18 December 2009 • Previous MMPs. Note: previous exploration drilling disturbances and security accounted for in previous exploration MMPs and security held with DITT. Proposed disturbances sourced from Section 6.1 of this MMP.
Security – Stage 2 Initial DSO Operations	
Total security amount (amended amount)	$576,422
Document reference for the security calculation	Existing disturbance data sources from: • Arc Gis • Survey data Arruwurra bulk sample – final volumes 18 December 2009 • Previous MMPs. Note: previous exploration drilling disturbances and security accounted for in previous exploration MMPs and security held with DITT. Proposed disturbances sourced from Section 6.2 of this MMP.
Security – Grade Control Drilling	
Total security amount (amended amount)	$199,359
Document reference for the security calculation	Existing disturbance data sources from: • Arc Gis • Survey data Arruwurra bulk sample – final volumes 18 December 2009 • Previous MMPs. Note: previous exploration drilling disturbances and security accounted for in previous exploration MMPs and security held with DITT. Proposed disturbances sourced from Section 6.3 of the MMP.

11 REQUIRED ATTACHMENTS

8.1	Y	Application for Variation of Authorisation (See Appendix A)
8.2	N/A	Nomination of Operator Form, where required
8.3	Y	Security Calculation Spreadsheets (Appendix I)
8.4	N/A	Evidence of Land Access Agreement if operating on an Exploration Licence on Pastoral Lease (e.g. two-ways exchange of email) Note: Agreement currently being executed between Avenira and AAC.
8.5	N/A	Disturbance tracking spreadsheet (for existing Authorisations)
8.6	Y	Spreadsheet with coordinates of proposed drill holes or polygons of target areas (Attachment)
8.7	Y	KML/shape files/track logs of proposed tracks, camp sites and proposed drill holes or polygons of target areas
8.8	Y	Map(s) of the work area(s) showing: title boundaries and title numbers current and proposed drill holes, or polygons of target areas current and proposed tracks rehabilitated areas camp sites heritage sites or significant environmental areas environmental constraints
8.10	N/A	Radiation Management Plan (if applicable)
8.12	Y	Document(s) being appended in relation to Section 2.2 (if any): Appendix E Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report, Low Ecological Services P/L (LES) 2009 Appendix F NT EPA Pre-referral Screening Report NT EPA Pre-referral Screening Report Appendix G Environmental Risk Assessment Appendix H Archaeological Survey Arruwurra Block- Barkly Highway NT Appendix J Weed Management Plan Appendix N Traffic Management Plan Appendix O Groundwater Management Plan Appendix Q Surface Water Management Plan Appendix R Air Quality and Dust Management Plan

12 REFERENCES

DNRETAS (2010). *Wonarah Phosphate Project Assessment Report 64. Minemakers Australia Pty Ltd. Environmental Assessment Report and Recommendations.* Prepared by the Environment, Heritage and Arts Division, Department of Natural Resources, Environment, The Arts and Sport (DNRETAS), April 2010.

EGi (2009). Wonarah Phosphate Project – Acid Forming Characteristics of Waste Rock Composite Samples from the Arruwurra Prospect and Main Zone and Low Grade Ore, Final. Prepared by Environmental Geochemistry International Pty Ltd for Coffey Natural Systems Pty Ltd, October 2009.

GRM (2009). Hydrological Baseline Assessment – Wonarah Phosphate Project. Prepared by Groundwater Resources Management for Minemakers Limited, July 2009.

GRM (2009). Hydrogeological and Water Supply Investigations – Wonarah Phosphate Project. Prepared for Minemakers Limited, by Groundwater Resources Management, October 2009.

Hill, T. (2009). Proposed Minemakers Phosphate Mine (MLA 27244) Archaeological Survey Arruwurra Block-Barkly Highway NT. Prepared for Central Land Council, Alice Springs, June 2009.

LES (2009). Minemakers Wonarah Phosphate Project, Baseline Flora and Fauna Report. Prepared by Low Ecological Services P/L for Coffey Natural Systems Pty Ltd, April 2009.

APPENDIX A DRAFT AUTHORISATION CERTIFICATE

NORTHERN TERRITORY OF AUSTRALIA

Mining Management Act 2001

AUTHORISATION 1170-01

To: **Avenira Limited** ACN 116 296 541

I, NICOLE SUSAN MANISON, Minister for Mining and Industry, as delegate of the Minister:

HAVING HAD REGARD TO the matters referred to in section 34 of the Act;

BEING SATISFIED ABOUT the matters referred to in section 36(5) of the Act;

IN ACCORDANCE WITH section 36(4) of the Act;

SUBJECT TO THE CONDITIONS set out in the Act and in the attached Schedules, which form part of this document and contain a full statement of the conditions imposed by the Minister under section 37(2) of the Act on Authorisation 1170-01 as at the date below.

AUTHORISE Avenira Limited ACN 116 296 541 (the "Operator") to carry out the mining activities identified in this document:

(a) on the mining site known as the Wonarah Phosphate Project situated within the title areas of ML33343 and ML33344 granted under the *Mineral Titles Act 2010*; and

(b) For the period of grant and any renewal of the titles specified in paragraph (a).

This Authorisation, subject to (a) and (b):

I. commences on the date this document is signed; and
II. comes into effect upon the payment of security identified in Schedule (1) Condition 9.a

____

Minister for Mining and Industry

(insert date)

SCHEDULE 1

Definitions

1. In this Schedule, unless the contrary intention appears:

   a. **Acidic and Metalliferous Drainage** or **AMD** means drainage (which may be generated from sources including waste rock piles, ore stockpiles, tailings storage facilities and tailings dams, processing areas or facilities, roadways and embankments constructed with sulfidic material, open cuts and mine pits, underground mines, heap and dump leach piles, and acid sulfate soils) with the characteristics detailed in Figure 1 of the Preventing Acid and Metalliferous Drainage, Leading Practice Sustainable Development Program for the Mining Industry (DFAT 2016). Acid and Metalliferous drainage includes acidic drainage and pH neutral metalliferous drainage (NMD), and saline drainage (SD), generally caused by the oxidation of sulfide minerals[1].

   b. **Act** means the *Mining Management Act 2001* and includes any statutory instruments made under it, any amendment to it, or replacement of it.

   c. **Department** means the Department of Industry, Tourism and Trade (or any other Northern Territory Department or Agency that is, from time to time, responsible for the administration of these conditions) and the delegates, officers, employees and other agents of that Department.

   d. **Director** means Executive Director Mining Operations, Senior Executive Director Mines, Deputy Chief Executive Officer Mining and Energy and/or Chief Executive Officer of the Department of Industry Tourism and Trade.

   e. **DSO Operations** means direct shipping ore operations.

   f. **EMP** is an acronym for environmental management plan.

   g. **ICE** is an acronym for Independent Certifying Engineer.

   h. **Independent**, in relation to a person, means the person has agreed in writing to:

      i. act independently of the parties with an interest in the person's engagement;

      ii. act with honesty, reason and with the degree of professional care, skill, knowledge, experience and diligence which may reasonably be expected of the person in carrying out the engagement; and

      iii. treat information received or prepared by the person as part of the engagement:

         1. in confidence such that the information is not disclosed to a party other than the parties with an interest in the engagement or the person without the consent of the other parties (unless the disclosure is reasonably required

[1] Australian Government Department of Industry Tourism and Resources (2016) Preventing Acid and Metalliferous Drainage, Leading Practice Sustainable Development Program for the Mining Industry. http://www.industry.gov.au/resource/Documents/LPSDP/LPSDP-AcidHandbook.pdf, Accessed 27 June 2018.

by law, such as the rules of a stock exchange or disclosure to a Minister, Parliament or Legislative Assembly); and

2. by freely sharing the information between parties with an interest in the engagement and the person, such that no one of those parties is less informed than another in relation to the engagement.

iv. report in writing to the parties with an interest in the engagement at the same time, immediately upon becoming aware of one of the following relevant matters:

1. any potential, perceived or actual conflicts of interest that arise, including any relationship or association, interest in assets, office held, professional or contractual obligation or provision of services relating to the parties with an interest in the engagement which might affect the ability of the person to perform the engagement impartially, diligently or independently;
2. any attempted interference or influence in the performance of the engagement by parties with an interest in the engagement; and
3. any failure to cooperate with the person or unresponsiveness to the person's requests by a party whose cooperation is required for the engagement.

i. **Mine** means the mining site known as the Wonarah Phosphate Project as described in Authorisation 1170-01.

j. **Minister** means the Minister responsible for the *Mining Management Act 2001*.

k. **MMP** means the current Mining Management Plan as approved by the Minister in respect of the mining site known as Wonarah Phosphate Project referred to in Authorisation 1170-01.

l. **Operator** means Avenira Limited ACN 116 296 541.

m. **Site** means the area of land identified in the MMP for which an Authorisation has been granted under section 36 of the Act.

n. **Phase 1** means the bulk sample MMP approved for grant of Authorisation 1170-01

o. **Phase 2** means a future MMP that seeks approval for Direct Shipping Ore mining

Interpretation

2. In this schedule, unless the contrary intention appears:

a. words defined or used in the Act have the same meaning as in the Act;

b. a reference to a document is a reference to that document as in effect from time to time;

c. the word "including" is not a word of limitation and is to be interpreted as though it were immediately followed by the words "but not limited to";

d. headings have been included for ease of reference only and do not affect interpretation;

e. a reference to the singular includes the plural and vice versa;

f. a reference to time is to the time at Darwin in the Northern Territory of Australia; and

g. monetary references are references to Australian currency.

General

3. Subject to any conditions contained in the Act and this schedule,[2] the Operator must comply with the commitments and activities contained in the MMP including the implementation of all systems referred to in the MMP.[3]

4. The Operator may only conduct mining activities identified in the MMP within the Site subject to any conditions contained in the Act, this schedule and the conditions commitments and systems contained in the MMP.

Mining Management Plan (MMP)

5. The Operator must on XX September and on each anniversary of that date (or such other date as nominated by the Operator and approved by the Minister), review the MMP and if necessary, amend the MMP.[4]

6. The Operator may at any time review and if necessary amend the MMP.[5]

7. Each time the Operator amends the MMP, the Operator must submit the MMP to the Minister for approval[6] and when doing so, the Operator must clearly identify the MMP amendments.[7]

8. On or before 14 days from the date of this Authorisation and within 14 days of the date of approval of any subsequent amendment to the MMP the Operator must make the MMP available to the public[8].

Security and levy

9. The Operator must provide a security of $2,339,484.00 in the form of cash or an unconditional bank guarantee to the Minister[9] for mining activities authorised by this Authorisation 1170-01.[10] This is to be paid as follows:

   a. a payment of $1,481,545.00 for existing disturbance on the Minemakers Australia Pty Ltd Wonarah Project prior to undertaking any new mining activities;

   b. a security of $82,158 prior to undertaking any of the activities described in section 6.1 of the approved MMP;

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[2] Section 37(1) *Mining Management Act 2001*
[3] Section 37(2) *Mining Management Act 2001*
[4] Section 41(1) *Mining Management Act 2001*
[5] Section 41(2) *Mining Management Act 2001*
[6] Section 41(1) (b) and 41(2) *Mining Management Act 2001*
[7] Section 41(3) *Mining Management Act 2001*
[8] Section 37(2)(b)(i) *Mining Management Act 2001*
[9] Section 43 *Mining Management Act 2001*
[10] Section 37(2)(b)(i) *Mining Management Act 2001*

c. a security of $576,422.00 prior to undertaking any of the activities described in section 6.2 of the approved MMP; and

d. a security of $199,359.00 prior to undertaking any of the activities described in section 6.3 of the approved MMP.

10. The security provided for under clause 9 will be reassessed, and may be revised, following each submission of an amended MMP. The Operator must provide the revised security amount in the form of cash or an unconditional bank guarantee to the Minister.

11. Each financial year, upon receipt of a written notice by the Minister as to the levy payable for that financial year, the Operator must pay a levy to the mining remediation fund of an amount calculated in accordance with the Act and as stated by the Minister in that written notice.[11]

Phase 1 - Bulk Sample Operations

12. During Phase 1 of the Project, the Operator must ensure that the Waste Rock Dump (WRD) is managed in accordance with the following:

    a. waste rock is placed in such a manner that the dump slope is stable at all times, and does not exceed 18 degrees; and

    b. perimeter toe drains and a basin/dam constructed in accordance with best practice, are installed to manage surface runoff.

13. If requested, the Operator provide to the Department a traffic management plan developed to the satisfaction of the Department of Infrastructure, Planning and Logistics.

14. The Operator must submit a rehabilitation plan for approval by the Minister that is to be implemented if Project does not progress to Direct Shipping Ore Operations.

Phase 2 - Direct Shipping Ore Operations

15. Prior to commencement of Phase 2, the Operator must submit an amended MMP for approval that details the Life of Mine development and progressive mine rehabilitation that includes:

    a. schedules and timelines of proposed mining structures to be developed, including related greenhouse gas mitigation measures;

    b. schedules and timelines for submission of detailed designs and as-built construction reports for structures, including subject to this Authorisation nominated structures that are required to undergo independent review by suitably qualified specialists;

    c. relevant Environmental Management Plans (EMPs) that demonstrate key risks from the proposed activities will be appropriately managed and routinely updated; and

    d. maximisation of pit backfilling and prompt rehabilitation of mining disturbances no longer in use.

16. The EMPs required under Condition 15.c, at a minimum, must include the following plans:

[11]Sections 37(2)(b)(ii), 44A and 44B *Mining Management Act 2001*

a. Flora Management Plan that details proposed regional and seasonal surveys and studies for near threatened and data deficient flora species and pre-clearance procedures, supported by NT Herbarium;

b. Fauna Management Plan that identifies animal welfare risks from vehicle strikes from increased frequency of road haulage from mining operations and how they will be addressed;

c. Weed Management Plan conforming with best practice requirements;

d. Water Management Plan (surface water and groundwater) including management of water quality and water balance to achieve efficient water use;

e. Flood Management and Assessment Plan, including surveillance requirements, endorsed by an independent suitably qualified specialist:

f. Erosion and Sediment Control Plan endorsed by an independent suitably qualified specialist;

g. Dust Management Plan to maintain the biodiversity values of the surrounding landscape; and

h. EMP monitoring sub-plans detailing criteria and associated Trigger, Action, Response Plan (TARPs) to inform onsite management including the application of adaptive management.

Waste Rock Management

17. Prior to the commencement of Phase 2, the Operator must appoint an Independent Certifying Engineer (ICE) approved by the Director to oversee the design and construction of the WRD.

18. Prior to construction in Phase 2 commencing, the Operator must provide to the Department for acceptance WRD designs, plans and manuals endorsed by the ICE that confirm:

    a. the design is in accordance with industry best practice guidelines based on the geotechnical and geochemical properties of the waste rock materials and site environmental conditions/setting;

    b. the design includes an appropriate cover system commensurate with the properties of the waste rock;

    c. the design of the WRD a safe, stable and non-polluting landform at closure; and

    d. an Operations, Maintenance and Surveillance (OMS) manual has been developed that is suitable for the life of mine management of the WRD.

Hazardous Materials

19. The Operator must manage hazardous materials in compliance with applicable Australian and NT standards, codes, and guidelines.

Rehabilitation

20. The Operator must:
    a. demonstrate a commitment to establishing an onsite nursery or support for another Northern Territory based nursery to propagate plants of local provenance for revegetation;
    b. revegetate mining disturbances in keeping with the Mine Closure Plan and using species of local provenance, where appropriate; and consistent with industry best-practice guidelines, including but not limited to Florabank (2021) or equivalent.

Mine Closure

21. The Operator must submit an updated Mine Closure Plan every two years, or an alternative timeframe agreed by the Department, that details how pit voids, WRD and other mining-related disturbances will be rehabilitated. The plan must be auditable and include:
    a. a Stakeholder Engagement Plan that details consultation with key stakeholders including Central Land Council (CLC) and traditional owners to inform closure objectives and facilitation of Indigenous employment;
    b. progress on determining the final closure objectives and associated closure criteria;
    c. timeframes for completion of works required to establish the final agreed closure objectives and associated closure criteria that will maximise the visual amenity of the final landscape;
    d. consideration of rehabilitation options and risk-based justification for the preferred closure strategies;
    e. landscape design/s, as appropriate;
    f. a commitment to and evidence of progressive and prompt rehabilitation of disturbed areas that are longer in use and maximisation of pit backfilling;
    g. the scope and schedule of rehabilitation studies and trials required to address knowledge gaps to inform required designs, including, testing of topsoil seedbank and seed viability, to determine if proposed closure objectives can be achieved;
    h. a monitoring program, including the monitoring timeframes, which is appropriate to assess compliance with the closure criteria; and
    i. the status of progressive rehabilitation, performance monitoring and adaptive management processes to demonstrate the preferred closure option/s is on a trajectory of success; and
    j. any further works that are required by the Operator to achieve the closure objectives.
22. A finalised Mine Closure Plan must reviewed by an independent suitably qualified specialist and be submitted to the Minister for approval not less than five years before planned closure.

APPENDIX B HYDROLOGICAL BASELINE ASSESSMENT

REPORT ON

HYDROLOGICAL BASELINE ASSESSMENT

WONARAH PHOSPHATE PROJECT

Prepared for

Minemakers Limited

Level 2, 34 Colin Street

WEST PERTH, WA 6005

Report Distribution

No. Copies

1	Minemakers Ltd. (electronic copies enclosed)
1	Groundwater Resource Management Pty Ltd

J090004R01(Final) July 2009

EXECUTIVE SUMMARY

Minemakers Australia Pty Ltd (MAPL) are planning to develop the Wonarah Phosphate Project, located about 240 km east of Tennant Creek in the Northern Territory. Operations are currently scheduled to start in mid 2010 with mining commencing in the Arruwurra Prospect situated in the south-western part of the project area. Initially in the order of 1.0 Mtpa of direct shipped ore will be trucked to Tennant Creek for onward rail haulage to Darwin and export from Darwin port.

MAPL has commissioned Groundwater Resource Management Pty Ltd to complete a baseline hydrological assessment to assist with the planning for this development.

The project is located within the internally draining Barkly Surface Water Management Area (SWMA), immediately west of the Georgina River catchment. Although situated in a semi-arid region with average annual rainfalls of between 300 and 400 mm, significant short duration rainfall events can and do occur, with daily rainfalls in excess of 200 mm having been recorded locally. Therefore runoff will report to the minor on-site creeks and drainages and appropriate surface water management will be required to minimise operational interruptions and potential asset loss.

The purpose of this report is therefore to present the findings from a desktop study of regional hydro-meteorological data that can be used in the future analyses and design of water management measures at the Wonarah Project. In particular this information may be used in the design of water management measures required for the proposed developments at Arruwurra and Main Zone .

The following key findings were made:

- The regional climate is one of extremes and droughts and major floods can occur in the same area within a few years of each other. The climate in this region is highly variable, both spatially and temporally, and this can make hydrologic analysis and the design of water management measures difficult.

- Climatic conditions in the region are monsoonal with well-defined wet and dry seasons, with nearly all rain falling between November and March and the greatest incidence during January and February. Light rains are sometimes received during the dry season, but the period between April and September is frequently rainless.

- Although tropical cyclones may bring heavy rains to the Barkly region, they are erratic in nature and occur relatively infrequently. An analysis of cyclone data for the last 98 years shows that, on average, one cyclone will pass within 200 km of the project every 6 or 7 years, or approximately every 50 years one will pass within 50 km of the site. However, it should be noted that this analysis only considered cyclone track location and not rainfall intensity.

- The Bureau of Meteorology (BoM) station at Ranken River is the closest to the Wonarah Project with a comparatively long record. Its mean and median annual rainfalls of 361 and 326 mm are considered to be representative of conditions at the project and their use is recommended for design purposes.

- Locally the wettest day on record occurred on 29 January 2000 as a result of Tropical Cyclone (TC) Steve when 215 mm was recorded at Annitowa. Significant rainfall across the region that day with four other local rainfall stations recording depths in excess of 120 mm. It is estimated that the rainfall associated with TC

Steve had an average recurrence interval (ARI) in excess of 100 years in the vicinity of the project.

- Short duration rainfall intensities due to cyclones and other tropical depression related events can be significant. The regional maximum six minute intensity of 192 mm/hr was recorded at Tennant Creek Airport in February 1982. This intensity has an ARI in excess of 50 years.

- In the absence of an acceptably long site evaporation record it is recommended that the average of pan evaporation data for the Brunette Downs and Camooweal Township stations be used for design purposes for the Wonarah project. This gives a mean annual pan evaporation of some 3,114 mm.

- A review of the BoM Wonarah temperature data indicates that typically there are in the order of 39 days each year with daily maximum temperatures in excess of 40°C, over half of which occur during December and January.

- BoM Wonarah relative humidity data show that mornings are more humid than afternoons. However, the general aridity of the region can be appreciated when it is noted that the mean 9 am relative humidity for January and February, the wettest months, is only about 50%.

- Streamflow data are very sparse for the region, with no reliable gauged data within the Barkly SWMA. A review of the available streamflow data showed that it is highly variable. The peak instantaneous flows at Ranken River at Soudan Homestead and Georgina River at Roxborough Downs of >2,000 and 3,833 m^3/sec are of similar magnitude despite the fact that the catchment for the latter is over 25 times larger.

- The mean annual flow at the Ranken and Georgina River stations is 172.1 GL and 1,042.3 GL respectively. This is equivalent to mean annual specific yields ranging between 0.2 and 1.2 x 10^{-3} $m^3/sec/km^2$ which is equivalent to mean annual runoff rates of about 10 to 40 mm. Assuming an average annual rainfall across the region of approximately 400 mm these runoff rates represent in the order of 2.5% to over 10% of the annual rainfall.

- A rainfall intensity-frequency-duration (IFD) relationship was developed for the Wonarah Project. In summary, the 100 Year ARI intensities for 1 hr, 3 hr, 12 hr, 24 hr and 72 hrs are 78.0, 37.2, 14.4, 9.3 and 7.3 mm/hr respectively (i.e. giving equivalent storm depths of 78, 112, 173, 223 and 526 mm).

- All of the on-site creeks and drainages are relatively minor and ephemeral in nature and likely only carry runoff following significant rainfall events. However, flows will occur periodically during the summer months from January to March, when the potential exposure to high intensity cyclonic or tropical depression related rainfall is greatest. Consequently runoff will report to the watercourses in the vicinity of the project and, on occasion, flows may be high and may cause flooding if appropriate measures are not in place.

- A preliminary catchment delineation has been carried out over the project, however peak flow estimates have not been calculated given the current preliminary nature of the mine facility layout plan. Such calculations will be necessary once the facility plan is more advanced in order to design flood protection diversions and bunds etc.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Minemakers Australia Pty Ltd (MAPL) are planning to develop the Wonarah Phosphate Project, located about 240 km east of Tennant Creek in the Northern Territory (Figure1). Operations are currently scheduled to start in mid 2010 with mining commencing in the Arruwurra Prospect situated in the south-western part of the project area. Initially in the order of 1.0 Mtpa of direct shipped ore will be trucked to Tennant Creek for onward rail haulage to Darwin and ultimate exportation from Darwin port.

MAPL has commissioned Groundwater Resource Management Pty Ltd to complete a baseline hydrological assessment to assist with the planning for this development.

Although the project is situated in a semi-arid region with average annual rainfalls of between 300 and 400 mm, significant short duration rainfall events can and do occur, with daily rainfalls in excess of half the annual average having been recorded locally. Therefore runoff will on occasion report to on-site creeks and drainages and appropriate surface water management measures will be required to minimise operational interruptions and asset damage or loss.

The purpose of this report is to present the findings from a desktop study of hydro-meteorological data from the region that can be used in the future analyses and design of water management measures at the Wonarah Project. In particular this information may be used in the design of the measures required for the developments at Arruwurra and Main Zone The results of the desktop study are presented in this report. An electronic copy of this report is provided on CD ROM at the back of the report.

2.0 DESKTOP HYDRO-METEOROLOGICAL STUDY

2.1 Data Sources

Climate data were obtained from the Wonarah Project automatic weather station (AWS) for approximately nine months from mid May 2008 to early March 2009. Given the limited nature of this data it was not possible to subject it to frequency analysis or draw longer term conclusions about the local climate. The AWS data were therefore excluded from the desktop study.

Apart from the limited AWS site data no other meteorological or steamflow data were available for the project. The desktop study therefore made extensive use of available local and regional data from the following sources (refer to Figures 1 and 2 for location maps):

2.1.1 Bureau of Meteorology (BoM) Data:

The following BoM data were obtained and used in the completion of the desktop study (all distances and directions measured from what is referred to on site as "Arruwurra Junction" at the junction of the main site tracks):

Table 1: Daily Rainfall Records for Local BoM Stations (All within 150 km of Site)

BoM Station Name	Station No.	Data Period	% Complete[1]	Distance from Site
Austral Downs	15004	1/7/1914 - 20/1/2009	73.0%	146.8 km SE
Avon Downs	15005	1/1/1909 - 26/6/2007	95.0%	108.3 km E
Ranken River	15026	1/1/1909 - 31/3/2008	72.6%	68.4 km NE
Wonarah	15034	1/4/1946 - 31/8/1974	98.8%	20.4 km NW
Alroy Downs	15036	1/10/1950 - 28/5/2004	98.9%	92.3 km NW
Alexandria	15088	1/1/1886 - 24/2/2009	87.8%	112.8 km N
Barkly Homestead	15145	1/3/1987 - 31/1/2007	82.0%	75.2 km NW
Number 36 Bore	15151	1/11/1982 - 31/3/2008	98.5%	118.4 km NE
Annitowa	15587	1/1/1966 - 30/11/2008	85.1%	129.7 km S
Epenarra	15657	1/1/1963 - 31/12/2007	96.2%	132.0 km SW

Note 1:. % Complete = No. of Days Recorded ÷ (End Date of Record - Start Date of Record).

Table 2: Pluviograph Data for Regional BoM Stations

BoM Station Name	Station No.	Data Period	Distance from Site
Brunette Downs	15085	20/12/1968 – 31/01/2006	165.3 km NW
Tennant Creek Airport	15135	15/10/1969 – 30/11/2005	241.7 km W
Ali Curung	15502	28/06/1988 – 31/05/2007	238.7 km SW
Camooweal Township	37010	27/09/1964 – 30/09/1997	174.7 km E

Table 3: Daily Evaporation for Regional BoM Stations

BoM Station Name	Station No.	Data Period	% Complete[1]	Distance from Site
Brunette Downs	15085	11/12/1968 – 24/2/2009	91	165.3 km NW
Camooweal Township	37010	13/06/1969 – 31/08/1997	86	174.7 km E

Note 1: % Complete = No. of Days Recorded ÷ (End Date of Record - Start Date of Record).

Table 4: Climate Summaries for Regional BoM Stations

BoM Station Name	Station No.	Distance from Site
Wonarah	15034	20.4 km NW
Brunette Downs	15085	165.3 km NW
Tennant Creek Post Office	15087	240.9 km W
Tennant Creek Airport	15135	241.7 km W
Ali Curung	15502	238.7 km SW
Camooweal Township	37010	174.7 km E

Note : Length of record and % Complete varies depending on parameter of interest.

Listing of Australian Cyclones 1907-2005 with full, published details and partial listing for 2005/2006 cyclone season with preliminary path details were also obtained from the BoM and reviewed as part of this study.

2.1.2 Northern Territory Department of Natural Resources, Environment, The Arts and Sport (NRETAS):

Stage and flow data were extracted from NRETA's database for the following surface water gauging stations:

Table 5: NRETAS Surface Water Data

Station Name	Station No.	Data Period	Distance from Site
Playford River at Alroy Downs Homestead	G0290004	19/11/75 – Present	92.5 km NW
Ranken River at Soudan Homestead	G0010005	9/08/65 – Present	59.1 km E
James River at Avon Downs Police	G0010006	14/04/65 – 28/04/87	109.7 km E
Shakespeare Creek at Lily Waterhole	G0010009	15/08/69 – 14/01/87	128.4 km SE

The Playford River station is located within the Barkly Surface Water Management Area (SWMA), while the other three stations are all located in the Georgina River SWMA to the east of the NT/QLD border. Unfortunately only approximate streamflow gaugings exist for the Playford and James River stations, while the Shakespeare Creek station has not been gauged at all. Rating curves have therefore not been developed for any of the three stations and only stage (level) data were available. Daily maximum, minimum and mean flow data were available however for the Ranken River station.

2.1.3 Queensland Department of Environment and Resource Management (DERM)

Summary flow data were also obtained for the Georgina River gauging station at Roxborough Downs (Station No. 001203A). This station is located within the part of the Georgina SWMA that lies with Queensland, approximately 364 km south east of the project site. This station commenced recording in October 1967, was closed in September 1988 and reopened in June 2005.

2.1.4 Mapping Data

The following mapping data were used in the completion of the desktop study:

- 1:250,000 scale electronic topographic survey data for Alroy (SE5315), Ranken (SE5316), Frew River (SF 5303) and Avon Downs (SF5304) sheets.
- Airborne photography and laser scanning/Lidar data to produce ortho imagery, 0.5 m interval contours and key spot heights.
- Miscellaneous preliminary proposed infrastructure shape files.

2.2 Desktop Study Findings

2.2.1 General

The Wonarah Project is located about 230 km east of Tennant Creek in the Northern Territory (Figure 1). It is situated within the internally draining Barkly SWMA which covers an area of some 123,000 km2 and has an estimated mean annual runoff volume in the order of 600,000 ML/year1. There is no major water storage, diversion or supply infrastructure within the Barkly SWMA and the volume of surface water used is less than 0.1% of the mean annual runoff available. No surface water licenses are current within the SWMA and what little surface water that is used, is used for stock watering. About 77% of the area is pastoral leasehold land, 12% is Aboriginal land, and the remaining land is for other mixed uses.

The SWMA area is bounded by the Barkly Tableland in the east, while in the west the management area borders the Whittington, Murchison and Davenport Ranges. The south-central part of the SWMA, within which the project is located, comprises gently undulating sand ridges and semi-desert of low relief. All rivers and creeks within the SWMA are ephemeral and tend to flow only for short periods following heavy rainfall. Only the larger rivers such as the Ranken and Playford have permanent water holes. The main rivers in the south are Elkedra and Frew, which originate from the ranges along the western boundary, and flow into the sand dune country. Most of the main rivers and creeks in the northern half of the SWMA, that originate from the Barkly Tableland and from the north western boundary flow into seasonally flooded swamps and lakes.

The northern half of the SWMA has a humid climate with mean annual rainfall in the order of 550 mm, while the southern half has an arid climate with a mean annual rainfall of some 250 mm. Taking an average rainfall of 400 mm per year across the whole 123,000 km^2 SWMA and comparing it to the estimated mean annual runoff volume of 600,000 ML/year indicates that in the order of 2% of annual rainfall reports to creeks and rivers as runoff.

Despite such comparatively low annual runoff, runoff rates can be significantly higher for the short duration rainfall events that can occur in the region; daily rainfalls in excess of 200 mm have been recorded close to the project. During such events significant runoff will report to

[1] Australian Natural Resources Atlas, Department of the Environment, Water, Heritage and the Arts, see http://www.anra.gov.au/index.html for more information.

minor creeks and drainages on the site and appropriate surface water management will be required to minimise operational interruptions and potential asset loss.

2.3 Meteorological Conditions

2.3.1 General

The climate of much of the Barkly region is semi-arid, merging into an arid zone at the southern limit and into a narrow sub-humid northern strip adjoining the Gulf of Carpentaria[2]. The climate is monsoonal with well-defined wet and dry seasons, with nearly all rain falling between November and March and the greatest incidence during January and February. Light rains are sometimes received during the dry season, but the period between April and September is frequently dry.

Although tropical cyclones may bring heavy rains to the Barkly region, they are erratic in nature and occur relatively infrequently. Typically they track either from east to west or from north-west to south-east. Disturbances following the former track usually develop in the Coral Sea and enter the region after passing across the Cape York Peninsula; those following the latter track usually arise in the Arafura Sea and enter the region after crossing Arnhem Land or the Gulf of Carpentaria.

Day temperatures are high throughout the year, particularly in October, November and December prior to the onset of the wet season. With the occurrence of wetter conditions and slightly lower temperatures in January and February, humidity rises and reaches its highest levels.

2.3.2 Regional Rainfall

The annual rainfall distribution in the Barkly region is strongly seasonal and the year may be divided into two main seasons, a short, wet summer and a long, dry winter, with two subsidiary transitional periods between them. By the latter part of January, the wet summer season, under the influence of the north-west monsoon, is usually established. Over the drier, southern parts of the region the monsoonal influence typically lasts only for a few weeks and is characterized by widespread but intermittent rainfall with more humid and slightly cooler conditions than those prevailing earlier. In the sub-humid, northern areas adjacent to the coast, the rainfall tends to be more persistent and the associated temperature and humidity effects more marked.

The monsoon usually wanes in March and a period of calm and variable winds commences and continues for about one month. Thunderstorms, with or without accompanying rains, are a feature of this period. As the temperature and humidity gradually fall the frequency and intensity of the thunderstorms decrease and the commencement of the dry season is soon indicated by the onset of steady south-easterly winds. In the south-eastern part of the region, within which the site is located, additional light rains can sometimes occur during the early winter months.

The dry season, characterized by south-easterly winds, cooler day temperatures, greater diurnal temperature variation, and low humidity, persists until late September or October when the south-east winds subside and a second transitional period of calm and variable

[2] Survey of the Barkly Region, Northern Territory and Queensland, 1947-48, C. S. Christian, L. C. Noakes, R. A. Perry, R. O. Slatyer, G. A. Stewart, and D. M. Traves, Land Research Series No.3. CSIRO, Melbourne 1954

winds commences. Day temperatures become hotter and thunderstorms occur with increasing frequency and violence until the monsoon sets in once again.

Dry season weather is normally very regular, and variations in the annual weather regime are mainly due to differences in the intensity of the monsoonal influence from year to year. Often when the monsoon is strongly developed, the rains that occur during the transition periods also tend to be more extensive and frequent; and conversely, when monsoonal development is weak, transitional period rains are often of sporadic occurrence and confined to the months closest to the monsoon period.

The wetter-north/drier-south rainfall distribution is evident in the median annual rainfall values of 373 mm and 325 mm for Brunette Downs and Ali Curung located some 165 km northwest and 238 km south west of the project respectively (see Figure 1 for location of regional rainfall stations).

2.3.3 Local Rainfall

In order to analyse rainfall conditions local to the project daily rainfall data were obtained for the ten closest BoM rainfall stations (refer to Table 2 for details). All of these stations fall within an approximately 150 km radius of the site as shown in Figure 2. Unfortunately the record obtained from the Wonarah project AWS was too short to make a meaningful comparison with any of the BoM stations. However, such a comparison should be made once the on-site record is of sufficient length, say 3-5 years minimum.

Annual Rainfall

Table 6 gives the maximum, minimum, mean and median annual rainfall for the local rainfall stations considered in the desktop review. Only full or complete years of data were used in the analysis given the difficulties in “patching” gaps in records. This meant that length of some of the data sets had to be reduced by as much as 40% in order to remove years where data were incomplete.

Table 6: Annual Rainfall at Local BoM Stations

Station Name	Minimum Annual Rainfall (mm)	Maximum Annual Rainfall (mm)	Mean Annual Rainfall (mm)	Median Annual Rainfall (mm)	No. of Complete Years
Austral Downs	98	858	334	293	61
Avon Downs	111	1,145	348	302	79
Ranken River	100	828	361	326	62
Wonarah	106	572	326	310	23
Alroy Downs	82	1,009	363	295	42
Alexandria	109	1,317	393	359	76
Barkly Homestead	177	737	346	340	12
Number 36 Bore	157	1,227	398	380	18
Annitowa	56	609	257	214	28
Epenarra	104	995	366	329	38

Note 1: All Annual Rainfall values above were calculated using complete years of data only.

It should also be noted that despite the data gaps it was possible to produce a continuous 102 year long rainfall record from 1907 to 2008 comprising only complete years of data from local rainfall stations. Data from the local stations has been selected in order of increasing distance from the site and is presented as Annual Series values in Appendix A.

Median annual rainfall was also calculated in addition to mean values as it is generally considered to represent rainfall central tendency better in areas with skewed rainfall data. This is the case in regions where exposure to a few, or even a single, extreme cyclonic rainfall event can have a disproportionate effect on the mean, but has much less effect on the median, given that it is based on ranked data.

Table 6 shows that the mean annual rainfalls for the local stations range from about 257 to 398 mm, while the median values range from approximately 214 to 380 mm. Given that the Ranken River station is the closest station to the project with a comparatively long record, its mean and median annual rainfalls of 361 and 326 mm are considered representative of conditions at the project and their use is recommended in water balance and other calculations until a record of sufficient length is collected on site[3].

Points of note from the analysis of the complete annual rainfall data sets for the local stations are as follows:

- Typically there is a one order of magnitude range between maximum and minimum annual rainfalls for most of the local rainfall stations with longer records.

- Minimum and maximum annual rainfalls of 106 mm and 572 mm were recorded at Wonarah in 1961 and 1962 respectively. Similarly maximum and minimum annual rainfalls of 737 mm and 177 mm were recorded at Barkly Homestead in 1993 and 1994 respectively. Such ranges in successive years reflects the highly variable nature of annual rainfall in the region.

- A preliminary frequency analysis of the 62 years of complete Ranken River annual rainfall data indicates that the 828 mm maximum annual rainfall that occurred in 1941 has an average recurrence interval (ARI) in excess of 50 years. The 100 year ARI wettest year would see in the order of 900 to 1000 mm of rainfall recorded at Ranken River. The annual minimum rainfall of 100 mm that fell in 1928 is in excess of the 100 year ARI annual drought for the area.

- The Alexandria station, some 113 km north of the project, recorded the local maximum annual rainfall of 1,317 mm in 2000. The annual rainfall data from this station are positively skewed due to the effect of this significantly wet year caused primarily by a 48 hour rainfall of 317 mm recorded during the 8 and 9 December 2000 as a result of Tropical Cyclone Sam (refer to discussion on cyclones below). Austral Downs and Number 36 Bore stations also recorded their wettest year in 2000.

- The Annitowa Mile station, some 130 km south of the project, recorded the local minimum annual rainfall of 56 mm in 1988. However the driest year in the region occurred in 1928 at Austral Downs, Avon Downs and Ranken River. The 1928 annual rainfall represents in excess of the 100 year ARI annual dry for much of the region.

[3] Although the Wonarah gauge is closer to the project site than Ranken River it was closed in 1974 and it is therefore not possible to determine if data from the Wonarah gauge is representative of the project site under contemporary meteorological conditions.

Monthly Rainfall

Mean, maximum and minimum monthly rainfall values were determined for all ten local BoM daily rainfall stations discussed above (refer to monthly rainfall tables and graphs in Appendix A). However only the values for Ranken River, the site considered to be most representative of the project, are shown in Table 7.

Table 7: Ranken River Monthly Rainfall - Data set comprising all 866 complete months

Month	Mean Monthly Rainfall[1] (mm)	Median Monthly Rainfall (mm)	Maximum Monthly Rainfall (mm)	Minimum Monthly Rainfall (mm)	No. of Complete Months
January	85.6	61.5	273.6	5.0	73
February	82.9	65.3	270.6	0	73
March	46.1	32.5	312.0	0	74
April	13.4	0.0	156.2	0	73
May	9.5	0.0	127.8	0	74
June	9.0	0.0	102.6	0	72
July	3.9	0.0	46.5	0	71
August	2.2	0.0	83.9	0	70
September	4.2	0.0	66.9	0	73
October	14.2	8.1	101.3	0	73
November	26.7	15.7	118.0	0	70
December	61.9	39.3	430.6	0	70

Note 1: The sum of the mean monthly rainfalls above does not equal the mean annual rainfall exactly due to differences in the length of the two data sets.

The Ranken River values were developed using 866 complete months of data. This is a larger data set than the 62 years of complete annual data presented above (i.e. 62 years x 12 months = 744 months) as data for complete months within incomplete years were used in the analysis.

Table 7 shows that the wettest months are typically from December to March, with the greatest rainfall generally occurring in January and February. August is the driest month with a combined total of only 153 mm recorded for the month in the 70 months for which there is data.

Comparison of the mean and median monthly values show the skewing effect that a few significant cyclone or tropical depression related rainfall events can have on the mean rainfall values. The maximum monthly values, particularly during the drier winter months, are due to rare short duration (less than 72 hours) tropical depression related events that skew the monthly mean.

Zero precipitation or dry months have been recorded at Ranken River throughout the year, with only the wettest month of January recording minimum values greater than zero.

Daily Rainfall

An analysis of daily rainfall data was carried out for the ten local BoM stations listed above. The ten wettest days on record are shown in Table 8 along with the station name, date and, where related, the tropical cyclone name.

Table 8: Maximum Daily Rainfall - Data set comprising all records for all local stations

Station Name	Date	Precipitation to 9am (mm)	Rank	Event Name
Annitowa	29/2/2000	215.0	1	TC Steve
Austral Downs	16/1/1953	209.8	2	Unnamed 1952 #4
Alexandria	19/3/1901	180.3	3	-
Austral Downs	8/2/1953	174.5	4	-
Alexandria	9/12/2000	172.4	5	TC Sam
Alroy Downs	4/2/1976	170.0	6	TC Alan
Epenarra	23/3/1982	170.0	7	-
Alexandria	4/2/1976	167.5	8	TC Alan
Alexandria	22/1/1941	166.4	9	-
Avon Downs	18/2/1934	162.6	10	-

Note: Prior to 1964 Tropical Cyclones were unnamed and were instead assigned a sequential number by BoM.

A preliminary annual frequency analysis was carried out on the daily rainfall record for Annitowa station. This showed that the wettest day on record of 215 mm which occurred on 29 February 2000 as a result of TC Steve had an ARI in excess of 100 years.

A listing of the ten wettest days at each of the local rainfall stations is provided in Appendix A. An intensity-frequency-duration (IFD) relationship has been developed for the project for design purposes and is discussed further in Section 3 of this report.

Sub-Daily Rainfall

Rainfall intensity data from the four automatic pluviograph stations closest to the site were inspected (refer to Table 2 for station details). Unfortunately little reliable data were available from these stations, with the automatic gauges being unavailable for much of the time. An analysis of the available data produced the maximum six minute intensities shown in Table 9.

Table 9: Maximum Six Minute Rainfall Intensities from Local BoM Stations

BoM Station Name	Approx. Record Length (yrs)	Maximum Six Minute Intensity (mm/hr)	Date of Occurrence
Brunette Downs	37	170	5 Jan 1974
Tennant Creek Airport	36	192	9 Feb 1982
Ali Curung	18	64	12 Mar 1989
Camooweal Township	33	166	1 Feb 1979

The analysis showed that short duration rainfall intensities in excess of 150 mm/hr have been recorded at local BoM stations and is indicative of intensities that might be experienced at the project. The 192 mm/hr maximum six minute intensity recorded at Tennant Creek in February 1982 is of particular note. That intensity has an ARI in excess of 50 years (refer to the development of the IFD relationship later in this report).

2.3.4 Cyclone Swept Path Analysis

As mentioned above, although the project is located within a region that is occasionally subject to tropical cyclones and tropical depressions, they are erratic in nature and occur relatively infrequently. Typically they track either from east to west developing in the Coral Sea and entering the region after passing across the Cape York Peninsula, or from north-west to south-east arising in the Arafura Sea and crossing Arnhem Land or the Gulf of Carpentaria.

Of particular significance to the area surrounding the Wonarah project was TC Sam in early December 2000 which gave rise to one of the top ten wettest days on record at five of the local BoM stations. Also of note is the local maximum daily rainfall of 215 mm which was recorded at Annitowa during TC Steve in February 2000. Such events cause flooding, road closures and operational interruptions and other problems in the region and will require careful planning to mitigate such effects on the proposed project facilities.

In order to estimate the frequency that cyclones might be expected in the region the swept paths of all cyclones from January 1907 to April 2006 were plotted and those that passed within a 2 degree radius (or approximately 200 km) of the project were noted. This 4-degree (or approximately 400 km) band of influence was arbitrarily chosen as the width within which a cyclone would cause some degree of operational impact on the proposed project, even if only minor.

This initial assessment showed that some 16 tropical cyclones entered the 4-degree wide band during the 98-year period of record, or that the long-term regional average is approximately one cyclone every six or seven years. The 2000/2001 cyclone season is of particular interest with TC Sam and Wylva both passing within 200 km of the project within eight weeks of each other.

A second assessment was carried out to determine the number of cyclones crossing within a 0.5 degree radius (or approximately 50 km) either side of the project. It was considered that cyclones crossing within this 1-degree band would have more significant impacts on the project, likely leading to some degree of production loss. This assessment showed that two cyclones passed within this narrower band over the 98-year period of record, or one approximately every 50 years.

The results of the cyclone swept path analyses are provided in Appendix B.

It should be noted that the above analyses are somewhat subjective as they only consider the cyclone frequency and not its intensity. Cyclone intensity varies from a gale force category 1 with wind speeds up to 125 km/hr to severe category 5 cyclones with gusts of more than 280 km/hr. Obviously a more intense cyclone passing further away may cause greater damage than a less intense cyclone in the immediate vicinity of the project. This is illustrated by the fact that the 215 mm maximum daily rainfall recorded at Annitowa on 29 Feb 2000 occurred as a result of TC Steve which was passing along the southern coast of the Gulf of Carpentaria, some 600 km to the north.

2.3.5 Evaporation

Brunette Downs and Camooweal Township are the closest reliable evaporation gauging sites to the Wonarah project. Mean monthly Class A bird-guarded pan evaporation for both stations is shown in Table 10 for complete months only[4] (plots of mean, maximum and minimum monthly evaporation are also presented in Appendix A).

Inspection of the data shows mean annual pan evaporation measured at both stations is one order of magnitude greater than mean annual rainfall for the region and that mean monthly evaporation is significantly greater than mean monthly rainfall throughout the year. Evaporation is highest in the early summer months of October, November and December with mean monthly evaporation in the range of 317 to 347 mm recorded at both stations. Mean monthly evaporation reduces to approximately half this amount during the winter months of June and July. Maximum daily pan evaporation rates of 67.4 mm and 63.5 mm have been recorded at Brunette Downs and Camooweal Township respectively.

Given that the proposed project is roughly equidistant between the Brunette Downs and Camooweal Township stations and in the absence of acceptable site evaporation data, it is recommended that the average of pan evaporation data for both stations be used for design purposes for the Wonarah Project.

Table 10: Mean Monthly Pan Evaporation at Brunette Downs and Camooweal Township and Estimated Values for Wonarah Project

Month	Mean Monthly Pan Evaporation (mm)		
	Brunette Downs	**Camooweal**	***Wonarah Estimate***
January	294	332	313
February	243	264	254
March	241	275	258
April	229	250	240
May	203	209	206
June	164	164	164
July	180	180	180
August	220	222	221
September	280	272	276
October	333	347	340
November	317	330	324
December	331	345	338
Mean Annual Evaporation (mm)	**3,035**	**3,189**	**3,114**

[4] It should be noted that the mean monthly evaporation rates shown in Table 10 are slightly different than those presented in BoM Climate Summaries for Brunette Downs and Camooweal Township (refer Appendix A). This is due to the fact that incomplete months were excluded in the analysis completed for this study, while the BoM do not exclude incomplete months from their analysis.

2.3.6 Temperature

The monthly temperature data for the Wonarah station, some 20 km northwest of the project, are summarised in Table 11 below.

Table 11: Monthly Temperature Data for Wonarah Station (°C)

Month	Mean daily maximum Temp	Mean daily minimum Temp	Highest daily Max Temp	Lowest daily Min Temp	Mean no. of days where Max Temp ≥ 30°C	Mean no. of days where Max Temp ≥ 40°C
Jan	38.2	24.2	45.8	15.0	26.7	10.3
Feb	37.1	23.6	44.3	16.8	24.0	6.0
Mar	35.6	22.0	42.3	14.5	25.6	2.3
Apr	33.1	18.9	39.2	8.3	21.7	0
May	28.2	14.4	36.1	2.8	10.4	0
Jun	25.8	11.1	35.0	-0.2	3.3	0
Jul	25.1	9.9	32.6	1.1	2.9	0
Aug	27.8	11.5	37.8	0.6	9.9	0
Sep	31.9	15.5	39.6	6.0	19.1	0
Oct	35.9	19.9	42.2	9.2	25.5	3.0
Nov	37.9	22.2	44.9	12.2	24.9	7.2
Dec	38.8	23.6	44.4	13.1	27.1	10.5

Note: Wonarah temperature values based on approximately 17 years of data years of data (1957-1974) approximately 81% complete.

Inspection of the data provides the following points of note regarding temperature:

- Mean daily maximum temperatures range from 38.8°C in December to 25.1°C in July.
- Mean daily minimum temperatures range from 24.2°C in January to 9.9°C in July.
- Highest and lowest daily temperatures of 45.8°C (5 Jan 1971) and -0.2°C (26 Jun 1965) respectively have been recorded at Wonarah.
- Days with daily maximum temperatures in excess of 30°C occur throughout the year with an average of approximately 221 days with maximum temperatures above 30°C.
- Typically Wonarah will have in the order of 39 days each year with daily maximum temperatures in excess of 40°C, over half of which will occur during December and January.

2.3.7 Relative Humidity

Mean 9 am and 3 pm relative humidity data are summarised in Table 12 below for the Wonarah station, some 20 km northwest of the project.

Table 12: Monthly Relative Humidity Data[5] for Wonarah Station (%)

Month	Mean 9 am Relative Humidity	Mean 3 pm Relative Humidity
Jan	45	28
Feb	***51***	***30***
Mar	43	27
Apr	38	23
May	41	26
Jun	45	27
Jul	41	25
Aug	33	20
Sep	***26***	***16***
Oct	30	18
Nov	31	19
Dec	36	23

Notes: Wonarah temperature values based on approximately 19 years of data years of data between 1950 and 1970.

Inspection of the data shows that, as expected, mornings are more humid than afternoons, but that the general aridity of the region can be appreciated when it is noted that the mean 9 am relative humidity for January and February, the wettest months, is only about 50%.

The data show that highest and lowest relative humidities can be expected during the months of February and September respectively. The highest values coincide with the occurrence of wetter conditions and slightly lower temperature in January and February, while the lowest humidities and temperatures are recorded during the dry season. All local stations record their lowest mean relative humidities during the months of July, August, and September. During the dry season, dews are not uncommon on clear nights, but frost occurrence is rare, being confined to the months of June, July, and August.

2.3.8 Wind Speed and Direction

Prior to closing in 1974 the Wonarah station, some 20 km northwest of the site, was the nearest BoM station that recorded mean daily wind speed and direction. The closest operational, long-term wind recording station, that also records maximum instantaneous wind gust speed, is at Tennant Creek Airport, approximately 240 km to the west[6]. Mean daily 9 am and 3 pm wind data are available for the Wonarah station from January 1957 to closure in August 1974 and for the Tennant Creek Airport from July 1969 to the present.

The mean monthly 9 am and 3 pm wind speeds for both Wonarah and Tennant Creek Airport and the maximum wind gusts for Tennant Creek Airport are shown in Table 13.

[5] It should be noted that while relative humidity is a traditional indicator of the air's moisture content it is not a measure of the actual amount of atmospheric moisture as it depends on the air temperature i.e. at 50% RH there is much more moisture in the air at an air temperature of 25°C than there is at 15°C. BoM do not take this dependence into account in their calculations and the above values should therefore be regarded as approximations only.

[6] Wind gust data were also obtained for Camooweal Township, some 175 km northeast of the project site, but were discarded due to its brevity (5.4 years) and poor level of completeness (11%).

Table 13: Mean Monthly 9 am and 3 pm Wind Speed for Wonarah and Tennant Creek Airport and Maximum Wind Gusts for Tennant Creek Airport

	Mean 9am Wind Speed (km/h)		Mean 3pm Wind Speed (km/h)		Highest Recorded Wind Gust (km/h)
Month	**Wonarah**	**Tennant Creek Airport**	**Wonarah**	**Tennant Creek Airport**	**Tennant Creek Airport**
Jan	11.5	17.0	12.0	15.4	117
Feb	13.6	16.7	12.0	15.9	102
Mar	14.3	19.6	13.6	17.6	95
Apr	17.2	23.7	13.0	17.3	98
May	16.9	24.7	13.3	16.7	81
Jun	15.5	24.4	12.4	16.5	78
Jul	17.7	23.7	13.8	15.5	80
Aug	19.1	25.3	12.9	16.1	78
Sep	19.2	25.6	13.1	16.0	76
Oct	18.0	24.9	12.6	14.5	104
Nov	16.4	21.7	11.6	13.8	100
Dec	16.5	18.3	12.2	14.1	106

Note: Wonarah mean monthly wind speed values based on some 17 years of data approximately 81% complete. Tennant Creek Airport mean monthly wind speed and maximum wind gust values based on some 38 years of data approximately 97% and 99% complete respectively.

Inspection of the mean monthly data shows that although wind speeds are typically higher at Tennant Creek than at Wonarah, the annual distribution is similar at both stations, with average wind speeds peaking in late winter months of August and September. Winds are fresher in the morning, with the 9 am observations typically higher than those for 3 pm.

Annual wind roses for the 9 am and 3 pm observations at Wonarah are provided in Appendix A[7]. These show that south-easterly's predominate in both the morning and afternoons throughout the year. Calm conditions were noted less than 10% of the time for both morning and afternoon observations.

Five months have recorded maximum gust speeds in excess of 100 km/h at Tennant Creek Airport with the maximum speed of 117 km/hr being recorded on 4 January 2004. Unfortunately it is not possible to compare these maximum gust speeds with the Wonarah BoM station as it was never equipped to record wind gust speed. However the Tennant Creek maximum gust speeds are typical of what may be expected at the project.

2.4 Hydrological Conditions

2.4.1 Review of Existing Data

Daily flow and stage (i.e. water surface level) data were extracted for the surface water stations shown in Table 14. Only the Playford River station is located within the Barkly SWMA; all of the others located within the adjoining Georgina River SWMA.

[7] The wind rose for Tennant Creek Airport was also obtained, but has not been presented as the distribution of wind direction is significantly different to the Wonarah site which is much closer to the project site.

Table 14: Regional Flow Gauging Stations

Station Name	Playford River	Ranken River	James River	Shakespeare Creek	Georgina River
Distance from Site (km)	92.5 km NW	59.1 km E	109.7 km E	128.4 km SE	364.0 km SE
Data Record Length (years)	~33	~42	~23	~17	~21
Catchment Area (km^2)	6,620	4,360	506	398	118,398
Mean Annual Flow (GL)	N/A	172.1	N/A	N/A	1,042.3
Median Annual Flow (GL)	N/A	39.9	N/A	N/A	328.7
Maximum Annual Flow (GL)	N/A	2,035.7 (2000)	N/A	N/A	6,288.0 (1976/77)
Minimum Annual Flow (GL)	N/A	0.6 (1972)	N/A	N/A	9.9 (1968/69)
Maximum Daily Flow (m^3/sec)	N/A (13/12/00)	1,720.9 (16/12/84)	N/A (24/1/77)	N/A (24/1/77)	3692.7 (24/2/77)
Peak Instantaneous Flow (m^3/sec)	N/A (13/12/00)	>>2,000 (4/1/09)	N/A (15/12/84)	N/A (24/1/77)	3,832.8 (24/2/77)

Note 1: Only stage data were available for the Playford River, James River and Shakespeare Creek stations. Consequently these records could only be used to indicate when large flow events occurred, rather than their magnitude.

Inspection of the data provides the following points of note:

- The annual flow data for the Ranken and Georgina River stations highlight the hydrological variability of the region, with both stations demonstrating the right-hand or positive skewness typical of all flow gauging stations in the region. It is interesting to note that there is one order of magnitude between mean and median annual flow volumes and some three orders between the minimum and maximum annual volumes.

- The mean annual flow at the Ranken and Georgina River stations is 172.1 GL and 1,042.3 GL respectively. This is equivalent to mean annual specific yields in the range of 0.2-1.2 x 10^{-3} $m^3/sec/km^2$ or mean annual runoff rates in the order of 10 to 40 mm which is comparable with inland catchments in the Pilbara region[8]. Assuming an average annual rainfall across the region of approximately 400 mm these runoff rates typically represent 2.5% to over 10% of the annual rainfall. It should be noted however that during short-duration, high-intensity localised rainfall events runoff rates will exceed these annual rates significantly.

- Ranken and Georgina River stations recorded their lowest annual flows in 1972 and 1968/69 with 0.6 and 9.9 GL respectively. This coincided with a sustained period of low rainfall with several of the regional stations recording their lowest annual rainfall depths during this period. However, the lowest regional streamflow likely occurred

[8] Median annual runoff rates in the order of 15 mm are reported for the De Grey River area in *Surface Hydrology of the Pilbara Region*, Ruprecht, J.K. and Ivansecu, S., Water and Rivers Commission (1996).

in 1928 (prior to construction of the flow monitoring stations) which saw annual rainfalls of 100 mm or less over much of the region. The average recurrence interval of the 1928 annual rainfall is in excess of 100 years.

- The hydrological variability in this extreme drought/flood climate is demonstrated by the peak instantaneous flows at both the Ranken and Georgina River stations which are of similar magnitude despite the fact that the latter catchment area is over 25 times larger.

- Significant rainfall-runoff events have occurred across the region and are reflected in the streamflow data. Of particular note is the peak instantaneous flow well in excess of 2,000 m^3/sec which was recorded at Ranken River in early January 2009[9]. This event was likely a pre-cursor to TC Charlotte which formed from a monsoon trough over the Gulf of Carpentaria during early January.

- Although flow data were unavailable for the Playford River, James River and Shakespeare Creek stations, an inspection of their stage data provided maximum flow depths of 4.6, 3.5 and 4.8 m respectively. The maximum depth at Playford River occurred on 13 December 2000 likely as a result of TC Sam following significant rainfalls across the region (172 mm was recorded at Alexandria four days earlier on 9 December 2000). The maximum stages at James River and Shakespeare Creek were attributable to the same regional runoff event that caused the maximum daily and instantaneous flows at the Georgina River gauging station.

The flow data reported above are used in the following section to estimate peak flows that might be expected in the creeks that cross the Wonarah project.

[9] The maximum gauged flow at the Ranken River station was 1,734 m^3/sec which had a stage of 3.69 m recorded on 27 Jan 1977. The event of early January 2009 peaked at 5.51 m stage.

3.0 WATER MANAGEMENT CONSIDERATIONS

3.1 General

Although the design of specific water management measures was not included in the scope of this baseline hydrological assessment, rainfall and streamflow design parameters are presented in this section for future use.

All the watercourses and drainages in the immediate vicinity of the Wonarah Project are ephemeral. However, flows will occur periodically during the summer months from January to March, when the potential exposure to high intensity rainfall is greatest. Consequently runoff will report to the watercourses in the vicinity of the project and, on occasion, flows may be high and may cause flooding if appropriate measures are not in place.

The hazard that such flooding poses to on-site facilities depends, amongst other things, on the following:

- the magnitude of the flood event;
- the proximity of the facility to the watercourse in flood;
- the sensitivity of the facility to flooding; and,
- the level of protective flood measures provided to the facility.

While the latter three factors can be controlled or engineered to some degree, the magnitude of the naturally occurring rainfall-runoff events that may lead to flooding cannot be controlled.

Although significant rainfall-runoff events do not occur cyclically, especially in a climatic region as variable as the Barkly SWMA, their probability of occurrence within any given period can be estimated. The reciprocal of this probability is typically expressed as an average recurrence interval (ARI) or return period and is the time that, on average, elapses between two events that equal or exceed the magnitude in question.

Table 15 shows the percentage probability for a range of different ARI flood events that could occur during the envisaged 10 year operational life of Stage 1 of the project.

Table 15: Percentage Probability of N-Year ARI Flood Event Occurring During 10 Year Operational Life of Stage 1 of the Project

Average Recurrence Interval (ARI) in Years	**5**	**10**	**20**	**50**	**100**	**200**
Probability of Occurrence	89%	65%	40%	18%	10%	5%

Typically a range of ARI events are used for the design of various mine facilities, depending on their sensitivity to flooding and the period of exposure. For example a temporary drain around a laydown area used during construction may be designed for a 2 year ARI event, while culverts below a main plant access road might be designed for the 10 or 20 year ARI event, depending on the consequences of failure. Good practice suggests that when preparing earthworks pads for mine facilities that they be kept above the 20 year ARI flood level as minimum[10].

The selection of a certain recurrence interval "design" event is generally left to the mine owners to determine based on industry practice and their attitude towards risk. The relevant regulatory authorities review the resulting facility design and make recommendations as necessary.

3.2 Preliminary Flow Estimates for On-site Creeks

Generally flow statistics at any location of interest can be generated using three different approaches (in order of preference):

- *Site Measured Streamflow Analysis* - from long-term streamflow records collected at the location of interest;
- *Regional Hydrological Analysis* - from streamflow records collected at the nearby watersheds with similar hydrological characteristics (e.g., similar drainage area, soils, vegetation and slopes); or,
- *Hydrological calculation/modelling* – using published regional methods applied to site specific rainfall and catchment characteristics.

Given the non-availability of site streamflow data and the paucity of suitable regional streamflow data, it is likely that hydrological calculations using the published methods will have to be used for the future design of on-site water management facilities.

Currently the most commonly applied calculation methods to Australian conditions are those presented in ARR97[11]. These typically involve the development of a rainfall intensity-frequency-duration (IFD) relationship for the site of interest and its application to specific catchment characteristics such as area, gradient, soil type, vegetation cover etc. in various forms of the Rational and Regional Frequency methods.

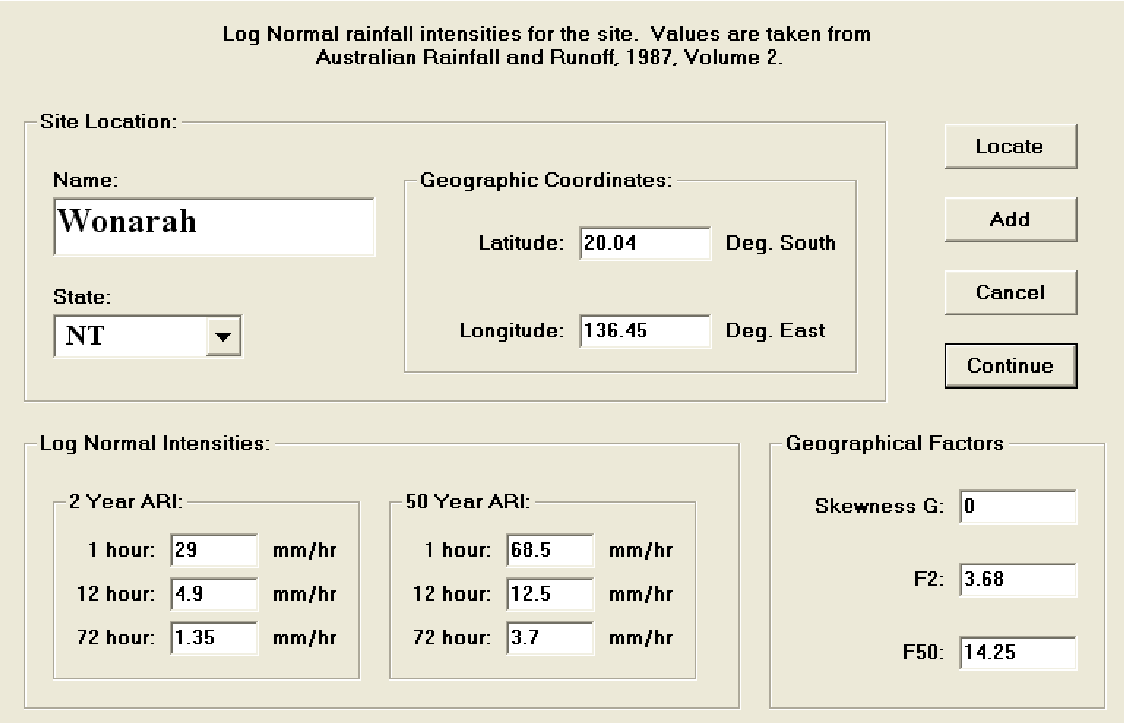
The IFD has been developed for the site and is presented in the following section. In addition a preliminary site catchment delineation has been prepared and is presented in Figure 3. Given the preliminary nature of the proposed mine facility layout however, peak flow estimates for the relatively minor on-site creeks have not been prepared. Once the proposed layout is more advanced peak flow estimates will be made for use in the design of flood diversion channels, protection bunds etc.

[10] Water and Rivers Commission, Western Australia, 2000, *Water Quality Protection Guidelines No. 6, Mining and Mineral Processing Minesite Stormwater*

[11] Institution Of Engineers Of Australia, 1997, Australian Rainfall And Runoff, Volume One, Book Four, Estimation Of Design Peak Discharges.

3.2.1 Intensity-Frequency-Duration Relationship

Point Intensity-Frequency-Duration (IFD) data were developed for Wonarah in accordance with Chapter 2 of ARR97 using the AUS-IFD computer software. The input parameters shown below were selected using Volume 2 of ARR97.



The resulting IFD relationship is presented in Appendix C of this report.

In summary, the 100 Year ARI intensities for 1, 3, 12, 24 and 72 hr duration events are 78.0, 37.2, 14.4, 9.3 and 7.3 mm/hr respectively i.e. giving equivalent storm depths of 78, 112, 173, 223 and 526 mm. An ARI of approximately 100 years could therefore be applied to the maximum regional daily rainfall depth of 215 mm which was recorded at Annitowa on 29 February 200 during TC Steve (refer to Table 8 earlier in report).

4.0 CLOSING REMARKS

A desktop hydro-meteorological study was completed to develop information that may be used in the future analyses and design of water management measures at the Wonarah Project. In particular this information may be used in the design of water management measures required for the proposed development of the initial Arruwurra Prospect.

We trust that this report satisfies Minemakers current requirements and we look forward to discussing the future development of the project with you.

Groundwater Resource Management Pty Ltd

Alistair Lowry — **Senior Water Resources Engineer**

Rob Garnham — **Principal Hydrogeologist**

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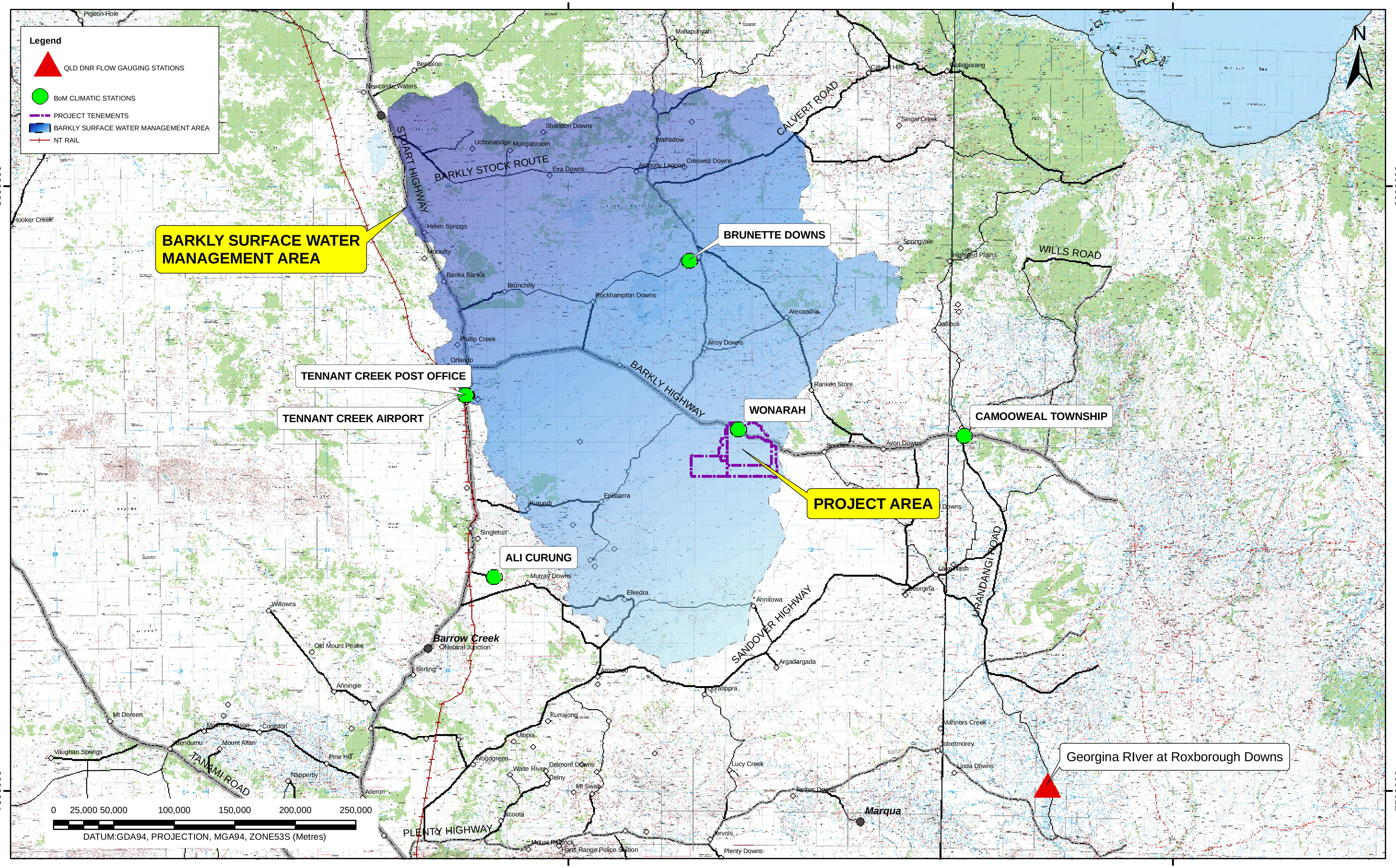

NOTES:

1. BASE MAP SHOWN GEOSCIENCE AUSTRALIA 250K TOPOGRAPHIC MOSIAC

GROUNDWATER RESOURCE MANAGEMENT

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DRAWN: DFH	DATE: 28.04.2009	TITLE: REGIONAL SITE LOCATION PLAN	
CHECKED: ARL	DATE: 30.04.2009		
SCALE: 1:3,000,000 @ A3		PROJECT No: J090004	FIGURE No: 1

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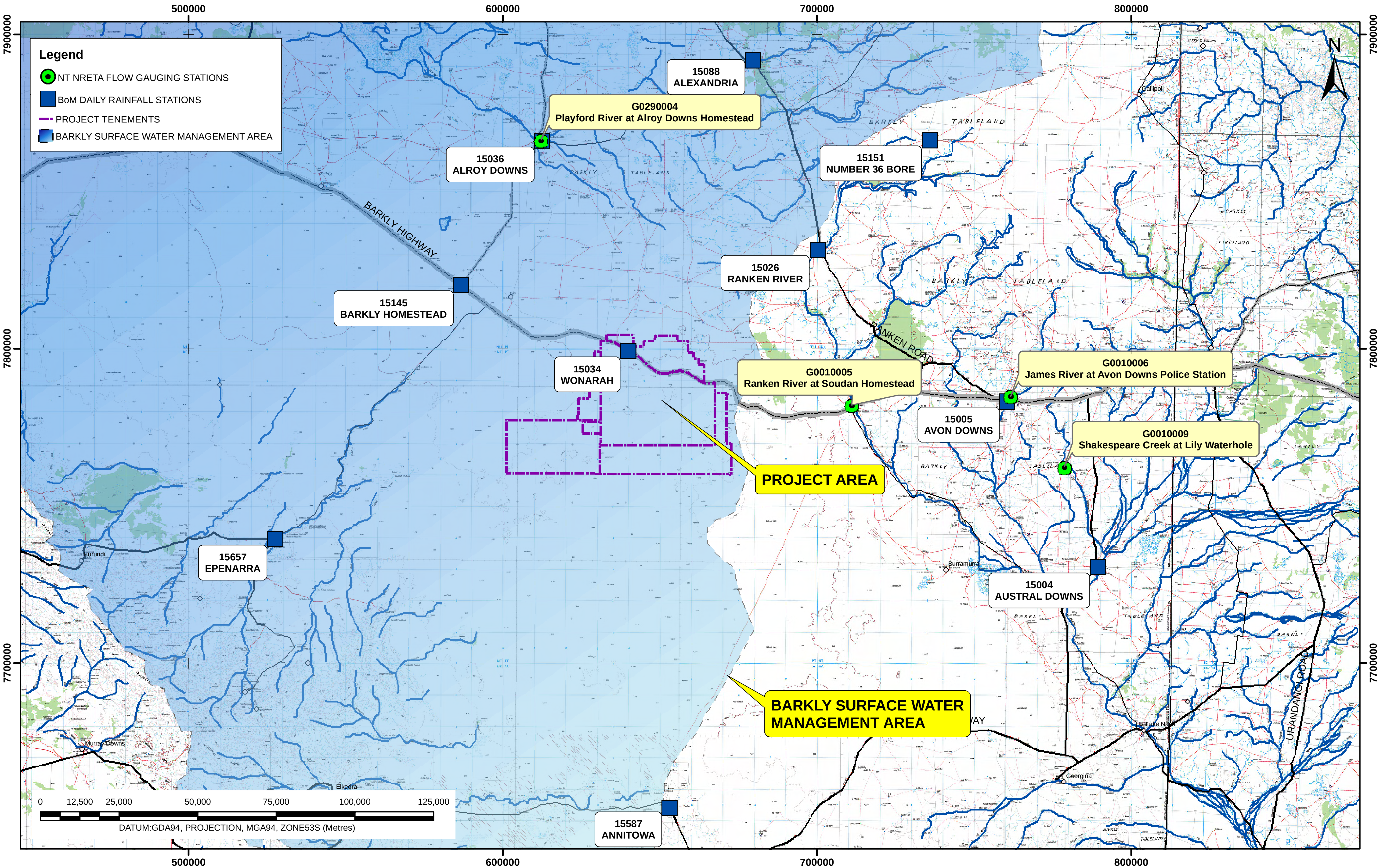
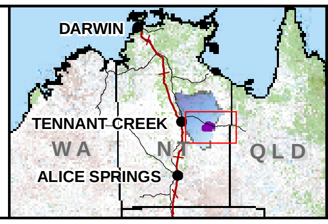


NOTES:

1. BASE MAP SHOWN GEOSCIENCE AUSTRALIA 250K TOPOGRAPHIC MOSIAC



GROUNDWATER RESOURCE MANAGEMENT

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DRAWN DFH	DATE 28.04.2009	TITLE LOCAL SITE LOCATION PLAN	
CHECKED ARL	DATE 30.04.2009		
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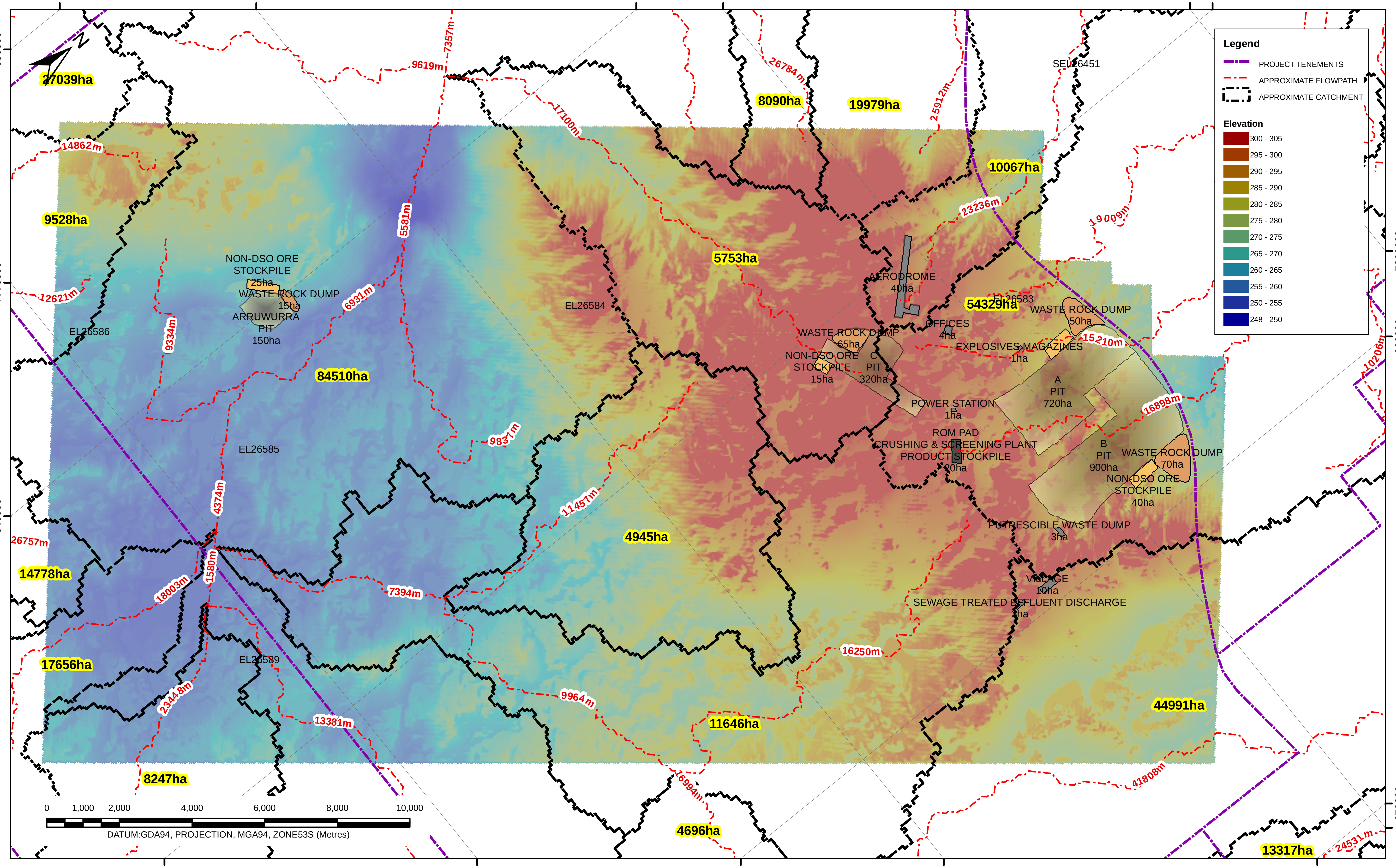
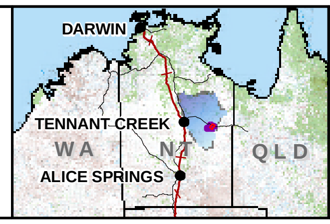


NOTES:

1. ELEVATION TIN, FLOWPATHS AND CATCHMENT AREAS DEVELOPED USING GIS TOOLS TO BE CONFIRMED IN FIELD.



GROUNDWATER
RESOURCE MANAGEMENT

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DRAWN: DFH	DATE: 28.04.2009	TITLE: LOCAL CATCHMENT DELINEATION PLAN	
CHECKED: ARL	DATE: 30.04.2009		
SCALE: 1:100,000 @ A3		PROJECT No: J090004	FIGURE No: 3

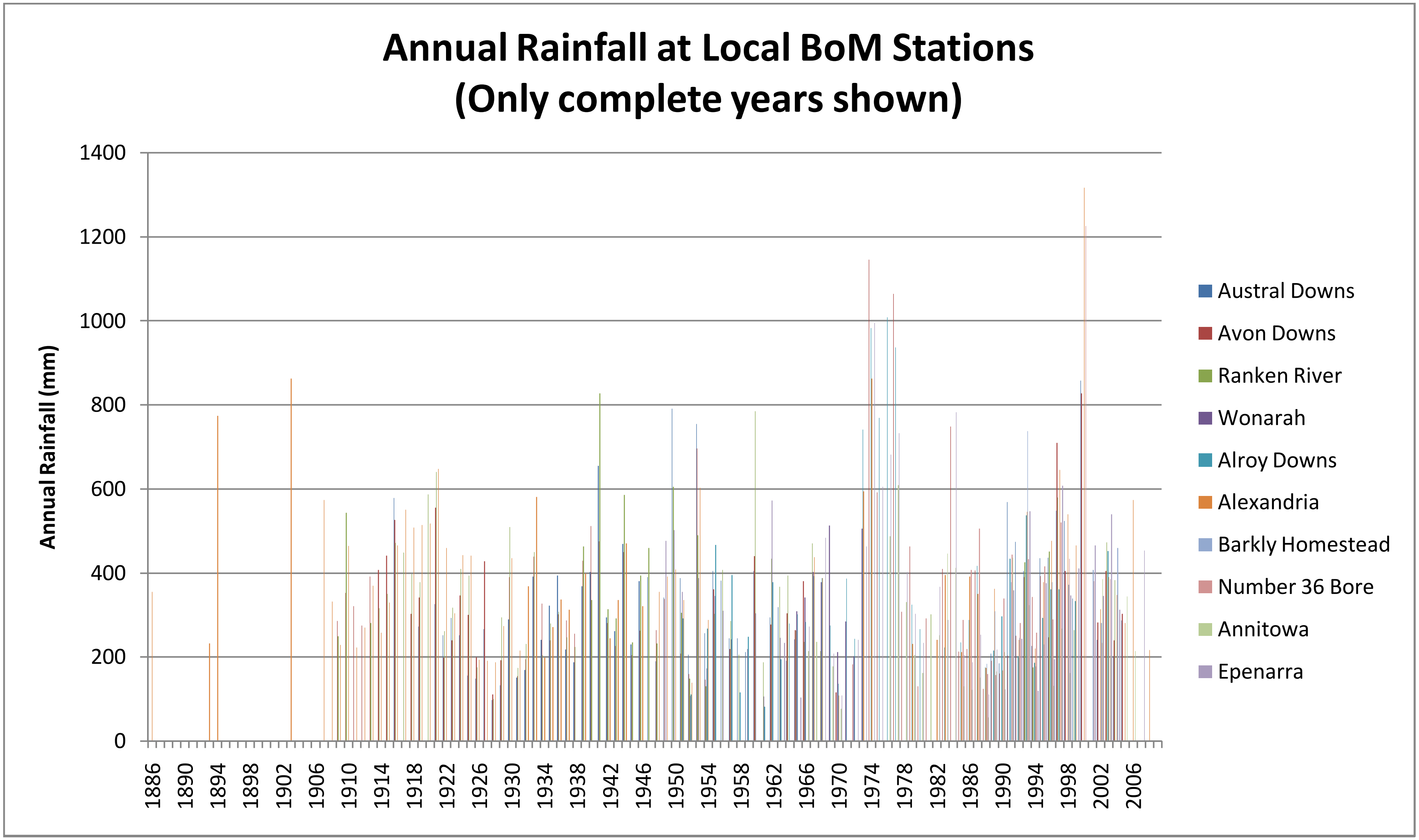
File Location : I:\CarrickConsulting\J090004_Wonarah_NT\03_ProjectData\01_Workspace

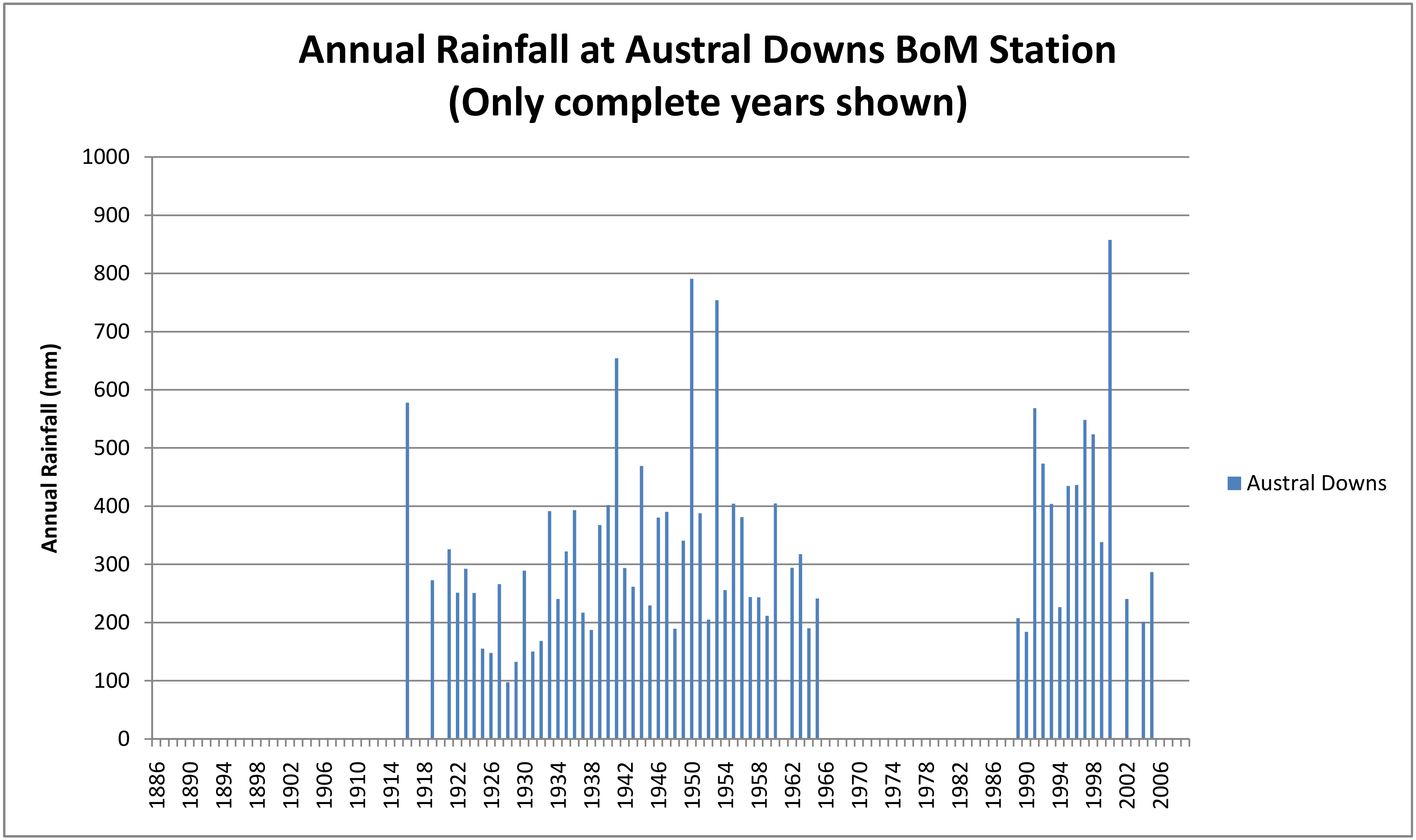
APPENDIX A

Hydro-meteorological Data

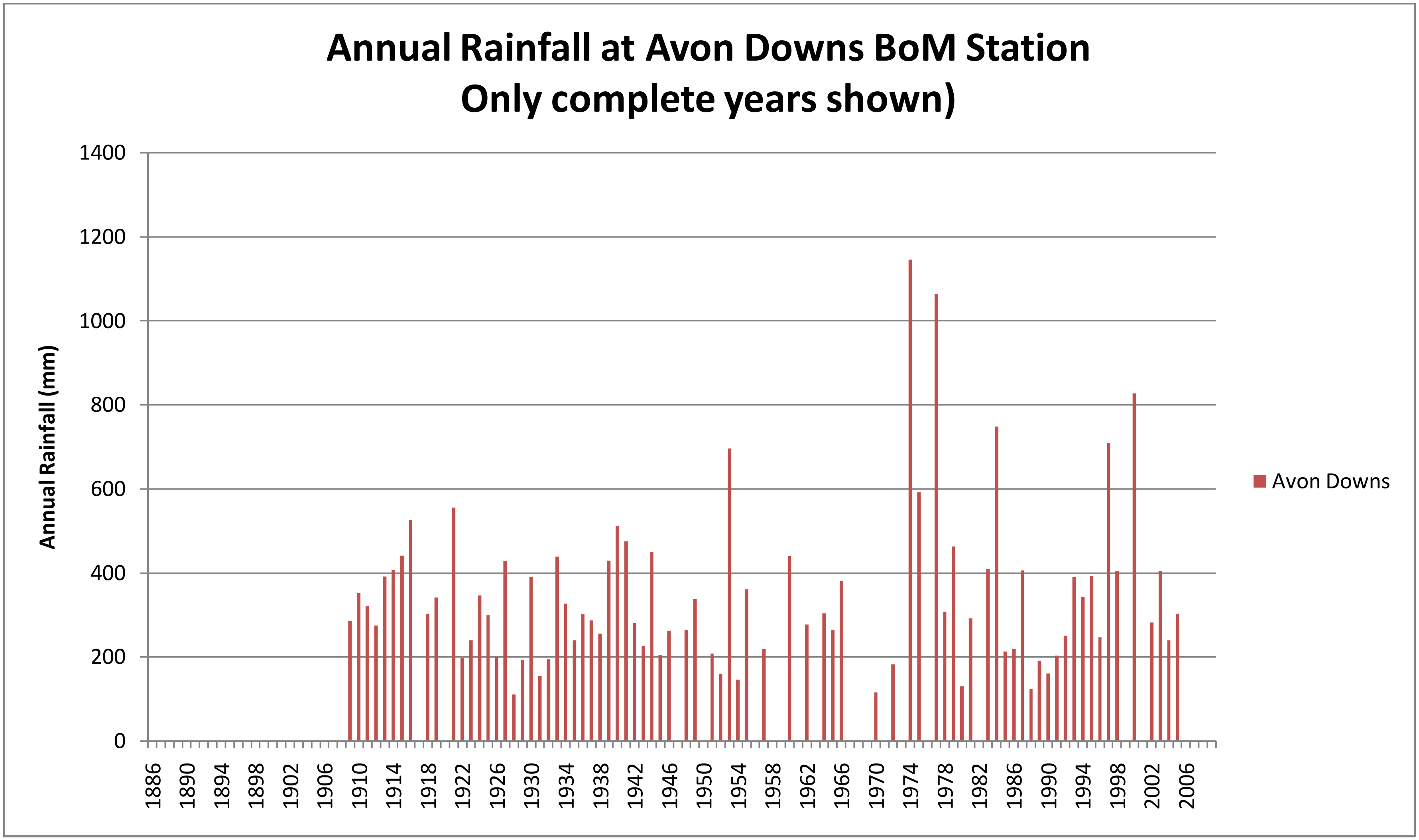
Annual Rainfalls at Local Rainfall Stations (Only complete years considered)										
YEAR	Austral Downs	Avon Downs	Ranken River	Wonarah	Alroy Downs	Alexandria	Barkly Homestead	Number 36 Bore	Annitowa	Epenarra
1886	-	-	-	-	-	354.4	-	-	-	-
1887	-	-	-	-	-	Incomplete	-	-	-	-
1888	-	-	-	-	-	Incomplete	-	-	-	-
1889	-	-	-	-	-	Incomplete	-	-	-	-
1890	-	-	-	-	-	Incomplete	-	-	-	-
1891	-	-	-	-	-	Incomplete	-	-	-	-
1892	-	-	-	-	-	Incomplete	-	-	-	-
1893	-	-	-	-	-	232.6	-	-	-	-
1894	-	-	-	-	-	774.7	-	-	-	-
1895	-	-	-	-	-	Incomplete	-	-	-	-
1896	-	-	-	-	-	Incomplete	-	-	-	-
1897	-	-	-	-	-	Incomplete	-	-	-	-
1898	-	-	-	-	-	Incomplete	-	-	-	-
1899	-	-	-	-	-	Incomplete	-	-	-	-
1900	-	-	-	-	-	Incomplete	-	-	-	-
1901	-	-	-	-	-	Incomplete	-	-	-	-
1902	-	-	-	-	-	Incomplete	-	-	-	-
1903	-	-	-	-	-	863.2	-	-	-	-
1904	-	-	-	-	-	Incomplete	-	-	-	-
1905	-	-	-	-	-	Incomplete	-	-	-	-
1906	-	-	-	-	-	Incomplete	-	-	-	-
1907	-	-	-	-	-	573.5	-	-	-	-
1908	-	-	-	-	-	331.4	-	-	-	-
1909	-	285.4	249	-	-	228.2	-	-	-	-
1910	-	352.5	542.8	-	-	463.7	-	-	-	-
1911	-	321.4	Incomplete	-	-	223	-	-	-	-
1912	-	274.7	Incomplete	-	-	269.2	-	-	-	-
1913	-	390.8	280.2	-	-	369.7	-	-	-	-
1914	Incomplete	407.6	316.5	-	-	257.8	-	-	-	-
1915	Incomplete	440.9	349.9	-	-	329.7	-	-	-	-
1916	578.3	526.4	472.1	-	-	465.8	-	-	-	-
1917	Incomplete	Incomplete	448.8	-	-	551.1	-	-	-	-
1918	Incomplete	302.2	397.1	-	-	508.2	-	-	-	-
1919	272.8	341.6	378.4	-	-	514.5	-	-	-	-
1920	Incomplete	Incomplete	586.6	-	-	518	-	-	-	-
1921	326.3	555.3	639.9	-	-	647.5	-	-	-	-
1922	251.4	197.7	261.5	-	-	459.7	-	-	-	-
1923	292.6	239.1	317.3	-	-	303.5	-	-	-	-
1924	251.2	346.2	409.4	-	-	442.9	-	-	-	-
1925	155.5	300.5	393.9	-	-	440.6	-	-	-	-
1926	147.9	199.2	174.5	-	-	193.4	-	-	-	-
1927	266.4	427.7	Incomplete	-	-	190.7	-	-	-	-
1928	97.8	111.1	100.1	-	-	187.6	-	-	-	-
1929	132.8	192.2	294.4	-	-	273.5	-	-	-	-
1930	289.3	390.5	508.9	-	-	435.2	-	-	-	-
1931	150.6	154.8	173.8	-	-	215.4	-	-	-	-
1932	168.7	194.7	231.2	-	-	367.7	-	-	-	-
1933	391.8	439	449.1	-	-	581.4	-	-	-	-
1934	241	327.3	203.9	-	-	198.6	-	-	-	-
1935	322.3	238.9	279.2	-	-	270.6	-	-	-	-
1936	393.6	300.8	307.3	-	-	337.1	-	-	-	-
1937	217.2	286.8	247.1	-	-	311.8	-	-	-	-
1938	187.6	254.8	224.1	-	-	Incomplete	-	-	-	-
1939	367.7	428.8	463.4	-	-	398.5	-	-	-	-
1940	402.1	512.1	335.6	-	-	Incomplete	-	-	-	-
1941	654.5	475.6	827.9	-	-	Incomplete	-	-	-	-
1942	293.9	281.1	314.1	-	-	244.2	-	-	-	-
1943	261.7	226.5	292.1	-	-	335.2	-	-	-	-
1944	469.1	449.2	585.9	-	-	470.8	-	-	-	-
1945	229.6	203.8	234.5	-	-	Incomplete	-	-	-	-
1946	380.7	262.5	393.8	Incomplete	-	321	-	-	-	-
1947	390.4	Incomplete	459.6	Incomplete	-	Incomplete	-	-	-	-

YEAR	Austral Downs	Avon Downs	Ranken River	Wonarah	Alroy Downs	Alexandria	Barkly Homestead	Number 36 Bore	Annitowa	Epenarra
1948	189.6	263.9	232.7	Incomplete	-	355.3	-	-	-	-
1949	341.1	337.5	Incomplete	476.6	-	390.8	-	-	-	-
1950	791	Incomplete	604.9	501.7	Incomplete	408	-	-	-	-
1951	388.2	207.9	304.5	354.7	291.4	335.4	-	-	-	-
1952	205.3	158.6	148.5	107.4	110.8	138.6	-	-	-	-
1953	754.1	695.9	489.8	387.3	Incomplete	602.4	-	-	-	-
1954	256.1	145.8	129.6	172.6	266.8	288.1	-	-	-	-
1955	404.5	360.8	302.6	345.3	466.7	Incomplete	-	-	-	-
1956	381.6	Incomplete	407.6	309.7	Incomplete	Incomplete	-	-	-	-
1957	244.1	218.8	285	242.3	394.4	Incomplete	-	-	-	-
1958	243.8	Incomplete	205.4	Incomplete	115.6	Incomplete	-	-	-	-
1959	211.9	Incomplete	Incomplete	219.2	248.2	Incomplete	-	-	-	-
1960	404.9	439.8	784.7	304.1	Incomplete	Incomplete	-	-	-	-
1961	Incomplete	Incomplete	187.2	106.2	81.5	Incomplete	-	-	-	-
1962	294.5	277.4	433.8	572.2	377.8	Missing	-	-	-	-
1963	318.1	Incomplete	367.3	246	194.2	Missing	-	-	-	232.9
1964	190.5	303.9	394	Incomplete	279	Incomplete	-	-	-	Missing
1965	241.8	263.9	261.9	308.3	301.3	Incomplete	-	-	-	103.9
1966	Incomplete	380	235.6	341.1	283.6	Missing	-	-	213.9	271.9
1967	Missing	Incomplete	470.4	402	392.1	437	-	-	236.2	Incomplete
1968	Missing	Missing	213.4	378.4	387.7	387.6	-	-	Incomplete	483.5
1969	Missing	Incomplete	Incomplete	512.8	274.1	Incomplete	-	-	177.6	207.9
1970	Missing	116	Missing	212	136.7	108.6	-	-	76.8	108.2
1971	Missing	Incomplete	Missing	284.2	385.9	Incomplete	-	-	Incomplete	Incomplete
1972	Missing	182.8	Missing	202	242.5	Incomplete	-	-	Missing	240.1
1973	Missing	Incomplete	Missing	506.1	741	594.2	-	-	Incomplete	463.6
1974	Missing	1145.4	Missing	Incomplete	982.7	863	-	-	Incomplete	995.2
1975	Missing	591.3	Missing	Closed	769.2	Incomplete	-	-	Incomplete	605.6
1976	Missing	Incomplete	Missing	Closed	1008.9	Incomplete	-	-	487.2	681.2
1977	Missing	1064.9	Missing	Closed	936.6	Incomplete	-	-	609.4	733.2
1978	Missing	307.8	Missing	Closed	Incomplete	Incomplete	-	-	330.8	402.1
1979	Missing	463.2	Missing	Closed	325	230.5	-	-	204	302.5
1980	Missing	129.5	Missing	Closed	265.8	Incomplete	-	-	161.6	232.8
1981	Missing	291.6	Missing	Closed	Incomplete	Incomplete	-	-	300.8	Incomplete
1982	Missing	Incomplete	Missing	Closed	Incomplete	241	-	Incomplete	251	367
1983	Missing	409.6	Missing	Closed	223	394.6	-	Incomplete	446.6	287.9
1984	Incomplete	749	Missing	Closed	Incomplete	Incomplete	-	Incomplete	412.5	782.6
1985	Missing	213.2	Missing	Closed	234.3	211.7	-	288.2	130.4	204.2
1986	Missing	218.6	Missing	Closed	288.2	391.8	-	406.6	121	187.3
1987	Missing	405.8	Missing	Closed	417.4	349.4	Incomplete	505.6	150.2	253
1988	Missing	124	Missing	Closed	175.6	173.2	184.1	159.8	56.2	110.5
1989	207.9	191	Missing	Closed	214.6	362	309	157.2	165.6	218
1990	184.4	161	Missing	Closed	296.2	167.8	Missing	338.5	211.7	122.9
1991	568.8	203	Missing	Closed	434.3	Incomplete	378.4	444	436.1	358.2
1992	473.4	249.9	Incomplete	Closed	201.8	241	245	280.2	Incomplete	242.6
1993	404.1	389.6	424.9	Closed	536.6	545.9	737.3	433.2	323.2	546.8
1994	226.6	342.7	175.5	Closed	186	219.5	177.2	257.9	Incomplete	119
1995	435	393.1	Incomplete	Closed	293	377.6	229.7	416.2	Incomplete	375.3
1996	436.5	246.2	450.3	Closed	360.5	476.9	377.6	289.4	131.1	194.4
1997	548.3	709.8	579.2	Closed	361	645.9	Incomplete	520	267	607.4
1998	523.6	404.4	Incomplete	Closed	Incomplete	539.8	371.8	434.3	162	346.4
1999	338.7	Incomplete	263.4	Closed	332.5	464.9	Incomplete	Incomplete	Incomplete	411
2000	857.9	827.6	Incomplete	Closed	Incomplete	1317.1	Incomplete	1226.8	Incomplete	Incomplete
2001	Incomplete	Incomplete	Incomplete	Closed	Incomplete	Incomplete	406.7	379.9	Incomplete	465.6
2002	240.7	281.5	Incomplete	Closed	Incomplete	313.3	280.2	233.3	385	345.4
2003	Incomplete	404.2	472.3	Closed	451.5	390.3	Incomplete	385.5	203.5	539.9
2004	201.6	239.1	382.6	Closed	Incomplete	347.4	459.9	Incomplete	Incomplete	312.4
2005	287	303.1	Incomplete	Closed	Missing	281.2	Incomplete	Incomplete	344.5	Incomplete
2006	Incomplete	Incomplete	Incomplete	Closed	Missing	574	Incomplete	Incomplete	214	Incomplete
2007	Incomplete	Incomplete	Missing	Closed	Missing	Incomplete	Incomplete	Incomplete	Missing	453.3
2008	Missing	Missing	Missing	Closed	Missing	216.7	Missing	Incomplete	Incomplete	Missing
2009	Incomplete	Missing	Missing	Closed	Missing	Incomplete	Missing	Incomplete	Missing	Missing

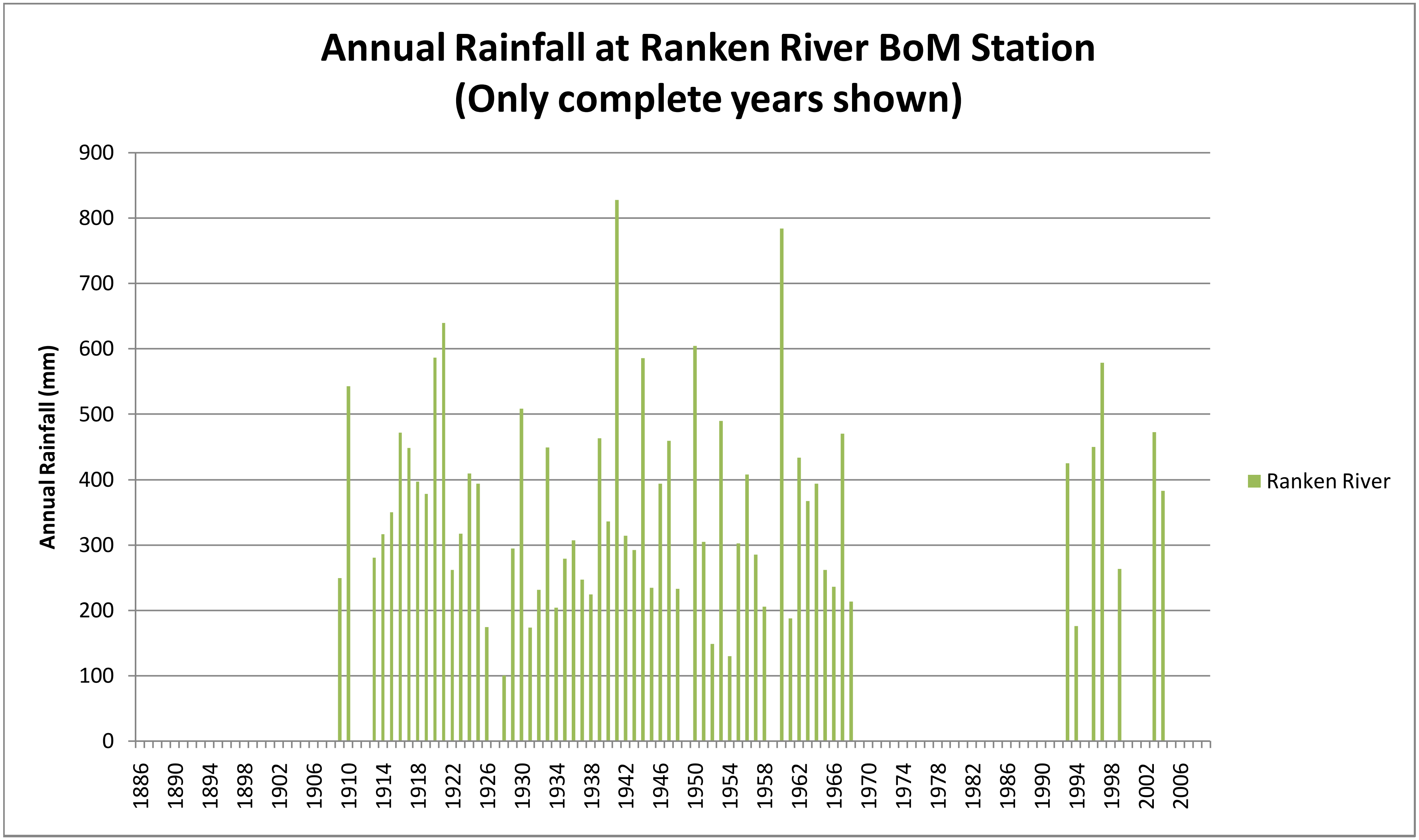

Annual Rainfall at Local BoM Stations
(Only complete years shown)
Annual Rainfall (mm)
1400
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Austral Downs
Avon Downs
Ranken River
Wonarah
Alroy Downs
Alexandria
Barkly Homestead
Number 36 Bore
Annitowa
Epenarra

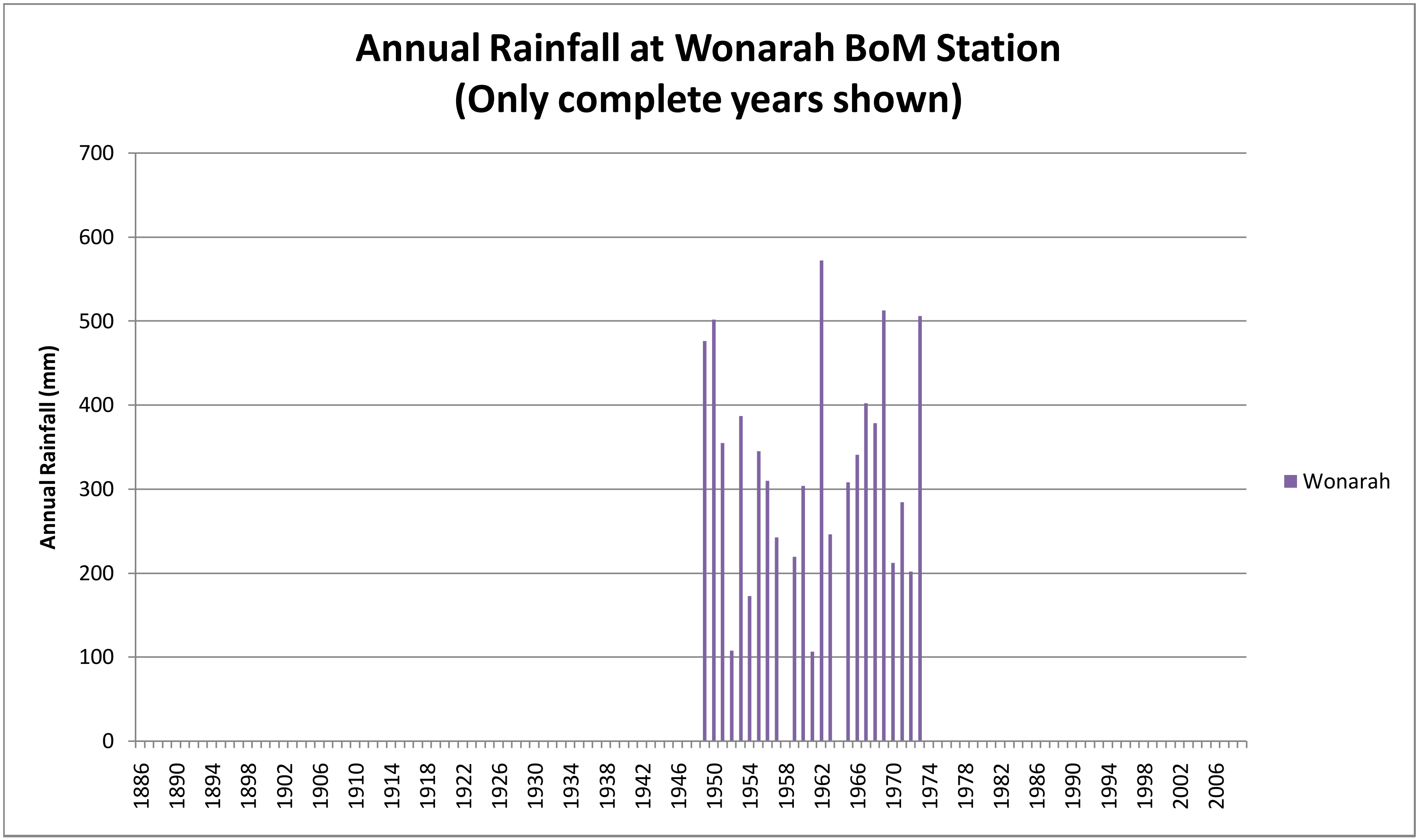


Annual Rainfall at Austral Downs BoM Station
(Only complete years shown)
Annual Rainfall (mm)
1000
900
800
700
600
500
400
300
200
100
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Austral Downs

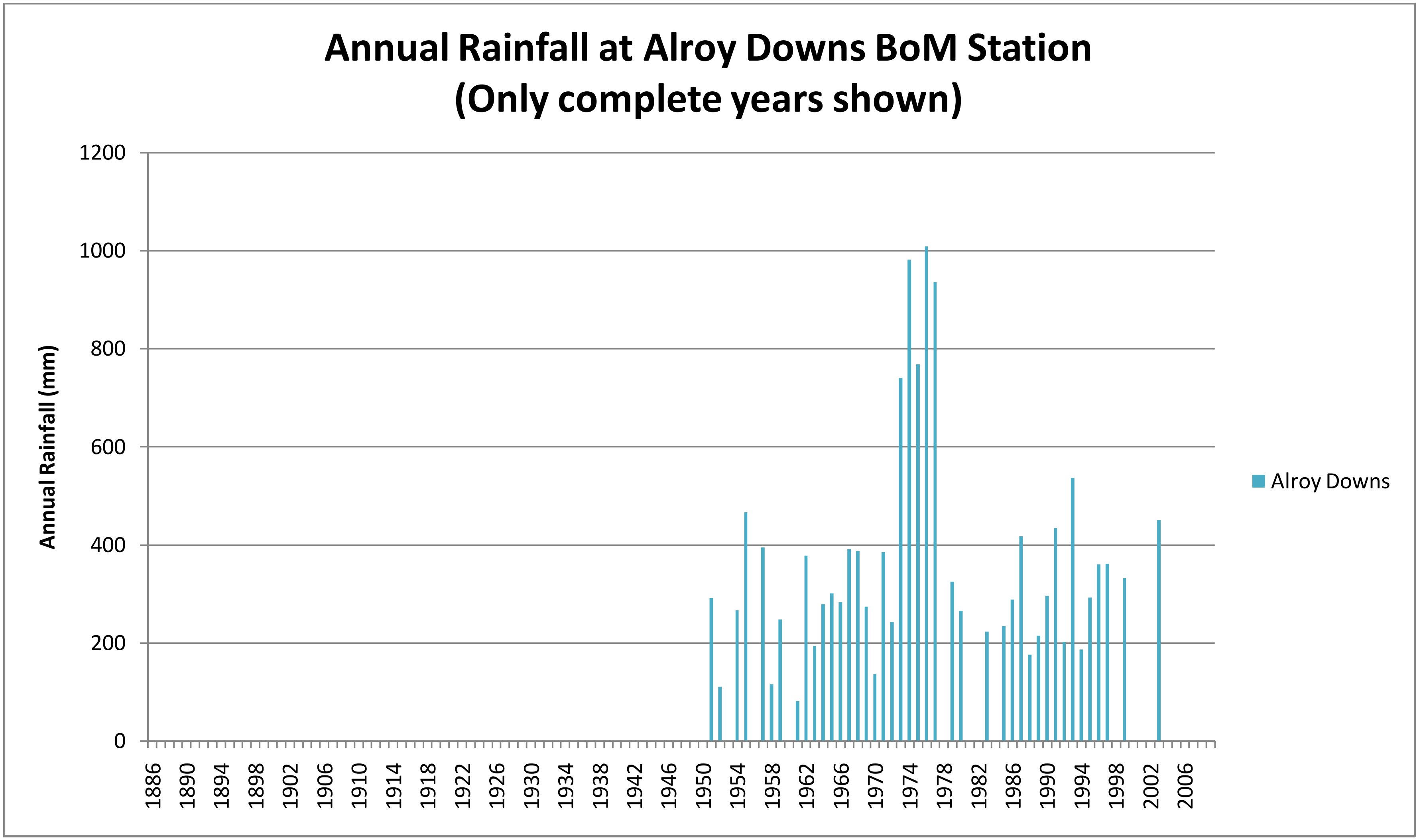


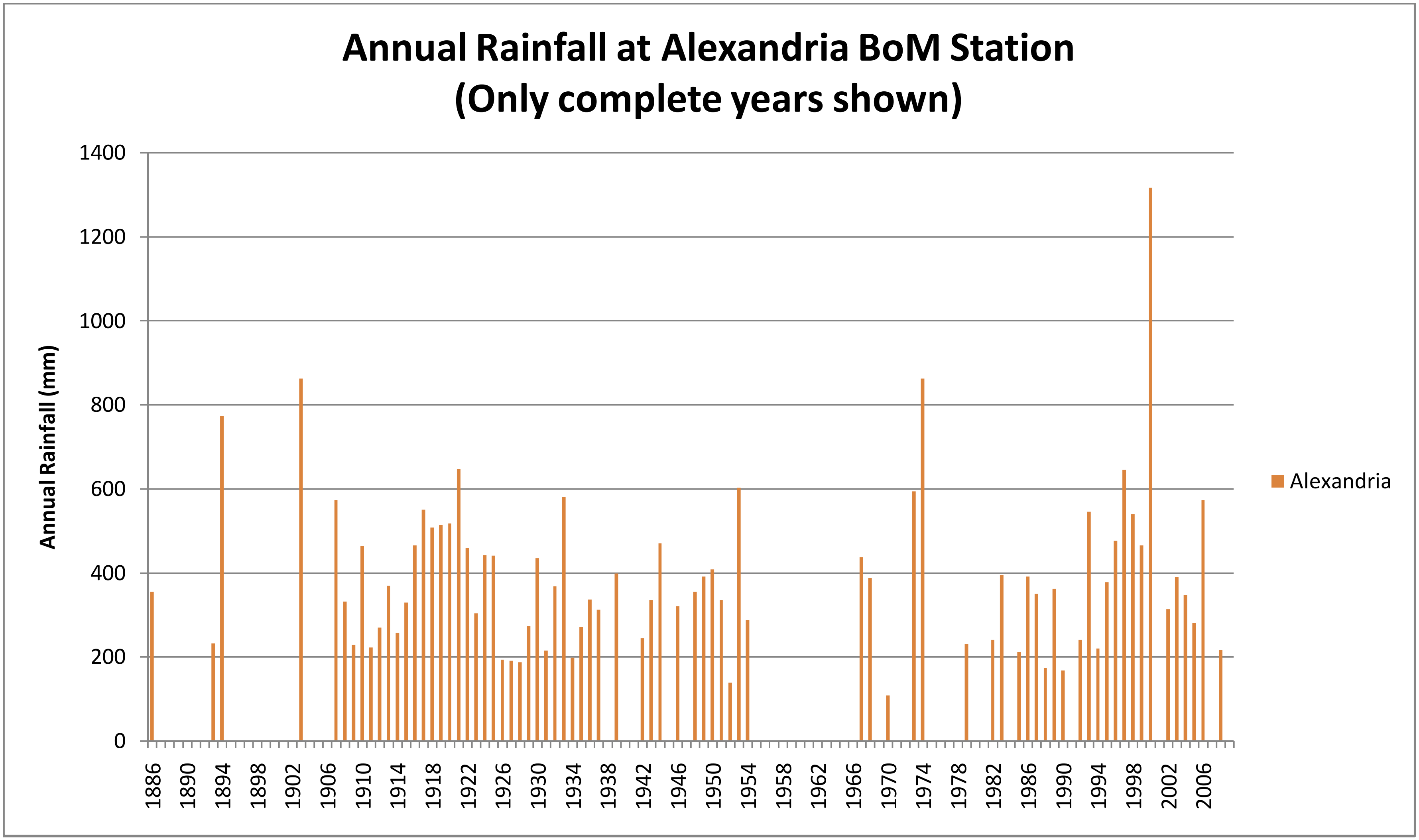
Annual Rainfall at Avon Downs BoM Station
Only complete years shown)
Annual Rainfall (mm)
1400
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Avon Downs


Annual Rainfall at Ranken River BoM Station
(Only complete years shown)
Annual Rainfall (mm)
900
800
700
600
500
400
300
200
100
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Ranken River

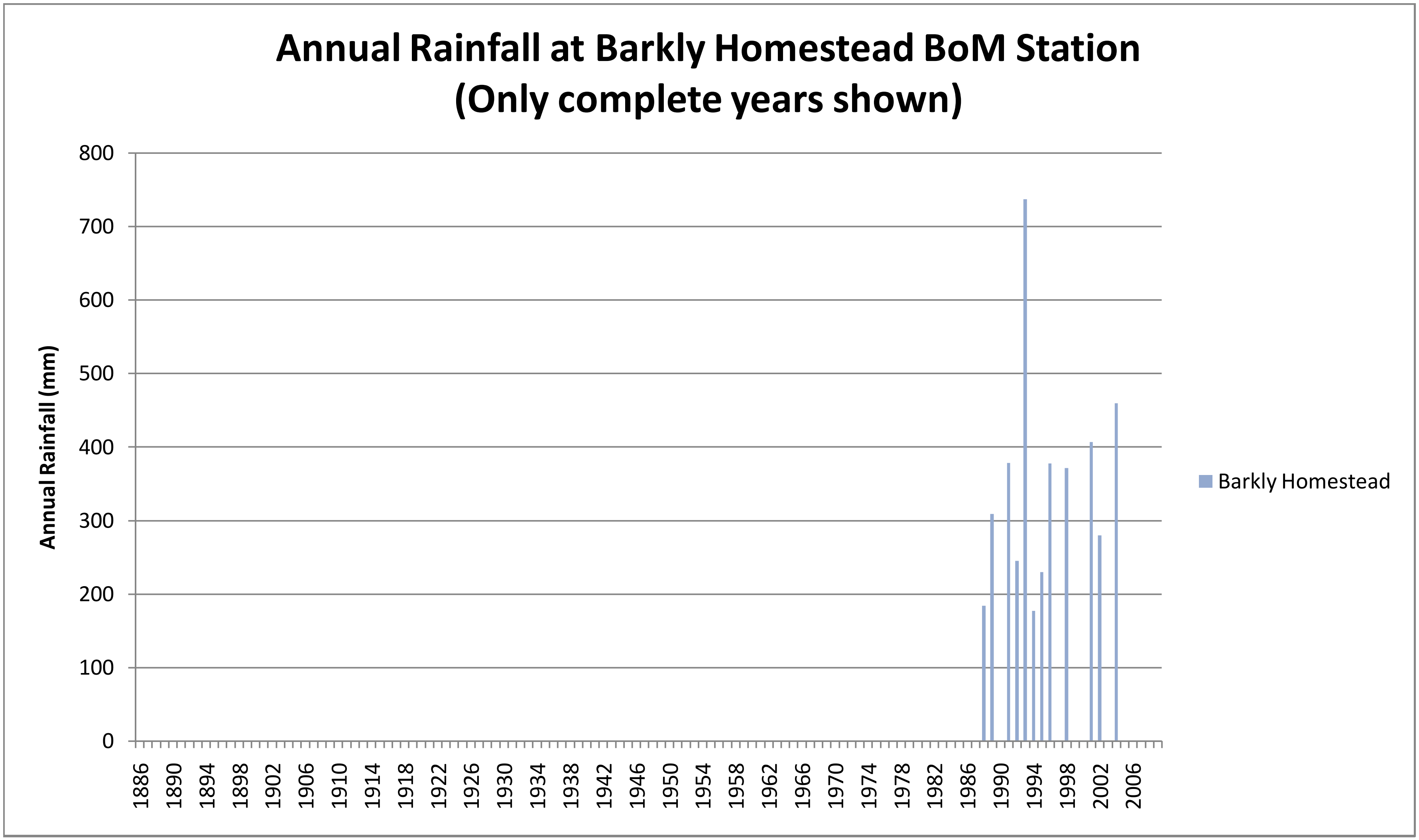


Annual Rainfall at Wonarah BoM Station
(Only complete years shown)
Annual Rainfall (mm)
700
600
500
400
300
200
100
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Wonarah

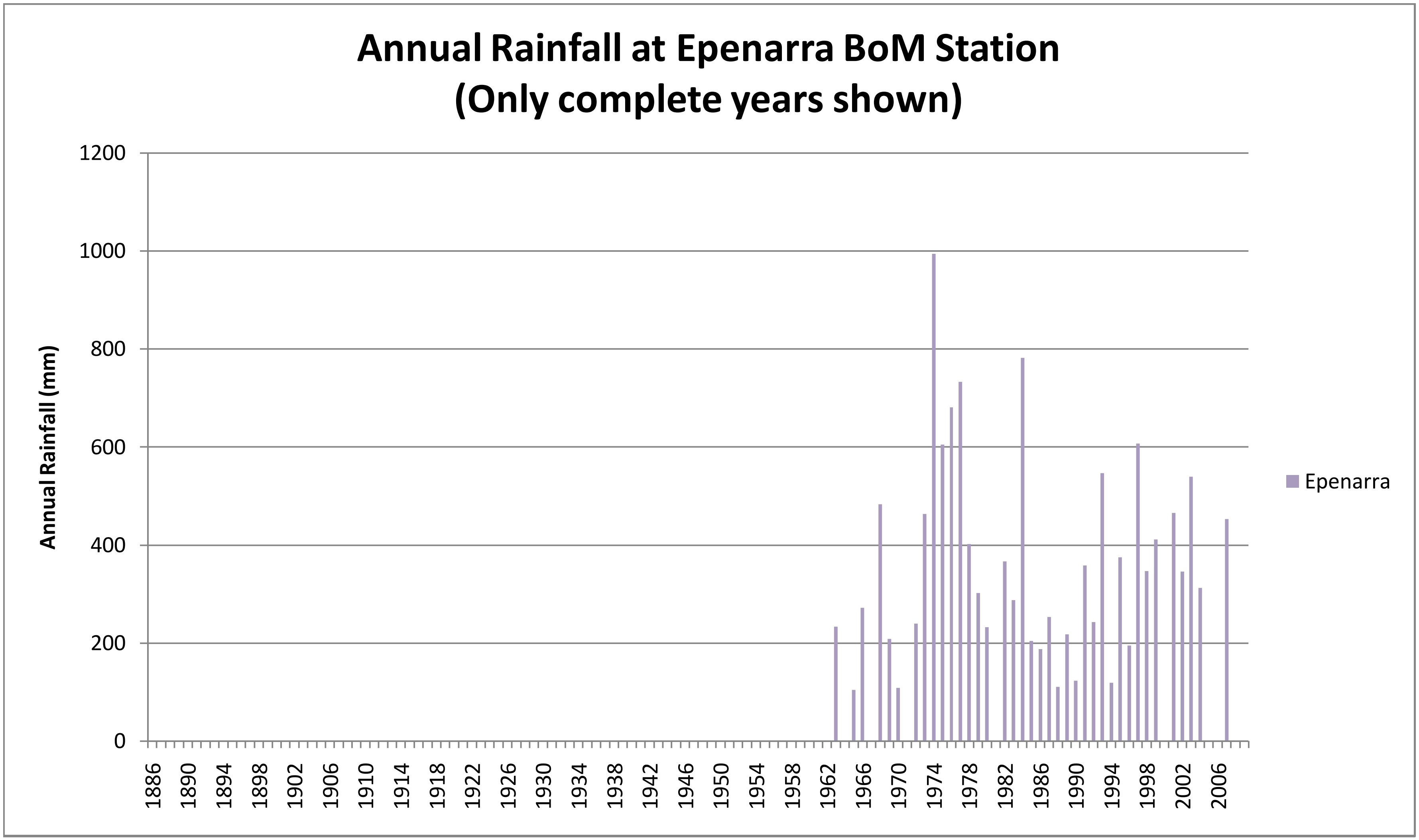

Annual Rainfall at Alroy Downs BoM Station
(Only complete years shown)
Annual Rainfall (mm)
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Alroy Downs



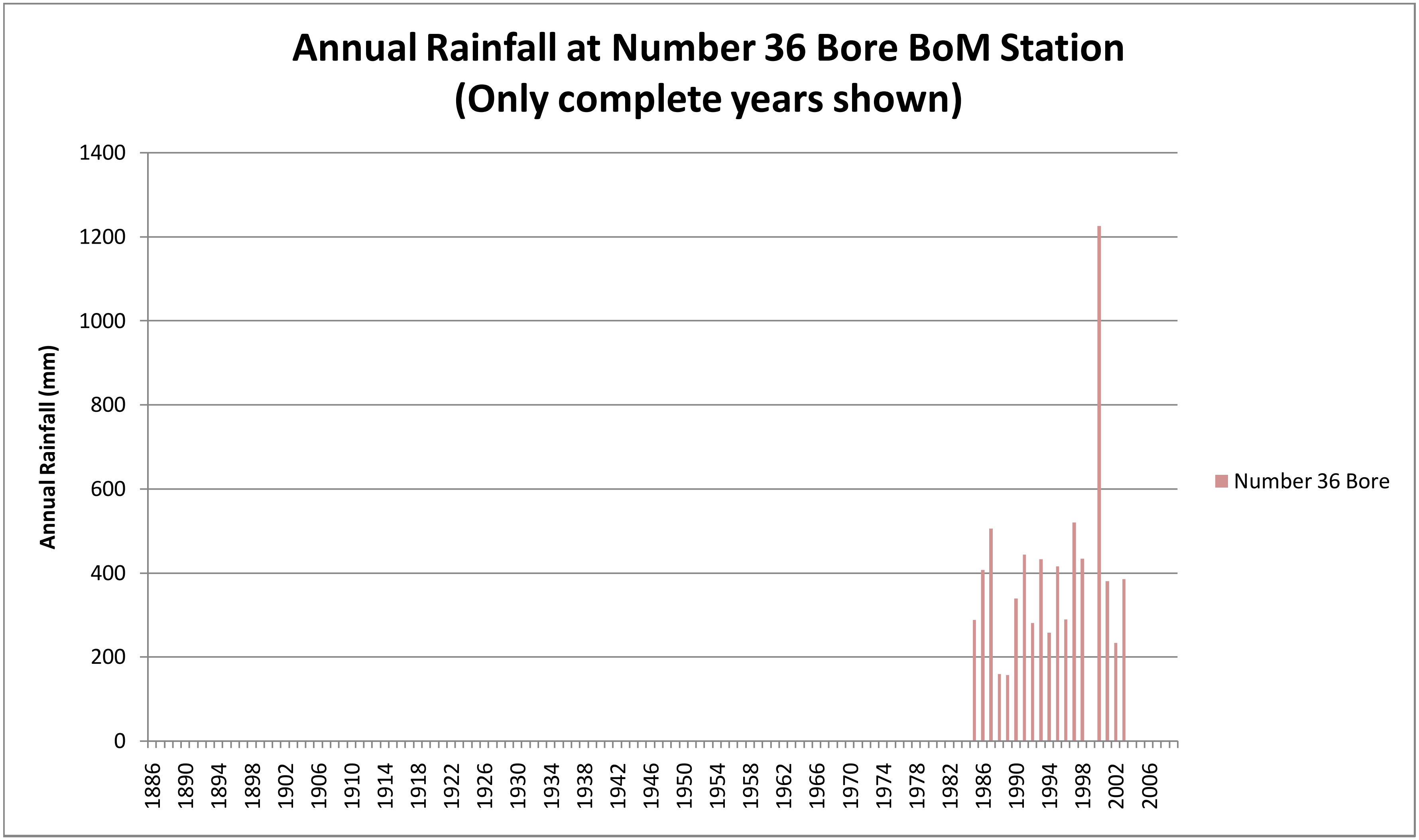
Annual Rainfall at Alexandria BoM Station
(Only complete years shown)
Annual Rainfall (mm)
1400
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Alexandria

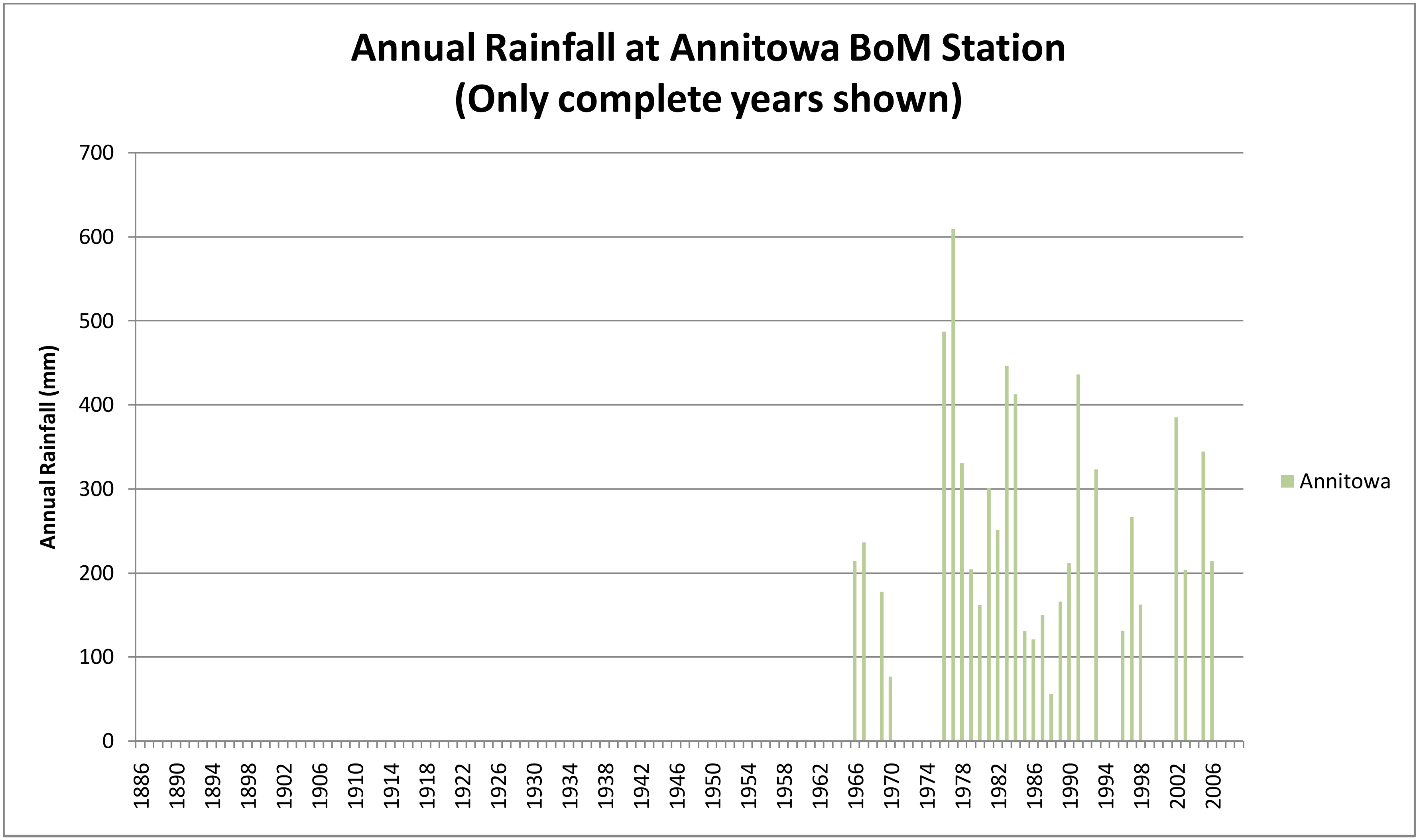


Annual Rainfall at Barkly Homestead BoM Station
(Only complete years shown)
Annual Rainfall (mm)
800
700
600
500
400
300
200
100
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Barkly Homestead



Annual Rainfall at Epenarra BoM Station
(Only complete years shown)
Annual Rainfall (mm)
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Epenarra

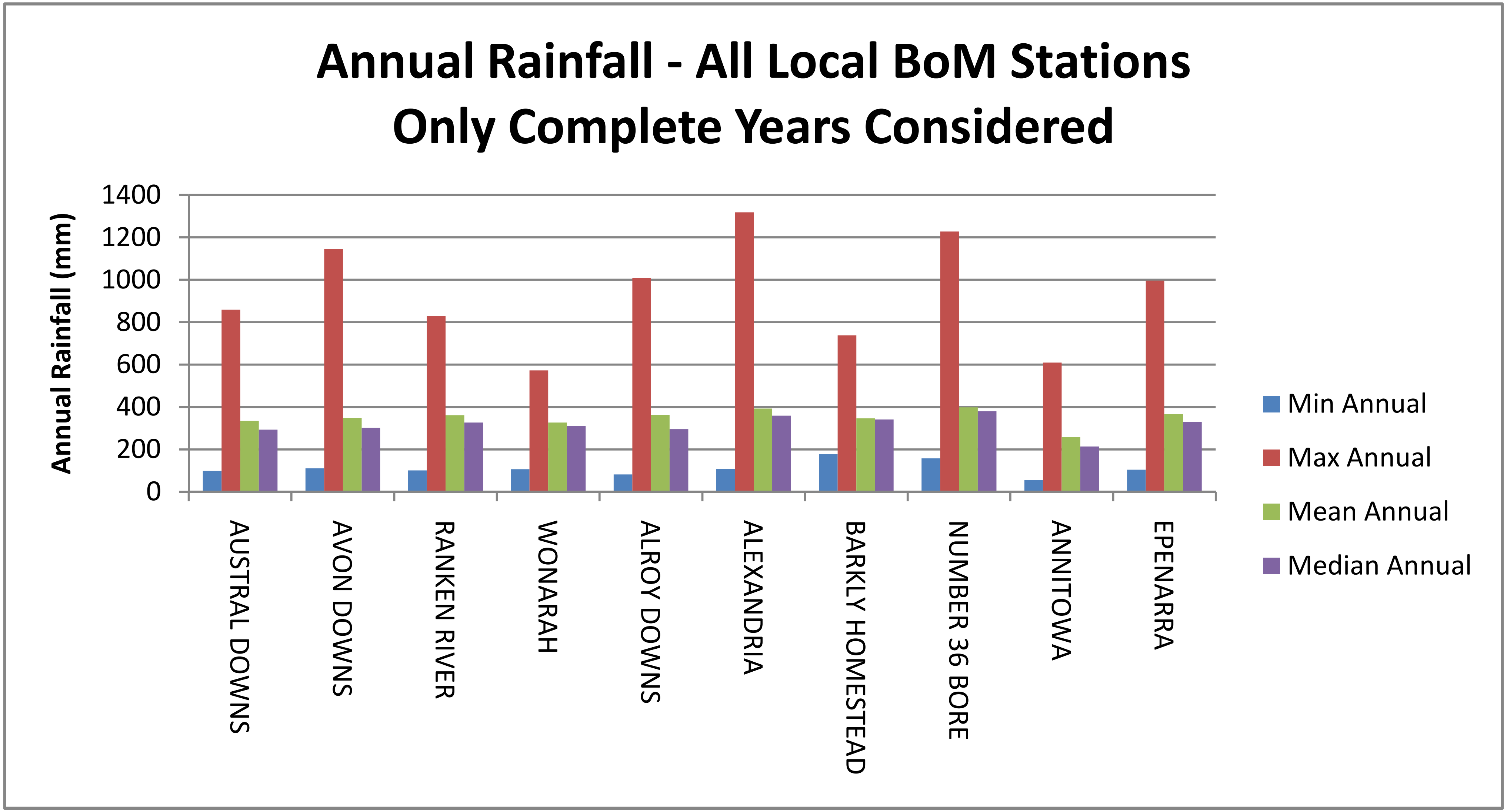

Annual Rainfall at Number 36 Bore BoM Station
(Only complete years shown)
Annual Rainfall (mm)
1400
1200
1000
800
600
400
200
0
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Number 36 Bore


Annual Rainfall at Annitowa BoM Station
(Only complete years shown)
Annual Rainfall (mm)
0
100
200
300
400
500
600
700
1886
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
Annitowa

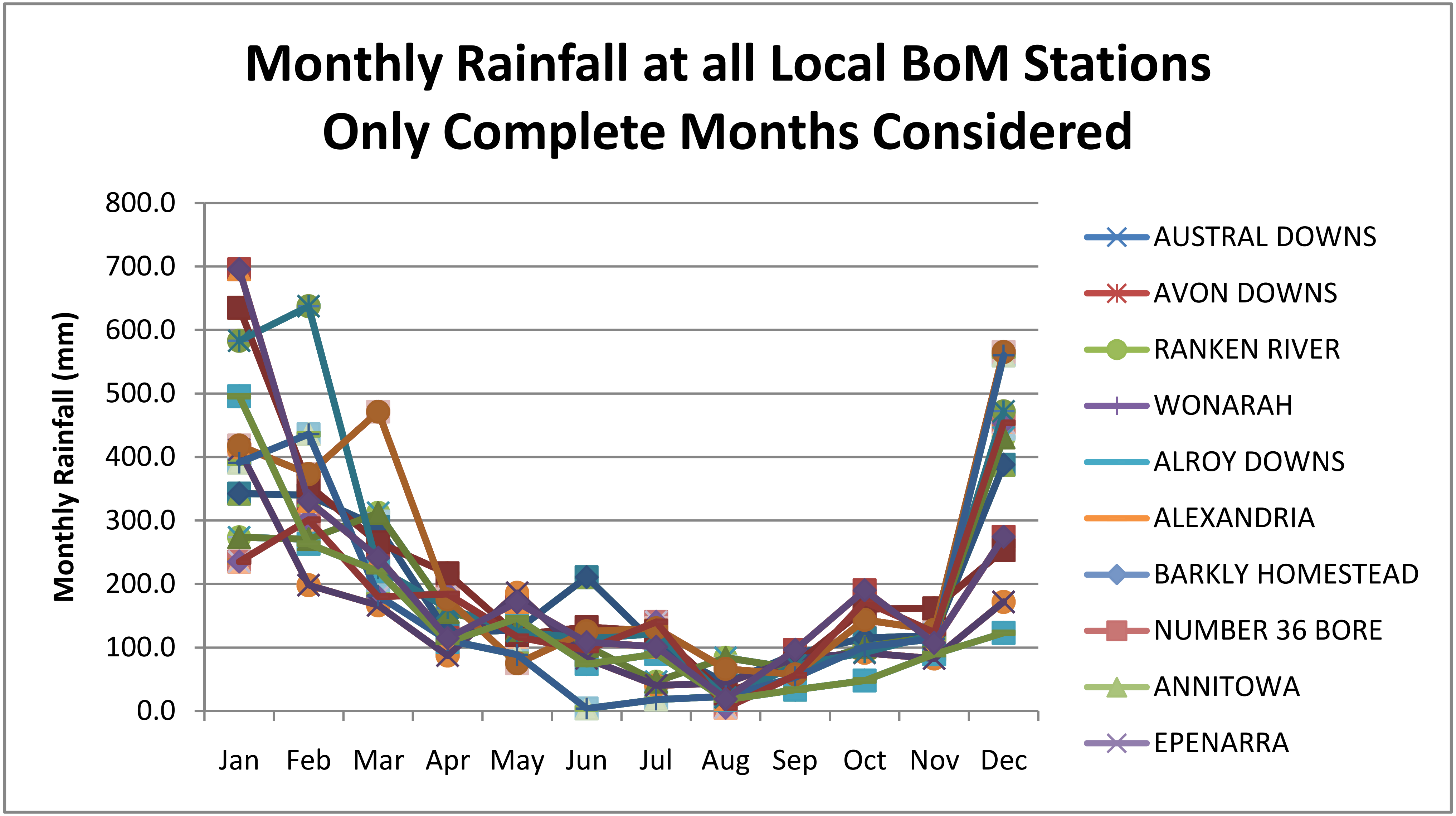
Monthly and Annual Rainfall Values
for Local Rainfall stations (all within 150 km of Site)

	Local BoM Rainfall Stations[1,2]																											
	AUSTRAL DOWNS			AVON DOWNS			RANKEN RIVER			WONARAH			ALROY DOWNS			ALEXANDRIA			BARKLY HOMESTEAD			NUMBER 36 BORE			ANNITOWA			
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Jan	0	342.5	70.3	0	635.0	87.7	5.0	273.6	85.6	0.8	411.4	73.4	0	583.0	93.9	0	418.1	94.4	4.1	391.1	109.1	0	235.3	90.3	0	495.6	74.1	0
Feb	0	339.6	86.6	0	355.2	81.1	0	270.6	82.9	3.6	198.3	61.0	0	637.4	107.4	0	373.1	92.3	0.0	436.0	98.6	0	301.2	82.8	0	263.4	69.1	0
Mar	0	289.9	39.3	0	265.5	46.2	0	312.0	46.1	0	166.4	48.4	0	224.9	48.0	0	471.4	56.7	0.0	181.8	36.3	0	180.0	51.3	0	220.2	22.1	0
Apr	0	123.0	11.3	0	216.9	12.4	0	156.2	13.4	0	87.3	11.7	0	162.0	16.1	0	175.7	12.9	0.0	111.4	14.7	0	184.5	17.3	0	108.6	10.5	0
May	0	127.6	12.1	0	119.9	9.3	0	127.8	9.5	0	186.1	19.1	0	125.5	12.2	0	75.1	7.1	0.0	88.6	12.4	0	117.0	11.7	0	145.8	13.6	0
Jun	0	210.9	12.4	0	132.3	10.2	0	102.6	9.0	0	82.6	6.7	0	114.1	4.6	0	125.5	9.0	0.0	4.0	0.4	0	96.0	8.0	0	74.0	4.7	0
Jul	0	104.1	4.8	0	125.6	5.5	0	46.5	3.9	0	40.5	4.7	0	122.0	5.7	0	130.2	3.5	0.0	18.0	1.7	0	140.4	6.7	0	90.0	7.4	0
Aug	0	43.7	2.7	0	27.5	2.0	0	83.9	2.2	0	44.2	4.5	0	21.4	1.8	0	66.3	2.3	0.0	23.2	3.7	0	5.1	0.4	0	17.8	1.2	0
Sep	0	90.2	4.7	0	73.7	6.0	0	66.9	4.2	0	83.2	6.8	0	72.0	6.5	0	57.7	5.4	0.0	53.0	6.4	0	56.4	4.2	0	33.5	4.4	0
Oct	0	114.9	14.0	0	160.4	16.4	0	101.3	14.2	0	91.6	16.2	0	92.4	15.9	0	143.6	13.0	0.0	101.4	21.7	0	172.8	22.5	0	48.2	12.5	0
Nov	0	119.1	24.4	0	161.8	24.1	0	118.0	26.7	0	82.8	20.0	0	120.2	27.3	0	127.8	28.3	0.0	113.6	32.4	0	123.8	33.2	0	89.4	23.5	0
Dec	0	387.9	49.4	0	253.5	55.0	0	430.6	61.9	0	172.0	53.3	0	472.0	64.6	0	565.4	63.7	4.0	560.0	96.0	3.0	453.8	89.1	0	123.0	35.3	0
Min Annual		**97.8**			**111.1**			**100.1**			**106.2**			**81.5**			**108.6**			**177.2**			**157.2**			**56.2**		
Max Annual		**857.9**			**1,145.4**			**827.9**			**572.2**			**1,008.9**			**1,317.1**			**737.3**			**1,226.8**			**609.4**		
Mean Annual		**334.1**			**347.5**			**360.5**			**325.7**			**363.5**			**392.6**			**346.4**			**398.3**			**257.5**		
Median Annual		***292.6***			***302.2***			***326.45***			***309.7***			***294.6***			***358.65***			***340.4***			***379.9***			***213.95***		

Notes:
1. Monthly values based on complete months only.
2. Annual values based on complete years only.



Annual Rainfall - All Local BoM Stations
Only Complete Years Considered
Annual Rainfall (mm)
1400
1200
1000
800
600
400
200
0
AUSTRAL DOWNS
AVON DOWNS
RANKEN RIVER
WONARAH
ALROY DOWNS
ALEXANDRIA
BARKLY HOMESTEAD
NUMBER 36 BORE
ANNITOWA
EPENARRA
Min Annual
Max Annual
Mean Annual
Median Annual


Monthly Rainfall at all Local BoM Stations
Only Complete Months Considered
Monthly Rainfall (mm)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
AUSTRAL DOWNS
AVON DOWNS
RANKEN RIVER
WONARAH
ALROY DOWNS
ALEXANDRIA
BARKLY HOMESTEAD
NUMBER 36 BORE
ANNITOWA
EPENARRA

Top 10 Wettest Days at Local BoM Stations

Station No.	Rainfall Station	Date	Precipitation to 9am (mm)	Rank
15004	AUSTRAL DOWNS	16/1/1953	209.8	1
15004	AUSTRAL DOWNS	8/2/1953	174.5	2
15004	AUSTRAL DOWNS	5/1/2005	140	3
15004	AUSTRAL DOWNS	12/2/1951	130	4
15004	AUSTRAL DOWNS	4/2/1916	116.3	5
15004	AUSTRAL DOWNS	28/2/1992	116	6
15004	AUSTRAL DOWNS	3/6/1944	115.6	7
15004	AUSTRAL DOWNS	23/1/1941	114.3	8
15004	AUSTRAL DOWNS	6/3/1950	107.2	9
15004	AUSTRAL DOWNS	8/2/1951	106.2	10
15005	AVON DOWNS	18/2/1934	162.6	1
15005	AVON DOWNS	24/1/1977	152	2
15005	AVON DOWNS	14/2/1927	147.3	3
15005	AVON DOWNS	6/1/1999	130	4
15005	AVON DOWNS	22/1/1915	129	5
15005	AVON DOWNS	18/1/1953	118.1	6
15005	AVON DOWNS	21/1/1974	115	7
15005	AVON DOWNS	19/2/1939	113.5	8
15005	AVON DOWNS	5/2/1967	112.5	9
15005	AVON DOWNS	30/12/1916	111.5	10
15026	RANKEN RIVER	25/12/1960	154.4	1
15026	RANKEN RIVER	22/1/1915	144.3	2
15026	RANKEN RIVER	4/3/1996	140	3
15026	RANKEN RIVER	9/12/2000	139.4	4
15026	RANKEN RIVER	14/1/1964	127.8	5
15026	RANKEN RIVER	17/2/1942	119.4	6
15026	RANKEN RIVER	21/2/1910	111	7
15026	RANKEN RIVER	1/3/1962	103.1	8
15026	RANKEN RIVER	15/2/1950	100.3	9
15026	RANKEN RIVER	18/3/1960	96.5	10
15034	WONARAH	14/1/1962	130.6	1
15034	WONARAH	7/2/1953	126.2	2
15034	WONARAH	21/1/1974	122.7	3
15034	WONARAH	23/12/1969	119.1	4
15034	WONARAH	2/1/1948	117.3	5
15034	WONARAH	29/12/1962	108	6
15034	WONARAH	26/3/1973	91.9	7
15034	WONARAH	9/1/1957	86.9	8
15034	WONARAH	12/1/1962	84.8	9
15034	WONARAH	20/5/1959	78	10
15036	ALROY DOWNS	4/2/1976	170	1
15036	ALROY DOWNS	20/12/1977	158	2
15036	ALROY DOWNS	30/12/1957	124	3
15036	ALROY DOWNS	9/12/2000	121	4
15036	ALROY DOWNS	5/2/1976	120.6	5
15036	ALROY DOWNS	7/1/1974	114	6
15036	ALROY DOWNS	25/4/1955	113.8	7
15036	ALROY DOWNS	27/3/1973	99.3	8
15036	ALROY DOWNS	8/7/1978	98	9
15036	ALROY DOWNS	2/7/1986	97	10

15088	ALEXANDRIA	19/3/1901	180.3	1
15088	ALEXANDRIA	9/12/2000	172.4	2
15088	ALEXANDRIA	4/2/1976	167.5	3
15088	ALEXANDRIA	22/1/1941	166.4	4
15088	ALEXANDRIA	25/12/1960	154.9	5
15088	ALEXANDRIA	8/12/2000	144.4	6
15088	ALEXANDRIA	23/1/1941	140	7
15088	ALEXANDRIA	5/3/1967	139.2	8
15088	ALEXANDRIA	24/1/1977	139	9
15088	ALEXANDRIA	24/1/1907	138.9	10
15145	BARKLY HOMESTEAD	9/12/2000	154	1
15145	BARKLY HOMESTEAD	17/2/1993	114.6	2
15145	BARKLY HOMESTEAD	19/1/2007	112	3
15145	BARKLY HOMESTEAD	28/4/2006	107	4
15145	BARKLY HOMESTEAD	19/1/2003	105	5
15145	BARKLY HOMESTEAD	22/3/1989	91	6
15145	BARKLY HOMESTEAD	4/1/1999	90	7
15145	BARKLY HOMESTEAD	8/12/2000	86	8
15145	BARKLY HOMESTEAD	21/2/1993	80.2	9
15145	BARKLY HOMESTEAD	5/1/1997	78	10
15151	NUMBER 36 BORE	27/3/1983	135	1
15151	NUMBER 36 BORE	3/12/1999	121	2
15151	NUMBER 36 BORE	11/4/2006	112	3
15151	NUMBER 36 BORE	22/5/1990	107	4
15151	NUMBER 36 BORE	1/7/1986	106.4	5
15151	NUMBER 36 BORE	22/2/2000	101.4	6
15151	NUMBER 36 BORE	8/12/1990	94.6	7
15151	NUMBER 36 BORE	9/12/2000	91	8
15151	NUMBER 36 BORE	1/3/1991	87	9
15151	NUMBER 36 BORE	29/1/1997	82.6	10
15587	ANNITOWA	29/2/2000	215	1
15587	ANNITOWA	22/1/1974	129	2
15587	ANNITOWA	15/12/2001	102	3
15587	ANNITOWA	7/1/2002	102	4
15587	ANNITOWA	7/11/2005	87	5
15587	ANNITOWA	7/1/2000	85	6
15587	ANNITOWA	26/11/2001	84	7
15587	ANNITOWA	17/1/1995	76.2	8
15587	ANNITOWA	18/2/1975	76	9
15587	ANNITOWA	29/01/1997	75	10
15657	EPENARRA	23/3/1982	170	1
15657	EPENARRA	6/2/1976	119.5	2
15657	EPENARRA	20/12/1993	114.2	3
15657	EPENARRA	21/1/1974	112.7	4
15657	EPENARRA	8/3/1974	103.3	5
15657	EPENARRA	7/1/1974	102.3	6
15657	EPENARRA	17/1/2007	100.8	7
15657	EPENARRA	20/2/1981	96.3	8
15657	EPENARRA	7/3/1972	96	9
15657	EPENARRA	31/10/1976	95	10

Top 100 Wettest Days at Local BoM Stations

Station No.	BoM Rainfall Station	Date	Precipitation to 9am (mm)	Rank
15587	ANNITOWA	29/2/2000	215.0	1
15004	AUSTRAL DOWNS	16/1/1953	209.8	2
15088	ALEXANDRIA	19/3/1901	180.3	3
15004	AUSTRAL DOWNS	8/2/1953	174.5	4
15088	ALEXANDRIA	9/12/2000	172.4	5
15036	ALROY DOWNS	4/2/1976	170.0	6
15657	EPENARRA	23/3/1982	170.0	7
15088	ALEXANDRIA	4/2/1976	167.5	8
15088	ALEXANDRIA	22/1/1941	166.4	9
15005	AVON DOWNS	18/2/1934	162.6	10
15036	ALROY DOWNS	20/12/1977	158.0	11
15088	ALEXANDRIA	25/12/1960	154.9	12
15026	RANKEN RIVER	25/12/1960	154.4	13
15145	BARKLY HOMESTEAD	9/12/2000	154.0	14
15005	AVON DOWNS	24/1/1977	152.0	15
15005	AVON DOWNS	14/2/1927	147.3	16
15088	ALEXANDRIA	8/12/2000	144.4	17
15026	RANKEN RIVER	22/1/1915	144.3	18
15004	AUSTRAL DOWNS	5/1/2005	140.0	19
15026	RANKEN RIVER	4/3/1996	140.0	20
15088	ALEXANDRIA	23/1/1941	140.0	21
15026	RANKEN RIVER	9/12/2000	139.4	22
15088	ALEXANDRIA	5/3/1967	139.2	23
15088	ALEXANDRIA	24/1/1977	139.0	24
15088	ALEXANDRIA	24/1/1907	138.9	25
15151	NUMBER 36 BORE	27/3/1983	135.0	26
15034	WONARAH	14/1/1962	130.6	27
15004	AUSTRAL DOWNS	12/2/1951	130.0	28
15005	AVON DOWNS	6/1/1999	130.0	29
15005	AVON DOWNS	22/1/1915	129.0	30
15587	ANNITOWA	22/1/1974	129.0	31
15026	RANKEN RIVER	14/1/1964	127.8	32
15034	WONARAH	7/2/1953	126.2	33
15036	ALROY DOWNS	30/12/1957	124.0	34
15034	WONARAH	21/1/1974	122.7	35
15036	ALROY DOWNS	9/12/2000	121.0	36
15151	NUMBER 36 BORE	3/12/1999	121.0	37
15036	ALROY DOWNS	5/2/1976	120.6	38
15657	EPENARRA	6/2/1976	119.5	39
15026	RANKEN RIVER	17/2/1942	119.4	40
15034	WONARAH	23/12/1969	119.1	41
15005	AVON DOWNS	18/1/1953	118.1	42
15034	WONARAH	2/1/1948	117.3	43
15004	AUSTRAL DOWNS	4/2/1916	116.3	44
15004	AUSTRAL DOWNS	28/2/1992	116.0	45
15004	AUSTRAL DOWNS	3/6/1944	115.6	46
15005	AVON DOWNS	21/1/1974	115.0	47
15145	BARKLY HOMESTEAD	17/2/1993	114.6	48
15004	AUSTRAL DOWNS	23/1/1941	114.3	49
15657	EPENARRA	20/12/1993	114.2	50
15036	ALROY DOWNS	7/1/1974	114.0	51
15036	ALROY DOWNS	25/4/1955	113.8	52

15005	AVON DOWNS	19/2/1939	113.5	53
15657	EPENARRA	21/1/1974	112.7	54
15005	AVON DOWNS	5/2/1967	112.5	55
15145	BARKLY HOMESTEAD	19/1/2007	112.0	56
15151	NUMBER 36 BORE	11/4/2006	112.0	57
15005	AVON DOWNS	30/12/1916	111.5	58
15026	RANKEN RIVER	21/2/1910	111.0	59
15034	WONARAH	29/12/1962	108.0	60
15004	AUSTRAL DOWNS	6/3/1950	107.2	61
15145	BARKLY HOMESTEAD	28/4/2006	107.0	62
15151	NUMBER 36 BORE	22/5/1990	107.0	63
15151	NUMBER 36 BORE	1/7/1986	106.4	64
15004	AUSTRAL DOWNS	8/2/1951	106.2	65
15145	BARKLY HOMESTEAD	19/1/2003	105.0	66
15657	EPENARRA	8/3/1974	103.3	67
15026	RANKEN RIVER	1/3/1962	103.1	68
15657	EPENARRA	7/1/1974	102.3	69
15587	ANNITOWA	15/12/2001	102.0	70
15587	ANNITOWA	7/1/2002	102.0	71
15151	NUMBER 36 BORE	22/2/2000	101.4	72
15657	EPENARRA	17/1/2007	100.8	73
15026	RANKEN RIVER	15/2/1950	100.3	74
15036	ALROY DOWNS	27/3/1973	99.3	75
15036	ALROY DOWNS	8/7/1978	98.0	76
15036	ALROY DOWNS	2/7/1986	97.0	77
15026	RANKEN RIVER	18/3/1960	96.5	78
15657	EPENARRA	20/2/1981	96.3	79
15657	EPENARRA	7/3/1972	96.0	80
15657	EPENARRA	31/10/1976	95.0	81
15151	NUMBER 36 BORE	8/12/1990	94.6	82
15034	WONARAH	26/3/1973	91.9	83
15145	BARKLY HOMESTEAD	22/3/1989	91.0	84
15151	NUMBER 36 BORE	9/12/2000	91.0	85
15145	BARKLY HOMESTEAD	4/1/1999	90.0	86
15151	NUMBER 36 BORE	1/3/1991	87.0	87
15587	ANNITOWA	7/11/2005	87.0	88
15034	WONARAH	9/1/1957	86.9	89
15145	BARKLY HOMESTEAD	8/12/2000	86.0	90
15587	ANNITOWA	7/1/2000	85.0	91
15034	WONARAH	12/1/1962	84.8	92
15587	ANNITOWA	26/11/2001	84.0	93
15151	NUMBER 36 BORE	29/1/1997	82.6	94
15145	BARKLY HOMESTEAD	21/2/1993	80.2	95
15034	WONARAH	20/5/1959	78.0	96
15145	BARKLY HOMESTEAD	5/1/1997	78.0	97
15587	ANNITOWA	17/1/1995	76.2	98
15587	ANNITOWA	18/2/1975	76.0	99
15587	ANNITOWA	29/01/1997	75.0	100

Top 100 Wettest Days at Local BoM Stations in Date Order				
Station No.	Rainfall Station	Date	Precipitation to 9am (mm)	Date Order
15088	ALEXANDRIA	19/3/1901	180.3	1
15088	ALEXANDRIA	24/1/1907	138.9	2
15026	RANKEN RIVER	21/2/1910	111	3
15026	RANKEN RIVER	22/1/1915	144.3	4
15005	AVON DOWNS	22/1/1915	129	5
15004	AUSTRAL DOWNS	4/2/1916	116.3	6
15005	AVON DOWNS	30/12/1916	111.5	7
15005	AVON DOWNS	14/2/1927	147.3	8
15005	AVON DOWNS	18/2/1934	162.6	9
15005	AVON DOWNS	19/2/1939	113.5	10
15088	ALEXANDRIA	22/1/1941	166.4	11
15088	ALEXANDRIA	23/1/1941	140	12
15004	AUSTRAL DOWNS	23/1/1941	114.3	13
15026	RANKEN RIVER	17/2/1942	119.4	14
15004	AUSTRAL DOWNS	3/6/1944	115.6	15
15034	WONARAH	2/1/1948	117.3	16
15026	RANKEN RIVER	15/2/1950	100.3	17
15004	AUSTRAL DOWNS	6/3/1950	107.2	18
15004	AUSTRAL DOWNS	8/2/1951	106.2	19
15004	AUSTRAL DOWNS	12/2/1951	130	20
15004	AUSTRAL DOWNS	16/1/1953	209.8	21
15005	AVON DOWNS	18/1/1953	118.1	22
15034	WONARAH	7/2/1953	126.2	23
15004	AUSTRAL DOWNS	8/2/1953	174.5	24
15036	ALROY DOWNS	25/4/1955	113.8	25
15034	WONARAH	9/1/1957	86.9	26
15036	ALROY DOWNS	30/12/1957	124	27
15034	WONARAH	20/5/1959	78	28
15026	RANKEN RIVER	18/3/1960	96.5	29
15026	RANKEN RIVER	25/12/1960	154.4	30
15088	ALEXANDRIA	25/12/1960	154.9	31
15034	WONARAH	12/1/1962	84.8	32
15034	WONARAH	14/1/1962	130.6	33
15026	RANKEN RIVER	1/3/1962	103.1	34
15034	WONARAH	29/12/1962	108	35
15026	RANKEN RIVER	14/1/1964	127.8	36
15005	AVON DOWNS	5/2/1967	112.5	37
15088	ALEXANDRIA	5/3/1967	139.2	38
15034	WONARAH	23/12/1969	119.1	39
15657	EPENARRA	7/3/1972	96	40
15034	WONARAH	26/3/1973	91.9	41
15036	ALROY DOWNS	27/3/1973	99.3	42
15036	ALROY DOWNS	7/1/1974	114	43
15657	EPENARRA	7/1/1974	102.3	44
15034	WONARAH	21/1/1974	122.7	45
15657	EPENARRA	21/1/1974	112.7	46
15005	AVON DOWNS	21/1/1974	115	47
15587	ANNITOWA	22/1/1974	129	48
15657	EPENARRA	8/3/1974	103.3	49
15587	ANNITOWA	18/2/1975	76	50
15036	ALROY DOWNS	4/2/1976	170	51
15088	ALEXANDRIA	4/2/1976	167.5	52

15036	ALROY DOWNS	5/2/1976	120.6	53
15657	EPENARRA	6/2/1976	119.5	54
15657	EPENARRA	31/10/1976	95	55
15005	AVON DOWNS	24/1/1977	152	56
15088	ALEXANDRIA	24/1/1977	139	57
15036	ALROY DOWNS	20/12/1977	158	58
15036	ALROY DOWNS	8/7/1978	98	59
15657	EPENARRA	20/2/1981	96.3	60
15657	EPENARRA	23/3/1982	170	61
15151	NUMBER 36 BORE	27/3/1983	135	62
15151	NUMBER 36 BORE	1/7/1986	106.4	63
15036	ALROY DOWNS	2/7/1986	97	64
15145	BARKLY HOMESTEAD	22/3/1989	91	65
15151	NUMBER 36 BORE	22/5/1990	107	66
15151	NUMBER 36 BORE	8/12/1990	94.6	67
15151	NUMBER 36 BORE	1/3/1991	87	68
15004	AUSTRAL DOWNS	28/2/1992	116	69
15145	BARKLY HOMESTEAD	17/2/1993	114.6	70
15145	BARKLY HOMESTEAD	21/2/1993	80.2	71
15657	EPENARRA	20/12/1993	114.2	72
15587	ANNITOWA	17/1/1995	76.2	73
15026	RANKEN RIVER	4/3/1996	140	74
15145	BARKLY HOMESTEAD	5/1/1997	78	75
15587	ANNITOWA	29/01/1997	75	76
15151	NUMBER 36 BORE	29/1/1997	82.6	77
15145	BARKLY HOMESTEAD	4/1/1999	90	78
15005	AVON DOWNS	6/1/1999	130	79
15151	NUMBER 36 BORE	3/12/1999	121	80
15587	ANNITOWA	7/1/2000	85	81
15151	NUMBER 36 BORE	22/2/2000	101.4	82
15587	ANNITOWA	29/2/2000	215	83
15088	ALEXANDRIA	8/12/2000	144.4	84
15145	BARKLY HOMESTEAD	8/12/2000	86	85
15145	BARKLY HOMESTEAD	9/12/2000	154	86
15088	ALEXANDRIA	9/12/2000	172.4	87
15026	RANKEN RIVER	9/12/2000	139.4	88
15036	ALROY DOWNS	9/12/2000	121	89
15151	NUMBER 36 BORE	9/12/2000	91	90
15587	ANNITOWA	26/11/2001	84	91
15587	ANNITOWA	15/12/2001	102	92
15587	ANNITOWA	7/1/2002	102	93
15145	BARKLY HOMESTEAD	19/1/2003	105	94
15004	AUSTRAL DOWNS	5/1/2005	140	95
15587	ANNITOWA	7/11/2005	87	96
15151	NUMBER 36 BORE	11/4/2006	112	97
15145	BARKLY HOMESTEAD	28/4/2006	107	98
15657	EPENARRA	17/1/2007	100.8	99
15145	BARKLY HOMESTEAD	19/1/2007	112	100

Monthly Climate Statistics for 'WONARAH' [015034
Created on [28 Jan 2009 17:39:00 GMT]

015034 WONARAH
Commenced: 1946
Last Record: 1974
Latitude: 19.90 Degrees South
Longitude: 136.34 Degrees East
Elevation: 240 m
State: NT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Num	Start `	End Year
Mean maximum temperature (Degrees C)	38.2	37.1	35.6	33.1	28.2	25.8	25.1	27.8	31.9	35.9	37.9	38.8	32.9	23	1950	1974
Highest temperature (Degrees C)	45.8	44.3	42.3	39.2	36.1	35	32.6	37.8	39.6	42.2	44.9	44.4	45.8	17	1957	1974
Date of Highest temperature	5-Jan-71	18-Feb-70	5-Mar-70	2-Apr-66	16-May-58	1-Jun-62	19-Jul-64	27-Aug-70	24-Sep-71	29-Oct-60	9-Nov-65	31-Dec-59	5-Jan-71	N/A	1957	1974
Lowest maximum temperature (Degrees C)	23.9	26.7	22.8	20.6	14.4	16.6	12.8	17.1	21.5	22.7	25	23.9	12.8	17	1957	1974
Date of Lowest maximum temperature	9-Jan-57	28-Feb-72	3-Mar-62	27-Apr-60	22-May-59	23-Jun-65	13-Jul-68	7-Aug-66	6-Sep-73	4-Oct-66	9-Nov-61	31-Dec-57	13-Jul-68	N/A	1957	1974
Decile 1 maximum temperature (Degrees C) for years 1957 to 1974	34.2	33.3	31.1	29.3	22.9	21.2	20.6	22.3	26.8	31.3	33.4	34.4		16	1957	1974
Decile 9 maximum temperature (Degrees C) for years 1957 to 1974	42.3	41.1	39.5	36.9	32.8	30.1	30	33	36.2	40	41.4	42.2		16	1957	1974
Mean number of days >= 30 Degrees C	26.7	24	25.6	21.7	10.4	3.3	2.9	9.9	19.1	25.5	24.9	27.1	221.1	17	1957	1974
Mean number of days >= 35 Degrees C	23.6	20.1	17.1	9.2	0.5	0.1	0	0.6	5.8	17.4	21.1	24	139.5	17	1957	1974
Mean number of days >= 40 Degrees C	10.3	6	2.3	0	0	0	0	0	0	3	7.2	10.5	39.3	17	1957	1974
Mean minimum temperature (Degrees C)	24.2	23.6	22	18.9	14.4	11.1	9.9	11.5	15.5	19.9	22.2	23.6	18.1	23	1950	1974
Lowest temperature (Degrees C)	15	16.8	14.5	8.3	2.8	-0.2	1.1	0.6	6	9.2	12.2	13.1	-0.2	17	1957	1974
Date of Lowest temperature	4-Jan-70	23-Feb-66	23-Mar-70	16-Apr-69	25-May-67	26-Jun-65	13-Jul-60	4-Aug-67	7-Sep-67	5-Oct-66	7-Nov-69	31-Dec-57	26-Jun-65	N/A	1957	1974
Highest minimum temperature (Degrees C)	30.6	30	29.3	26.7	25	21.1	19.9	20	26.4	30.6	31.7	31.1	31.7	17	1957	1974
Date of Highest minimum temperature	14-Jan-69	25-Feb-62	4-Mar-73	5-Apr-58	15-May-58	3-Jun-63	5-Jul-66	30-Aug-65	1-Sep-64	31-Oct-67	3-Nov-65	17-Dec-59	3-Nov-65	N/A	1957	1974
Decile 1 minimum temperature (Degrees C) for years 1957 to 1974	21.6	21.1	18.6	14.9	9.4	6.2	5.5	7.2	11	15.8	18.5	19.8		16	1957	1974
Decile 9 minimum temperature (Degrees C) for years 1957 to 1974	27.5	26.7	25.4	22.8	19.4	16.2	14.7	16.2	20.1	23.9	26.1	26.8		16	1957	1974
Mean number of days <= 2 Degrees C	0	0	0	0	0	0.2	0.2	0.1	0	0	0	0	0.5	17	1957	1974
Mean number of days <= 0 Degrees C	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	17	1957	1974
Mean daily ground minimum temperature Degrees C																
Lowest ground temperature Degrees C																
Date of Lowest ground temperature														N/A		
Mean number of days ground min. temp. <= -1 Degrees C																
Mean rainfall (mm)	71.8	61	47.8	11.7	19.2	6.7	4.7	4.5	6.8	16	20	54.4	317.5	28	1946	1974
Highest rainfall (mm)	411.4	198.3	166.4	87.3	186.1	82.6	40.5	44.2	83.2	91.6	82.8	172	572.2	28	1946	1974
Date of Highest rainfall	1974	1967	1965	1971	1968	1973	1956	1947	1947	1954	1949	1969	1962	N/A	1946	1974
Lowest rainfall (mm)	0.8	3.6	0	0	0	0	0	0	0	0	0	0	106.2	28	1946	1974
Date of Lowest rainfall	1949	1961	1963	1969	1973	1974	1974	1972	1972	1972	1968	1951	1961	N/A	1946	1974
Decile 1 monthly rainfall (mm) for years 1946 to 1974	7.5	4.5	0	0	0	0	0	0	0	0	0	2.7	184.4	28	1946	1974
Decile 5 (median) monthly rainfall (mm) for years 1946 to 1974	33	51.2	21.6	1.1	0	0	0	0	0	8.8	14.2	40.1	308.3	28	1946	1974
Decile 9 monthly rainfall (mm) for years 1946 to 1974	175.7	140.6	140	44.9	50.7	10.2	18.5	11	18.9	49.3	50.5	116.8	504.3	28	1946	1974
Highest daily rainfall (mm)	130.6	126.2	91.9	39.4	78	68.1	22.6	44.2	47.5	73.4	33.8	119.1	130.6	28	1946	1974
Date of Highest daily rainfall	14-Jan-62	7-Feb-53	26-Mar-73	13-Apr-71	20-May-59	16-Jun-73	11-Jul-56	17-Aug-47	5-Sep-47	27-Oct-69	30-Nov-58	23-Dec-69	14-Jan-62	N/A	1946	1974
Mean number of days of rain	6.1	6.2	4.5	1.4	1.2	0.7	0.8	0.6	0.9	2	3	5.1	32.5	28	1946	1974
Mean number of days of rain >= 1 mm	5	5.4	3.8	1	0.9	0.6	0.7	0.5	0.8	1.6	2.6	4	26.9	28	1946	1974
Mean number of days of rain >= 10 mm	1.8	1.9	1.5	0.4	0.5	0.2	0.1	0.1	0.2	0.4	0.7	1.5	9.3	28	1946	1974
Mean number of days of rain >= 25 mm	0.8	0.5	0.6	0.1	0.2	0.1	0	0	0	0.1	0.1	0.6		28	1946	1974
Mean daily wind run (km)																
Maximum wind gust speed (km/h)																
Date of Maximum wind gust speed														N/A		
Mean daily sunshine (hours)																
Mean daily solar exposure (MJ/(m*m))	25.8	24.6	23.9	21.6	18.8	17.2	18.2	21	23.9	25.3	27	26.8	22.8	19	1990	2009
Mean number of clear days	6.3	5.3	6.6	13.2	15	16.1	18.1	19.3	16.6	15.6	9.6	8	149.7	17	1957	1974
Mean number of cloudy days	8.2	8.6	8.2	3.5	5.1	2.8	2.4	1.1	1.5	3.4	4.3	6.9	56	17	1957	1974
Mean daily evaporation (mm)																
Mean 9am temperature (Degrees C)	30.2	29.4	28.2	25.5	20.6	17.6	16.5	19	23.6	27.9	30.1	31	25	23	1950	1974
Mean 9am wet bulb temperature (Degrees C)	21.6	21.6	19.9	16.9	13.2	11.4	10.1	11.1	13.5	17	19.1	20.2	16.3	21	1950	1974
Mean 9am dew point temperature (Degrees C)	15.6	15.9	13.5	8.3	5.4	3.9	2	0.7	1.4	5.2	7.8	10.7	7.5	13	1957	1970
Mean 9am relative humidity (%)	45	51	43	38	41	45	41	33	26	30	31	36	38	19	1950	1970
Mean 9am cloud cover (okas)	3.3	3.5	3.1	1.9	2.2	1.5	1.3	1	1.3	1.8	2.5	2.7	2.2	23	1950	1974
Mean 9am wind speed (km/h) for years 1957 to 1974	11.5	13.6	14.3	17.2	16.9	15.5	17.7	19.1	19.2	18	16.4	16.5	16.3	15	1957	1974
Mean 3pm temperature (Degrees C)	36.5	35.9	34.4	32.3	27.6	25.2	24.4	27.3	31.1	34.9	36.8	37.2	32	23	1950	1974
Mean 3pm wet bulb temperature (Degrees C)	22.5	22.7	21.2	19	16	14.9	13.8	14.7	16.3	19.1	20.5	21.7	18.5	21	1950	1974
Mean 3pm dew point temperature (Degrees C)	12.7	13.3	11.5	7.5	4.6	3.2	1.4	0.3	-0.1	3.3	5.8	9.6	6.1	13	1957	1970
Mean 3pm relative humidity (%)	28	30	27	23	26	27	25	20	16	18	19	23	23	19	1950	1970
Mean 3pm cloud cover (oktas)	4.8	4.8	4.5	3	2.5	1.7	1.2	1	1.5	2.6	3.5	4.1	2.9	23	1950	1974
Mean 3pm wind speed (km/h) for years 1957 to 1974	12	12	13.6	13	13.3	12.4	13.8	12.9	13.1	12.6	11.6	12.2	12.7	14	1957	1974

Monthly Climate Statistics for 'BRUNETTE DOWNS' [015085]
Created on [28 Jan 2009 13:58:35 GMT]

015085 BRUNETTE DOWNS
Commenced: 1891
Last Record: 2008
Latitude: 18.64 Degrees South
Longitude: 135.95 Degrees East
Elevation: 218 m
State: NT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C)	37.2	36.4	35.2	33.6	29.9	26.8	26.7	29.5	33.5	36.7	38	38.5	33.5	44	1957	2008
Highest temperature (Degrees C)	44.3	45.5	42.5	39.1	38.1	34.7	35.8	37.4	40.3	44.2	44.3	45.5	45.5	44	1957	2008
Date of Highest temperature	20-Jan-85	19-Feb-83	1-Mar-83	22-Apr-80	6-May-07	22-Jun-96	17-Jul-95	28-Aug-85	26-Sep-97	23-Oct-87	28-Nov-82	2-Dec-07	2-Dec-07	N/A	1957	2008
Lowest maximum temperature (Degrees C)	23.5	22.7	22.9	19	13.3	10.8	14.4	15.6	19.5	15.5	19.9	21.5	10.8	44	1957	2008
Date of Lowest maximum temperature	17-Jan-03	29-Feb-96	25-Mar-73	26-Apr-83	23-May-59	21-Jun-07	2-Jul-99	17-Aug-07	5-Sep-78	20-Oct-00	17-Nov-81	26-Dec-06	21-Jun-07	N/A	1957	2008
Decile 1 maximum temperature (Degrees C) for years 1957 to 2008	32.4	32	31.2	29.6	25.1	21.7	22	24.5	28.2	32.4	34	34.2		43	1957	2008
Decile 9 maximum temperature (Degrees C) for years 1957 to 2008	41.3	40.6	38.8	36.8	33.9	31.6	31.1	33.8	37.5	40	41.4	41.9		43	1957	2008
Mean number of days >= 30 Degrees C	28.8	25.9	28	26.3	16.7	6.8	5.9	15.1	24.1	29.1	27.6	28.4	262.7	44	1957	2008
Mean number of days >= 35 Degrees C	22.7	18.5	17.3	10.6	1.2	0	0	1.3	11.9	23.8	24.1	25.2	156.6	44	1957	2008
Mean number of days >= 40 Degrees C	7.1	4.8	1	0	0	0	0	0	0.1	3.5	8.7	10.6	35.8	44	1957	2008
Mean minimum temperature (Degrees C)	24.5	24.2	22.3	19.2	15	11.4	10.5	12.5	16.6	20.7	23	24.3	18.7	44	1957	2008
Lowest temperature (Degrees C)	16.5	16.1	11.4	8.7	4	1.7	1.4	1.7	5	7.5	13.2	15	1.4	44	1957	2008
Date of Lowest temperature	6-Jan-05	7-Feb-62	31-Mar-70	30-Apr-99	28-May-08	27-Jun-71	10-Jul-83	16-Aug-57	2-Sep-86	11-Oct-82	18-Nov-81	27-Dec-69	10-Jul-83	N/A	1957	2008
Highest minimum temperature (Degrees C)	31	30.6	28.8	27.2	25	24.3	21.7	23.2	25.8	29	30.4	31.2	31.2	44	1957	2008
Date of Highest minimum temperature	3-Jan-94	9-Feb-86	12-Mar-85	11-Apr-86	17-May-58	19-Jun-05	28-Jul-93	26-Aug-99	28-Sep-97	23-Oct-87	21-Nov-87	3-Dec-07	3-Dec-07	N/A	1957	2008
Decile 1 minimum temperature (Degrees C) for years 1957 to 2008	22	21.9	19	15	10.1	6.4	5.9	7.5	11.4	15.8	18.9	21.2		43	1957	2008
Decile 9 minimum temperature (Degrees C) for years 1957 to 2008	27.2	26.7	25.2	23	19.8	16.6	15.5	17.5	21.8	25.1	26.7	27.4		43	1957	2008
Mean number of days <= 2 Degrees C	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1	44	1957	2008
Mean number of days <= 0 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	44	1957	2008
Mean daily ground minimum temperature Degrees C	22.5	22.9	20.8	17.4	12.3	8.7	7.2	8.9	14.4	18.3	20.4	22.3	16.3	10	1999	2008
Lowest ground temperature Degrees C	14.1	13.6	10	6.5	3.4	-1.9	-4.2	-3.1	3.9	6.4	10.2	12.5	-4.2	10	1999	2008
Date of Lowest ground temperature	6-Jan-05	5-Feb-05	23-Mar-03	24-Apr-01	29-May-02	19-Jun-04	27-Jul-01	15-Aug-02	14-Sep-04	1-Oct-02	14-Nov-01	13-Dec-02	27-Jul-01	N/A	1999	2008
Mean number of days ground min. temp. <= -1 Degrees C	0	0	0	0	0	0.1	0.9	0.4	0	0	0	0	1.4	10	1999	2008
Mean rainfall (mm)	104.3	98.7	54.9	14.7	8.1	7.2	4.5	1.4	6.1	15.4	29	67.5	411.8	114	1891	2008
Highest rainfall (mm)	473.2	620.9	317.9	220.5	201.4	107.9	164.6	40.1	125.9	130.7	187.7	393	1200.4	114	1891	2008
Date of Highest rainfall	1919	1976	1941	1896	1955	1973	1986	1947	1978	1975	1941	2000	1976	N/A	1891	2008
Lowest rainfall (mm)	0	0	0	0	0	0	0	0	0	0	0	0	85.1	114	1891	2008
Date of Lowest rainfall	1911	1965	2008	2008	2008	2008	2008	2008	2007	2004	1964	1951	1897	N/A	1891	2008
Decile 1 monthly rainfall (mm) for years 1891 to 2008	12	13.4	0	0	0	0	0	0	0	0	1.4	8.1	199	109	1891	2008
Decile 5 (median) monthly rainfall (mm) for years 1891 to 2008	76.8	71.4	29.5	1.9	0	0	0	0	0	4.6	22.8	46	373.2	109	1891	2008
Decile 9 monthly rainfall (mm) for years 1891 to 2008	232.6	219.1	160.6	37.2	23.9	17.1	7.2	2.2	18.1	45.8	58.1	155.3	692.3	109	1891	2008
Highest daily rainfall (mm)	182.4	261.8	164.2	70.4	95	83.6	142.2	27.9	65.3	75.2	92.5	120.7	261.8	109	1891	2009
Date of Highest daily rainfall	22-Jan-19	4-Feb-76	1-Mar-84	20 Apr 18	24-May-55	3-Jun-44	2-Jul-86	18-Aug-66	28-Sep-78	21-Oct-00	20-Nov-41	25-Dec-60	4-Feb-76	N/A	1891	2009
Mean number of days of rain	8.1	8.2	4.9	1.6	0.9	0.7	0.6	0.3	0.8	2	3.8	6.2	38.1	109	1891	2008
Mean number of days of rain >= 1 mm	6.5	6.6	3.8	1.2	0.7	0.6	0.4	0.2	0.6	1.5	2.9	4.6	29.6	109	1891	2009
Mean number of days of rain >= 10 mm	2.7	2.7	1.5	0.4	0.2	0.2	0.1	0.1	0.2	0.4	0.8	1.8	11.1	109	1891	2009
Mean number of days of rain >= 25 mm	1.1	1.1	0.6	0.1	0.1	0.1	0	0	0.1	0.2	0.2	0.7	4.3	109	1891	2009
Mean daily wind run (km)																
Maximum wind gust speed (km/h)														0	2008	2008
Date of Maximum wind gust speed														N/A	2008	2008
Mean daily sunshine (hours)																
Mean daily solar exposure (MJ/(m*m))	25	24.4	24	21.6	19.2	17.6	18.6	21.3	24.1	25.6	27	25.9	22.9	19	1990	2009
Mean number of clear days	4.4	3.5	7.2	11.1	16.2	18	20.6	21.5	19.3	14.7	8.4	5.2	150.1	44	1957	2008
Mean number of cloudy days	13.5	11.2	9.4	5.4	3.9	2.7	1.6	1.4	2.4	4.3	6.4	10.1	72.3	44	1957	2008
Mean daily evaporation (mm)	9.3	8.3	7.8	7.7	6.4	5.7	5.8	7.3	9	10.6	10.6	10.4	8.2	38	1968	2008
Mean 9am temperature (Degrees C)	29	28.2	26.7	24.4	19.9	16	15.2	18.4	23.5	27.8	29.5	30.1	24.1	44	1957	2008
Mean 9am wet bulb temperature (Degrees C)	23.3	23.2	21.1	17.4	13.8	10.8	9.8	11.5	14.9	18.2	20.5	22.5	17.2	41	1957	2008
Mean 9am dew point temperature (Degrees C)	19.7	20.3	17.1	11.3	7.5	4.8	2.6	2.8	5.7	9.4	13.5	17.3	11	41	1957	2008
Mean 9am relative humidity (%)	61	65	59	47	47	49	44	38	35	36	42	50	48	41	1957	2008
Mean 9am cloud cover (okas)	4.5	4.4	3.8	2.7	2.2	1.8	1.6	1.4	1.6	2.2	3.1	3.9	2.8	44	1957	2008
Mean 9am wind speed (km/h) for years 1957 to 2008	10.7	9.5	10	13.4	14.4	14.2	14.3	15.6	16.5	15.7	14.8	12	13.4	42	1957	2008
Mean 3pm temperature (Degrees C)	35.8	35.1	34.2	32.8	29.2	26.2	26	28.8	32.7	35.8	36.9	37.1	32.6	44	1957	2008
Mean 3pm wet bulb temperature (Degrees C)	23.9	24.2	22.5	20.1	17.6	15.4	14.6	15.8	17.8	20.2	21.9	23.3	19.8	41	1957	2008
Mean 3pm dew point temperature (Degrees C)	16.6	17.8	14.8	10.3	7.4	4.8	2.2	2.2	3.3	7.2	11	14.3	9.3	41	1957	2008
Mean 3pm relative humidity (%)	37	40	35	28	27	27	23	20	18	20	24	30	27	41	1957	2008
Mean 3pm cloud cover (oktas)	5.3	5.4	4.7	3.8	2.7	2	1.5	1.5	2	3.1	4.1	5	3.4	44	1957	2008
Mean 3pm wind speed (km/h) for years 1957 to 2008	11.7	10.6	11.2	11.9	12.2	12.9	12.9	13	12.9	11.5	11.3	10.8	11.9	42	1957	2008

Monthly Climate Statistics for 'TENNANT CREEK POST OFFICE' [015087]
Created on [28 Jan 2009 17:13:54 GMT]

015087 TENNANT CREEK POST OFFICE
Commenced: 1874
Last Record: 2000
Latitude: 19.65 Degrees South
Longitude: 134.19 Degrees East
Elevation: 377 m
State: NT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C)	37.3	36.3	35	32	27.7	24.7	24.4	27.4	31.4	35	37	37.7	32.2	61	1910	1970
Highest temperature (Degrees C)	46.1	45.2	43.9	40	37.8	34.2	33.3	36.4	38.9	42.8	44.2	44.9	46.1	61	1910	1970
Date of Highest temperature	3-Jan-39	18-Feb-70	23-Mar-61	1-Apr-42	5-May-42	1-Jun-62	31-Jul-43	27-Aug-70	30-Sep-55	20-Oct-57	2-Nov-35	18-Dec-25	3-Jan-39	N/A	1910	1970
Lowest maximum temperature (Degrees C)	19.7	17.2	18.9	16.6	12.2	9.2	9.4	14.7	18.3	17.7	20	21.7	9.2	61	1910	1970
Date of Lowest maximum temperature	12-Jan-21	23-Feb-49	19-Mar-49	27-Apr-20	22-May-59	28-Jun-35	2-Jul-38	6-Aug-66	2-Sep-29	29-Oct-45	4-Nov-56	31-Dec-57	28-Jun-35	N/A	1910	1970
Decile 1 maximum temperature (Degrees C) for years 1910 to 1970	32.8	31.1	31	27.8	22.8	20	19.6	22.2	26.7	30	32.8	33.3		62	1910	1970
Decile 9 maximum temperature (Degrees C) for years 1910 to 1970	41.6	40.6	38.8	36	31.7	29.4	29.4	32.2	35.6	38.9	40.6	41.2		62	1910	1970
Mean number of days >= 30 Degrees C	29.6	26.5	28.9	22.7	9.5	2.5	2.4	9	20.8	27.9	28.4	29.7	237.9	61	1910	1970
Mean number of days >= 35 Degrees C	24.2	19.8	18.3	6.2	0.3	0	0	0.1	5.1	18.1	23.2	25.3	140.6	61	1910	1970
Mean number of days >= 40 Degrees C	7.8	4	1	0	0	0	0	0	0	1.4	5.3	8.7	28.2	61	1910	1970
Mean minimum temperature (Degrees C)	24.6	23.9	22.5	19.3	15.2	12	11	12.7	16.4	20.5	23	24.2	18.8	61	1910	1970
Lowest temperature (Degrees C)	15.7	11.1	11.9	10	5.4	2.8	2.4	2.8	5.6	10.7	13.3	11.7	2.4	61	1910	1970
Date of Lowest temperature	12-Jan-21	25-Feb-49	25-Mar-66	30-Apr-52	31-May-25	25-Jun-13	30-Jul-19	26-Aug-31	17-Sep-51	2-Oct-24	26-Nov-55	31-Dec-57	30-Jul-19	N/A	1910	1970
Highest minimum temperature (Degrees C)	31.7	30.8	29.4	26.1	25.1	22.5	21.1	22.8	26.6	29.4	30.6	32.5	32.5	61	1910	1970
Date of Highest minimum temperature	6-Jan-52	19-Feb-70	8-Mar-58	16-Apr-68	5-May-42	3-Jun-63	23-Jul-38	24-Aug-55	20-Sep-42	28-Oct-59	21-Nov-29	16-Dec-25	16-Dec-25	N/A	1910	1970
Decile 1 minimum temperature (Degrees C) for years 1910 to 1970	21.6	21.1	19.4	15	10.6	7.8	7	8.3	11.9	15.8	19.4	21.1		61	1910	1970
Decile 9 minimum temperature (Degrees C) for years 1910 to 1970	27.8	26.7	25.6	23.2	19.4	16.6	15.3	17.2	20.6	24.9	26.7	27.2		61	1910	1970
Mean number of days <= 2 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	61	1910	1970
Mean number of days <= 0 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	61	1910	1970
Mean daily ground minimum temperature Degrees C																
Lowest ground temperature Degrees C																
Date of Lowest ground temperature														N/A		
Mean number of days ground min. temp. <= -1 Degrees C																
Mean rainfall (mm)	88.4	90.4	50.6	15.1	11.5	6.6	5.5	2.8	6.7	15.4	27.9	50.7	369.8	124	1874	2000
Highest rainfall (mm)	389.9	379.8	430.6	196.4	172.4	82.8	94.4	83.3	70.9	77.7	170.8	198.8	864.8	124	1874	2000
Date of Highest rainfall	1957	1919	1930	1896	1968	1973	1895	1886	1877	1880	2000	1888	1930	N/A	1874	2000
Lowest rainfall (mm)	0	0	0	0	0	0	0	0	0	0	0	0	93.9	124	1874	2000
Date of Lowest rainfall	1989	1937	1997	1995	2000	1999	2000	2000	2000	1994	1986	1981	1935	N/A	1874	2000
Decile 1 monthly rainfall (mm) for years 1874 to 2000	7	3	0	0	0	0	0	0	0	0	2	4.8	182.7	116	1874	2000
Decile 5 (median) monthly rainfall (mm) for years 1874 to 2000	69.4	64.4	19.6	2.8	0	0	0	0	0	10.8	21.5	37.5	336	116	1874	2000
Decile 9 monthly rainfall (mm) for years 1874 to 2000	196.2	222.4	150	41.5	36.5	22.5	20.2	7.4	23.8	42.6	61.8	117	569.1	116	1874	2000
Highest daily rainfall (mm)	186.7	234.2	166.4	101.6	69.3	47.2	40.6	36.3	32.8	47.1	75.2	102.9	234.2	117	1875	2000
Date of Highest daily rainfall	5-Jan-13	28-Feb-10	3-Mar-30	05 Apr 1896	12-May-68	15-Jun-73	3-Jul-00	04 Aug 188	15-Sep-75	29-Oct-75	22-Nov-42	30 Dec 1888	28-Feb-10	N/A	1875	2000
Mean number of days of rain	6.2	6.2	3.7	1.4	1.1	0.9	0.6	0.4	1	2.4	3.8	5.5	33.2	116	1874	2000
Mean number of days of rain >= 1 mm	5.2	5	3	1.2	0.9	0.7	0.5	0.3	0.7	1.8	2.9	4.2	26.4	117	1875	2000
Mean number of days of rain >= 10 mm	2.2	2.2	1.2	0.4	0.3	0.2	0.2	0.1	0.2	0.4	0.8	1.3	9.5	117	1875	2000
Mean number of days of rain >= 25 mm	1	1	0.5	0.1	0.1	0.1	0	0	0	0.1	0.2	0.5	3.6	117	1875	2000
Mean daily wind run (km)																
Maximum wind gust speed (km/h)																
Date of Maximum wind gust speed														N/A		
Mean daily sunshine (hours)																
Mean daily solar exposure (MJ/(m*m))	25.7	24.7	24.1	21.9	18.9	17.2	18.4	21.2	23.8	25.4	26.6	26.3	22.8	19	1990	2009
Mean number of clear days	9.7	10.2	13.3	19.3	20.2	21.2	23	24.2	20.9	17	13.8	11.1	203.9	59	1910	1970
Mean number of cloudy days	7.3	6.9	5.1	2.7	3.2	2.4	2	0.8	1.1	3.2	4	5.9	44.6	59	1910	1970
Mean daily evaporation (mm)	12.1	11.8	11.7	10.7	8.7	6.9	6.8	8.3	10.4	11.8	13.2	12.8	10.4	10	1958	1970
Mean 9am temperature (Degrees C)	30	29	27.8	24.7	20.2	16.8	16.1	18.7	23.3	27.5	29.9	30.6	24.6	60	1910	1970
Mean 9am wet bulb temperature (Degrees C)	21.1	21.2	19.1	15.7	12.9	10.8	9.8	11	13.7	16.7	19	20.5	16	58	1910	1970
Mean 9am dew point temperature (Degrees C)	14.8	15.6	12.2	7.2	5	3.6	1.6	1.1	2.8	6.2	9.8	12.9	7.7	58	1910	1970
Mean 9am relative humidity (%)	46	50	42	36	39	44	40	33	29	30	34	39	39	58	1910	1970
Mean 9am cloud cover (okas)	3.3	3.1	2.5	1.7	1.9	1.6	1.5	1.1	1.4	2	2.3	3	2.1	59	1910	1970
Mean 9am wind speed (km/h) for years 1910 to 1970	13.2	12.7	14.3	17.8	17.5	16.8	17.4	17.3	18.1	17.7	16.7	14.7	16.2	59	1910	1970
Mean 3pm temperature (Degrees C)	36	35.2	34.2	31.4	27.1	24.1	23.9	26.7	30.7	34	35.9	36.4	31.3	60	1910	1970
Mean 3pm wet bulb temperature (Degrees C)	22	22.1	20.8	18.2	15.8	14	13.5	14.6	16.7	19	20.6	21.7	18.2	58	1910	1970
Mean 3pm dew point temperature (Degrees C)	12.3	13.3	10.8	6.9	4.7	3.3	1.5	1.2	2.2	5.5	8.5	11	6.8	58	1910	1970
Mean 3pm relative humidity (%)	29	32	28	24	26	28	25	21	19	20	22	26	25	58	1910	1970
Mean 3pm cloud cover (oktas)	4.4	4.1	3.6	2.3	2.2	1.7	1.4	1.1	1.5	2.7	3.4	3.9	2.7	59	1910	1970
Mean 3pm wind speed (km/h) for years 1910 to 1970	11.7	11.8	11.9	12.2	11.4	11.3	11.3	10.7	11.2	11.4	11.3	11.3	11.5	59	1910	1970

Monthly Climate Statistics for 'TENNANT CREEK AIRPORT' [015135]

Created on [28 Jan 2009 17:13:40 GMT]

015135 TENNANT CREEK AIRPORT
Commenced: 1969
Last Record: 2008
Latitude: 19.64 Degrees South
Longitude: 134.18 Degrees East
Elevation: 376 m
State: NT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C)	36.8	35.8	34.4	31.7	27.7	24.5	24.6	27.4	31.5	34.8	36.5	37.3	31.9	39	1969	2008
Highest temperature (Degrees C)	44	44.5	40.7	38.4	36.4	32.9	34.7	35.5	38.9	41.6	43.4	45.4	45.4	39	1969	2008
Date of Highest temperature	5-Jan-71	18-Feb-70	3-Mar-88	9-Apr-05	4-May-07	15-Jun-02	16-Jul-95	29-Aug-92	27-Sep-97	22-Oct-87	30-Nov-96	2-Dec-07	2-Dec-07	N/A	1969	2008
Lowest maximum temperature (Degrees C)	24.2	24	20	15.1	16.1	8	11.9	14.1	15.7	14.8	15.5	20.4	8	39	1969	2008
Date of Lowest maximum temperature	19-Jan-06	2-Feb-04	9-Mar-00	25-Apr-83	14-May-79	20-Jun-07	14-Jul-84	14-Aug-78	9-Sep-74	20-Oct-00	17-Nov-81	25-Dec-06	20-Jun-07	N/A	1969	2008
Decile 1 maximum temperature (Degrees C) for years 1969 to 2008	31.8	30.8	30.2	27.6	23.1	19.8	20.3	22.6	26.2	29.7	31.9	32.7		40	1969	2008
Decile 9 maximum temperature (Degrees C) for years 1969 to 2008	40.9	39.9	38	35.2	31.7	29.3	29	32.1	36	38.9	40.1	40.9		40	1969	2008
Mean number of days >= 30 Degrees C	29.4	26.2	28.2	23	8.5	1.9	1.7	8.1	21	27.7	28.8	30	234.5	39	1969	2008
Mean number of days >= 35 Degrees C	22.6	17.3	14.7	3.6	0.2	0	0	0.2	5.8	17.4	21.6	24.8	128.2	39	1969	2008
Mean number of days >= 40 Degrees C	6.1	2.8	0.3	0	0	0	0	0	0	0.9	3.5	6.2	19.8	39	1969	2008
Mean minimum temperature (Degrees C)	25	24.6	23.3	20.4	16.4	12.9	12.2	14.4	18.4	21.8	23.8	24.9	19.8	39	1969	2008
Lowest temperature (Degrees C)	17.2	17.2	14.6	11.6	6.7	5.3	4.5	6	7.4	11.6	10.7	15.7	4.5	39	1969	2008
Date of Lowest temperature	14-Jan-02	3-Feb-04	31-Mar-73	26-Apr-83	27-May-74	27-Jun-77	14-Jul-78	3-Aug-90	16-Sep-77	21-Oct-00	19-Nov-81	28-Dec-06	14-Jul-78	N/A	1969	2008
Highest minimum temperature (Degrees C)	33.2	31.4	29.7	27.8	24.5	21.3	21.9	23.8	27.6	30.2	31.6	32.1	33.2	39	1969	2008
Date of Highest minimum temperature	5-Jan-71	26-Feb-86	7-Mar-88	21-Apr-98	6-May-88	22-Jun-96	16-Jul-90	29-Aug-92	30-Sep-88	15-Oct-87	23-Nov-90	31-Dec-86	5-Jan-71	N/A	1969	2008
Decile 1 minimum temperature (Degrees C) for years 1969 to 2008	22.1	22	20.4	16.6	12.3	8.7	8.3	10.4	13.3	17.7	20.1	21.8		40	1969	2008
Decile 9 minimum temperature (Degrees C) for years 1969 to 2008	28	27.5	26	23.9	20.4	17.3	16.2	18.9	22.9	25.7	27.1	28		40	1969	2008
Mean number of days <= 2 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	39	1969	2008
Mean number of days <= 0 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	39	1969	2008
Mean daily ground minimum temperature Degrees C	24	23.7	22	18.9	14.8	11.2	10.3	12.5	16.5	20.2	22.5	23.7	18.4	39	1969	2008
Lowest ground temperature Degrees C	16.3	14.9	12.5	10	4	2.3	2.1	2.7	4.5	9.6	11.1	12.8	2.1	39	1969	2008
Date of Lowest ground temperature	22-Jan-07	9-Feb-73	25-Mar-76	30-Apr-76	27-May-74	24-Jun-81	10-Jul-74	3-Aug-90	16-Sep-77	19-Oct-74	18-Nov-81	28-Dec-06	10-Jul-74	N/A	1969	2008
Mean number of days ground min. temp. <= -1 Degrees C	0	0	0	0	0	0	0	0	0	0	0	0	0	39	1969	2008
Mean rainfall (mm)	107.5	121	55.7	15.8	7.6	5.6	4.6	1.7	8.1	20.2	38	67.6	451.9	39	1969	2008
Highest rainfall (mm)	357.4	377	237.6	135.4	50.8	85.3	74.2	18.2	55.6	107.2	159.8	249.8	1004.2	39	1969	2008
Date of Highest rainfall	2006	2003	2001	2000	1978	1973	1978	2003	1975	2005	2000	2000	2000	N/A	1969	2008
Lowest rainfall (mm)	2.2	1	0	0	0	0	0	0	0	0	1.8	1.8	170	39	1969	2008
Date of Lowest rainfall	1985	1989	1991	2008	2008	2006	2008	2008	2006	2008	1986	1981	1970	N/A	1969	2008
Decile 1 monthly rainfall (mm) for years 1969 to 2008	12.9	9.9	1.8	0	0	0	0	0	0	0	5	11.8	225.9	39	1969	2008
Decile 5 (median) monthly rainfall (mm) for years 1969 to 2008	92.8	87	32	1.8	0	0	0	0	1	14.9	31.3	43.9	415.2	39	1969	2008
Decile 9 monthly rainfall (mm) for years 1969 to 2008	250.7	315.3	148.8	52.9	29.1	16.8	9.8	6.4	26.5	48.7	72.2	149.2	727.5	39	1969	2008
Highest daily rainfall (mm)	138.4	153.6	96.4	102.8	22.6	45.5	62.2	17.6	29.6	51.6	71.6	134.8	153.6	40	1969	2009
Date of Highest daily rainfall	26-Jan-82	17-Feb-03	25-Mar-07	22-Apr-00	7-May-86	15-Jun-73	9-Jul-78	15-Aug-03	29-Sep-79	29-Oct-75	13-Nov-00	23-Dec-93	17-Feb-03	N/A	1969	2009
Mean number of days of rain	9.6	9.3	6.1	1.9	1.4	0.9	0.7	0.7	1.8	3.9	5.8	7.6	49.7	39	1969	2008
Mean number of days of rain >= 1 mm	7.6	7.6	4.4	1.4	1	0.6	0.4	0.4	1.1	2.9	4.1	5.7	37.2	40	1969	2009
Mean number of days of rain >= 10 mm	3.2	3.4	1.8	0.4	0.4	0.2	0.1	0	0.2	0.6	1.1	2.1	13.5	40	1969	2009
Mean number of days of rain >= 25 mm	1.4	1.5	0.5	0.1	0	0.1	0.1	0	0.1	0.1	0.4	0.8		40	1969	2009
Mean daily wind run (km)	388	371	395	426	427	442	415	433	416	420	401	382	410	17	1992	2008
Maximum wind gust speed (km/h)	117	102	95	98	81	78	80	78	76	104	100	106	117	38	1969	2008
Date of Maximum wind gust speed	4-Jan-04	24-Feb-87	12-Mar-02	14-Apr-84	30-May-00	29-Jun-02	18-Jul-98	16-Aug-70	22-Sep-08	15-Oct-69	19-Nov-04	1-Dec-96	4-Jan-04	N/A	1969	2008
Mean daily sunshine (hours)	9.3	9	9.2	9.9	9.7	9.9	10.2	10.5	10.2	10.1	9.7	9.6	9.8	39	1969	2008
Mean daily solar exposure (MJ/(m*m))	25.7	24.7	24.1	21.9	18.9	17.2	18.4	21.2	23.8	25.4	26.6	26.3	22.8	19	1990	2009
Mean number of clear days	6.5	5.4	10.4	15.6	18.9	20.5	23.3	22.8	20.3	16.6	11.3	8.1	179.7	39	1969	2008
Mean number of cloudy days	12.2	12	9.1	5.3	4.2	2.7	1.9	1.7	2.4	4.6	6.2	10	72.3	39	1969	2008
Mean daily evaporation (mm)	12.7	11.5	11.4	11	8.7	7.3	7.5	9.3	11.7	13.2	13.6	13.3	10.9	37	1969	2008
Mean 9am temperature (Degrees C)	29.2	28.4	27.1	24.3	20	16.2	15.8	18.6	23.2	27.1	29	29.8	24.1	39	1969	2008
Mean 9am wet bulb temperature (Degrees C)	21.1	21.3	19	15.6	12.7	10.1	9.3	10.5	13.3	16.1	18.5	20.3	15.6	39	1969	2008
Mean 9am dew point temperature (Degrees C)	15.1	16.1	12.5	7.3	4.8	2.7	0.5	-0.2	1.8	4.7	9.1	12.9	7.3	39	1969	2008
Mean 9am relative humidity (%)	49	54	46	37	40	42	38	31	28	29	35	41	39	39	1969	2008
Mean 9am cloud cover (okas)	4.3	4.4	3.4	2.4	2.2	1.8	1.3	1.4	1.7	2.2	3	3.7	2.6	39	1969	2008
Mean 9am wind speed (km/h) for years 1969 to 2008	17	16.7	19.6	23.7	24.7	24.4	23.7	25.3	25.6	24.9	21.7	18.3	22.1	40	1969	2008
Mean 3pm temperature (Degrees C)	35.4	34.5	33.4	30.8	27	23.8	23.9	26.6	30.6	33.6	35.2	35.8	30.9	39	1969	2008
Mean 3pm wet bulb temperature (Degrees C)	21.9	22.2	20.5	18	15.6	13.5	12.9	14	16.1	18.2	19.9	21.2	17.8	39	1969	2008
Mean 3pm dew point temperature (Degrees C)	12.4	13.8	10.9	7.1	4.5	2.1	-0.1	-0.9	0.6	3.5	7.3	10.4	6	39	1969	2008
Mean 3pm relative humidity (%)	31	35	30	25	26	26	22	18	17	19	22	26	25	39	1969	2008
Mean 3pm cloud cover (oktas)	4.8	5	4.2	3.1	2.4	1.8	1.4	1.4	1.9	2.8	3.7	4.5	3.1	39	1969	2008
Mean 3pm wind speed (km/h) for years 1969 to 2008	15.4	15.9	17.6	17.3	16.7	16.5	15.5	16.1	16	14.5	13.8	14.1	15.8	39	1969	2008

Monthly Climate Statistics for 'ALI CURUNG' [015502]
Created on [28 Jan 2009 13:33:31 GMT]

015502 ALI CURUNG
Commenced: 1967
Last Record: 2008
Latitude: 21.00 Degrees South
Longitude: 134.40 Degrees East
Elevation: 375 m
State: NT

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C)	38	36.8	35.4	32.2	27.5	24.2	24.4	27	32.3	35.2	36.8	37.7	32.3	21	1988	2008
Highest temperature (Degrees C)	45	44.8	41.9	39.3	36.6	33.3	34.2	35.4	40.4	42.1	44.5	46	46	21	1988	2008
Date of Highest temperature	29-Jan-90	3-Feb-98	22-Mar-93	2-Apr-05	5-May-07	9-Jun-05	16-Jul-95	28-Aug-96	22-Sep-03	18-Oct-02	17-Nov-90	2-Dec-07	2-Dec-07	N/A	1988	2008
Lowest maximum temperature (Degrees C)	24.1	25	20.2	18.6	15.4	8	13.4	17.8	19.2	18.8	22	21	8	21	1988	2008
Date of Lowest maximum temperature	28-Jan-97	18-Feb-01	9-Mar-00	18-Apr-90	29-May-04	20-Jun-07	2-Jul-98	1-Aug-90	21-Sep-93	4-Oct-97	14-Nov-01	25-Dec-06	20-Jun-07	N/A	1988	2008
Decile 1 maximum temperature (Degrees C) for years 1988 to 2008	33	31.8	31.1	27.5	22.5	19.1	19.7	21.6	26.4	29.5	31.8	32.8		20	1988	2008
Decile 9 maximum temperature (Degrees C) for years 1988 to 2008	42	41.1	39	36.2	32.2	30	29.4	32.5	36.9	39.8	41.1	41.7		20	1988	2008
Mean number of days >= 30 Degrees C	29.2	25.1	28.2	22.9	8.4	2.9	2	7.7	21	26.2	27.2	26.7	227.5	21	1988	2008
Mean number of days >= 35 Degrees C	24.9	19.2	19	6.2	0.3	0	0	0.2	8.8	18.2	20.4	22.7	139.9	21	1988	2008
Mean number of days >= 40 Degrees C	10.7	5.6	1.4	0	0	0	0	0	0	2.6	5.7	7.9	33.9	21	1988	2008
Mean minimum temperature (Degrees C)	23.8	23.3	21	16.6	11.9	8.3	7.2	9.1	14.8	18.7	21.3	23.2	16.6	21	1988	2008
Lowest temperature (Degrees C)	15.8	15.3	10.1	5.9	1	-2.5	-1.2	-1	4.2	7.3	12.4	14.8	-2.5	21	1988	2008
Date of Lowest temperature	22-Jan-07	2-Feb-90	25-Mar-97	30-Apr-99	31-May-00	23-Jun-88	1-Jul-02	2-Aug-90	3-Sep-03	1-Oct-02	24-Nov-96	28-Dec-06	23-Jun-88	N/A	1988	2008
Highest minimum temperature (Degrees C)	31.1	30.7	28.5	26.3	21.6	18.5	18.4	20.5	27.3	28.6	30.6	30.7	31.1	21	1988	2008
Date of Highest minimum temperature	19-Jan-89	3-Feb-98	2-Mar-92	11-Apr-05	2-May-94	3-Jun-04	20-Jul-98	29-Aug-04	23-Sep-03	26-Oct-89	30-Nov-96	30-Dec-02	19-Jan-89	N/A	1988	2008
Decile 1 minimum temperature (Degrees C) for years 1988 to 2008	20.3	20	16.2	11.8	7	3.3	3	4.2	8.9	13.5	17	19.2		20	1988	2008
Decile 9 minimum temperature (Degrees C) for years 1988 to 2008	27.1	26.3	24.9	21.6	17.5	14	12	15	20.5	23.5	25.5	27		20	1988	2008
Mean number of days <= 2 Degrees C	0	0	0	0	0.2	1	1.5	0.4	0	0	0	0	3.1	21	1988	2008
Mean number of days <= 0 Degrees C	0	0	0	0	0	0.2	0.2	0.1	0	0	0	0	0.5	21	1988	2008
Mean daily ground minimum temperature Degrees C	21.2	21.2	18.6	14	9.2	5.5	4.1	6	11.3	15.4	18.2	20.7	13.8	20	1988	2008
Lowest ground temperature Degrees C	10	10.2	6.5	1.3	-2.4	-6	-5.8	-5.5	-2	0.2	7.4	8.5	-6	20	1988	2008
Date of Lowest ground temperature	11-Jan-92	2-Feb-90	16-Mar-94	27-Apr-92	29-May-02	29-Jun-04	1-Jul-02	17-Aug-02	14-Sep-04	1-Oct-02	4-Nov-89	17-Dec-89	29-Jun-04	N/A	1988	2008
Mean number of days ground min. temp. <= -1 Degrees C	0	0	0	0	0.2	2.4	3	1.6	0.1	0	0	0	7.3	20	1988	2008
Mean rainfall (mm)	80.4	101.4	32.3	19.1	18.2	5.8	5.3	3.9	8.1	22.5	31.5	63.8	386.9	30	1967	2008
Highest rainfall (mm)	442.7	379.8	141.4	83.3	154.3	43.4	34.4	25.6	55.6	122.2	99.4	375.5	905	30	1967	2008
Date of Highest rainfall	1974	1975	2001	2000	1968	2005	2006	1973	1993	2005	2001	2000	2000	N/A	1967	2008
Lowest rainfall (mm)	0.6	0	0	0	0	0	0	0	0	0	0	0	153.7	30	1967	2008
Date of Lowest rainfall	1989	1989	2002	2008	2008	2006	2008	2007	2006	2004	1969	1972	1969	N/A	1967	2008
Decile 1 monthly rainfall (mm) for years 1967 to 2008	2.8	10.5	2	0	0	0	0	0	0	0	1	10.5	191.9	30	1967	2008
Decile 5 (median) monthly rainfall (mm) for years 1967 to 2008	56.8	53.7	19.4	0.4	0	0	0.2	0	1.3	7.2	25.2	48.5	325.8	30	1967	2008
Decile 9 monthly rainfall (mm) for years 1967 to 2008	152.5	219.1	82.1	58.1	55.1	28.2	18.5	20.1	22.4	48	69.7	109.6	708	30	1967	2008
Highest daily rainfall (mm)	132	126.2	68	46.5	58.4	21.7	29.4	13.7	48.8	62.9	56	98.2	132	30	1967	2009
Date of Highest daily rainfall	21-Jan-74	12-Feb-97	17-Mar-75	2-Apr-71	21-May-90	20-Jun-05	14-Jul-06	23-Aug-71	28-Sep-93	21-Oct-05	18-Nov-97	13-Dec-00	21-Jan-74	N/A	1967	2009
Mean number of days of rain	6.9	7.9	4	2	1.8	1.2	1	1	1.5	3.8	4.6	6.8	42.5	30	1967	2008
Mean number of days of rain >= 1 mm	5.9	6.7	3.2	1.6	1.4	0.7	0.8	0.7	0.9	2.9	3.4	5.2	33.4	30	1967	2009
Mean number of days of rain >= 10 mm	2.5	2.6	1	0.7	0.5	0.2	0.1	0.1	0.2	0.6	1.1	1.9	11.5	30	1967	2009
Mean number of days of rain >= 25 mm	1.1	1.1	0.3	0.2	0.3	0	0	0	0.1	0.1	0.3	0.7		30	1967	2009
Mean daily wind run (km)																
Maximum wind gust speed (km/h)																
Date of Maximum wind gust speed														N/A		
Mean daily sunshine (hours)																
Mean daily solar exposure (MJ/(m*m))	26.5	25.1	24.5	21.4	18.1	16.6	17.9	20.7	23.5	25.4	27.1	27.1	22.8	19	1990	2009
Mean number of clear days	7.7	7.4	13.6	15.5	17.8	18.5	22.4	21.3	17.4	15.7	10.6	8.1	176	21	1988	2008
Mean number of cloudy days	7.9	8.2	5.3	3.6	4.1	2.5	1.3	1.8	2.7	4.6	4.7	8.2	54.9	21	1988	2008
Mean daily evaporation (mm)	10.4	9.1	8.8	7.6	5.4	4.5	4.6	6.2	8.3	9.6	10.4	10	7.9	20	1988	2008
Mean 9am temperature (Degrees C)	30.5	29.3	27.7	23.8	18.4	14.5	13.9	17.1	23.7	27.5	29.3	30.4	23.8	21	1988	2008
Mean 9am wet bulb temperature (Degrees C)	21.3	21.4	18.9	15.4	12.4	9.4	8.6	10	13.8	16.5	18.6	20.5	15.6	16	1988	2008
Mean 9am dew point temperature (Degrees C)	14.9	16.2	12.3	8	6.3	3.8	1.9	0.9	3.6	6.2	9.9	13.5	8.1	16	1988	2008
Mean 9am relative humidity (%)	44	51	42	40	48	52	46	35	30	31	37	42	41	16	1988	2008
Mean 9am cloud cover (okas)	3.3	3.5	2.4	2	2	1.8	1.1	1.1	1.5	2	2.7	3.3	2.2	21	1988	2008
Mean 9am wind speed (km/h) for years 1988 to 2008	12.4	11	13.4	13.7	12.8	12.4	11.6	14.2	15.8	16.7	15.8	12.9	13.6	19	1988	2008
Mean 3pm temperature (Degrees C)	36.8	35.6	34.5	31.3	26.7	23.5	23.8	26.3	31.4	34.1	35.5	36.4	31.3	21	1988	2008
Mean 3pm wet bulb temperature (Degrees C)	22.5	22.8	21	18.5	16.1	13.7	13.3	14.1	17.1	18.8	20.5	21.9	18.4	16	1988	2008
Mean 3pm dew point temperature (Degrees C)	13	14.8	11.5	8	6.5	3.8	1.8	0.4	3.4	5.5	9.1	11.8	7.5	16	1988	2008
Mean 3pm relative humidity (%)	29	35	29	27	31	30	25	20	19	21	26	28	27	16	1988	2008
Mean 3pm cloud cover (oktas)	4.6	4.5	3.5	2.8	2.3	1.9	1	1.2	2	2.8	3.7	4.5	2.9	21	1988	2008
Mean 3pm wind speed (km/h) for years 1988 to 2008	11.5	11.4	12.1	11.3	11	11	10.8	12.6	12.3	12	12	11.1	11.6	19	1988	2008

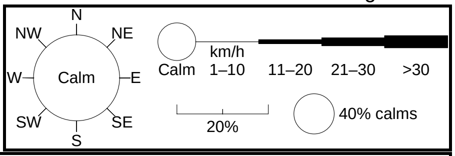
Monthly Climate Statistics for 'CAMOOWEAL TOWNSHIP' [037010]
Created on [29 Jan 2009 01:05:59 EST]

037010 CAMOOWEAL TOWNSHIP
Commenced: 1891
Last Record: 2008
Latitude: 19.92 Degrees South
Longitude: 138.12 Degrees East
Elevation: 231 m
State: QLD

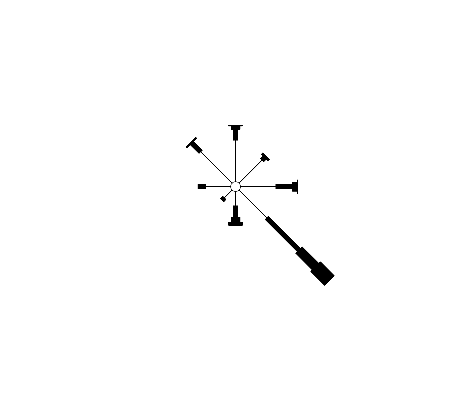
Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Years	Start Year	End Year
Mean maximum temperature (Degrees C)	37.4	36.2	35.3	33	28.9	25.9	25.8	28.3	32.3	35.8	37.5	38.1	32.9	100	1907	2008
Highest temperature (Degrees C)	45.4	45.5	42.8	40	38.2	35.6	35.7	37.3	41	44	44.5	46.6	46.6	68	1939	2008
Date of Highest temperature	11-Jan-71	19-Feb-83	2-Mar-51	5-Apr-66	4-May-07	1-Jun-62	17-Jul-95	28-Aug-85	30-Sep-00	23-Oct-87	27-Nov-82	23-Dec-90	23-Dec-90	N/A	1939	2008
Lowest maximum temperature (Degrees C)	24	15	20.7	19.1	13.3	9.8	11	15	15.2	17	20.7	19.4	9.8	68	1939	2008
Date of Lowest maximum temperature	17-Jan-03	24-Feb-49	29-Mar-56	26-Apr-83	23-May-59	20-Jun-07	24-Jul-84	8-Aug-96	8-Sep-87	20-Oct-00	17-Nov-81	21-Dec-50	20-Jun-07	N/A	1939	2008
Decile 1 maximum temperature (Degrees C) for years 1939 to 2008	32.8	31.7	31.4	29	24.3	21.1	21.2	23.3	27.2	31.3	33.5	33.7		68	1939	2008
Decile 9 maximum temperature (Degrees C) for years 1939 to 2008	41.7	40.6	39	36.7	33.3	30.6	30.4	33	36.7	39.7	41.1	42		68	1939	2008
Mean number of days >= 30 Degrees C	28.7	26.5	28.1	25.2	14.4	4.5	4.3	11.5	23	28.8	28.7	29.4	253.1	68	1939	2008
Mean number of days >= 35 Degrees C	23.8	19.8	19.7	9.9	0.9	0	0	0.8	8.6	21.6	24.6	25.5	155.2	68	1939	2008
Mean number of days >= 40 Degrees C	8.7	4.6	1.3	0	0	0	0	0	0.1	2.6	7.9	10.9	36.1	68	1939	2008
Mean minimum temperature (Degrees C)	24.3	23.7	21.8	18	13.4	9.9	8.8	10.9	15.1	19.5	22.3	23.8	17.6	100	1907	2008
Lowest temperature (Degrees C)	13.5	12.8	10	4.4	2.4	-2.2	-0.3	0	3.9	5.7	7.5	14.4	-2.2	68	1939	2008
Date of Lowest temperature	30-Jan-78	25-Feb-49	27-Mar-46	30-Apr-52	30-May-74	27-Jun-71	20-Jul-04	1-Aug-77	1-Sep-43	2-Oct-41	2-Nov-74	14-Dec-52	27-Jun-71	N/A	1939	2008
Highest minimum temperature (Degrees C)	33.3	29.7	30.5	27.5	23.9	21.7	21.8	22.4	26.6	31.1	30.6	31.4	33.3	68	1939	2008
Date of Highest minimum temperature	2-Jan-43	19-Feb-86	1-Mar-83	12-Apr-86	3-May-64	3-Jun-63	27-Jul-93	25-Aug-95	25-Sep-89	29-Oct-48	22-Nov-08	31-Dec-90	2-Jan-43	N/A	1939	2008
Decile 1 minimum temperature (Degrees C) for years 1939 to 2008	21.2	21	18	13	8	4	3.6	5.6	9.3	14.1	18	20		68	1939	2008
Decile 9 minimum temperature (Degrees C) for years 1939 to 2008	27.3	26.7	25.3	22.8	19	15.4	14.4	16.7	20.8	24.4	26.3	27.3		68	1939	2008
Mean number of days <= 2 Degrees C	0	0	0	0	0	0.8	1.2	0.3	0	0	0	0	2.3	68	1939	2008
Mean number of days <= 0 Degrees C	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0.2	68	1939	2008
Mean daily ground minimum temperature Degrees C	23.3	22.6	20.7	16.6	11.8	8.4	7.3	9	13.2	18.1	21.2	22.6	16.2	32	1938	1970
Lowest ground temperature Degrees C	6.7	10.6	7.2	-15	-0.6	-5	-2.2	-3	2.3	3.3	10.4	12	-15	30	1939	1970
Date of Lowest ground temperature	27-Jan-59	11-Feb-59	27-Mar-46	27-Apr-43	31-May-51	20-Jun-49	13-Jul-60	15-Aug-41	13-Sep-41	2-Oct-41	28-Nov-55	10-Dec-41	27-Apr-43	N/A	1939	1970
Mean number of days ground min. temp. <= -1 Degrees C	0	0	0	0	0	0.4	0.4	0.1	0	0	0	0	0.9	30	1939	1970
Mean rainfall (mm)	95.5	90.9	54.7	14.3	11.1	10	5.5	2.9	6	14.2	28.8	59.3	392.4	116	1891	2008
Highest rainfall (mm)	592.8	384.6	311.1	239	147.1	116.8	82.1	88.4	80.2	125.3	137.5	289.2	1003.3	116	1891	2008
Date of Highest rainfall	1974	2000	1903	2006	1955	1937	1900	1893	1947	1930	1917	2000	1974	N/A	1891	2008
Lowest rainfall (mm)	0	0	0	0	0	0	0	0	0	0	0	0	100.4	116	1891	2008
Date of Lowest rainfall	1972	2001	2001	2008	2008	2006	2008	2008	2007	2006	1968	1938	2001	N/A	1891	2008
Decile 1 monthly rainfall (mm) for years 1891 to 2008	14.5	12.6	1.5	0	0	0	0	0	0	0	1.4	9.7	199.6	117	1891	2008
Decile 5 (median) monthly rainfall (mm) for years 1891 to 2008	66.1	71.2	36	2	0.6	0	0	0	0	5.3	21.6	47	368.3	117	1891	2008
Decile 9 monthly rainfall (mm) for years 1891 to 2008	196.1	194.4	140.1	45.3	29.2	33.9	14.4	8.8	22.6	41.8	64.9	121.5	598	117	1891	2008
Highest daily rainfall (mm)	226.1	112.8	191.3	110	70.4	57	76.7	53.3	36.3	85	130	116.3	226.1	116	1891	2009
Date of Highest daily rainfall	30-Jan-08	28-Feb-92	31-Mar-58	29-Apr-06	24-May-55	29-Jun-98	2-Jul-00	17 Aug 189	5-Sep-47	21-Oct-00	16-Nov-12	19-Dec-50	30-Jan-08	N/A	1891	2009
Mean number of days of rain	8.2	8.1	5.3	1.6	1.3	1.1	0.8	0.5	1.1	2.6	4.2	6.1	40.9	117	1891	2008
Mean number of days of rain >= 1 mm	7.1	6.8	4.3	1.2	1	0.8	0.6	0.3	0.8	2	3.1	5	33	116	1891	2009
Mean number of days of rain >= 10 mm	2.6	2.6	1.5	0.4	0.4	0.3	0.1	0.1	0.2	0.4	1	1.8	11.4	116	1891	2009
Mean number of days of rain >= 25 mm	1.1	1	0.6	0.2	0.1	0.1	0	0	0	0.1	0.2	0.6	4	116	1891	2009
Mean daily wind run (km)														6	2003	2008
Maximum wind gust speed (km/h)														6	1963	2008
Date of Maximum wind gust speed														N/A	1963	2008
Mean daily sunshine (hours)														0	1963	1964
Mean daily solar exposure (MJ/(m*m))	25.2	24.4	23.8	21.3	18.6	17.1	18.2	21	23.9	25.5	26.5	26.4	22.7	19	1990	2009
Mean number of clear days	8.2	6.5	10.5	15.5	17.4	20.6	23.1	24	21.4	16.9	12.8	10.5	187.4	57	1939	1997
Mean number of cloudy days	8.4	8.6	6.7	3.2	3.4	2.2	1.9	1.3	1.9	3.2	3.8	6	50.6	57	1939	1997
Mean daily evaporation (mm)	9.8	8.5	8.2	7.7	6.3	5.3	5.5	7.1	9.1	10.9	11.1	10.8	8.4	25	1969	1997
Mean 9am temperature (Degrees C)	29.6	28.6	27.5	24.8	20.3	16.1	15.4	18.5	23.5	27.9	30	30.6	24.4	99	1907	2008
Mean 9am wet bulb temperature (Degrees C)	22.3	22.4	20.2	16.9	13.8	10.9	9.8	11.2	14	17.3	19.5	21.3	16.6	88	1907	2008
Mean 9am dew point temperature (Degrees C)	17.7	18.4	14.7	9.9	6.3	4.3	2	1.2	2.9	6.9	10.4	14.4	9.1	61	1939	2008
Mean 9am relative humidity (%)	55	61	51	44	45	51	47	36	30	32	36	44	44	62	1938	2008
Mean 9am cloud cover (okas)	3.1	3.3	2.4	1.6	1.7	1.5	1.1	0.8	1	1.6	2.1	2.5	1.9	90	1907	1997
Mean 9am wind speed (km/h) for years 1939 to 2008	10.3	9.2	10.2	12.4	12.3	11.1	10.9	13.4	14.9	14.7	13.2	11.5	12	68	1939	2008
Mean 3pm temperature (Degrees C)	35.6	34.7	34.1	32	28.1	25.1	24.9	27.4	31.3	34.5	36.1	36.5	31.7	97	1907	2008
Mean 3pm wet bulb temperature (Degrees C)	23.1	23.3	21.8	19.3	17.1	15	14.2	15.1	16.9	19.3	20.9	22.2	19	87	1907	2008
Mean 3pm dew point temperature (Degrees C)	14.9	15.9	12.9	8.9	6	3.7	1.4	0.3	1.1	4.9	8.1	11.7	7.5	61	1939	2008
Mean 3pm relative humidity (%)	34	37	32	26	27	27	24	19	17	19	22	27	26	62	1938	2008
Mean 3pm cloud cover (oktas)	4.4	4.5	3.8	2.6	2.2	1.6	1	0.9	1.4	2.4	3.3	3.9	2.7	88	1907	1997
Mean 3pm wind speed (km/h) for years 1939 to 2008	11.7	11.3	11.8	12.6	12.8	13.4	13.6	13.6	13.4	12.6	11.6	11.3	12.5	67	1939	2008

Wind Roses using data between Jan 1957 and Aug 1974 for Wonarah

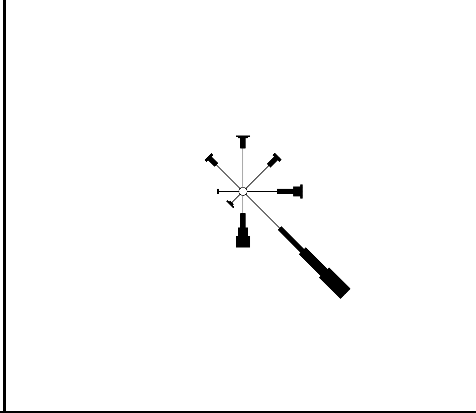
Site Number 015034 • Locality: Ranken • Opened Apr 1946 • Closed 31 Dec 1974
Latitude 19°53'54"S • Longitude 136°20'09"E • Elevation 240m



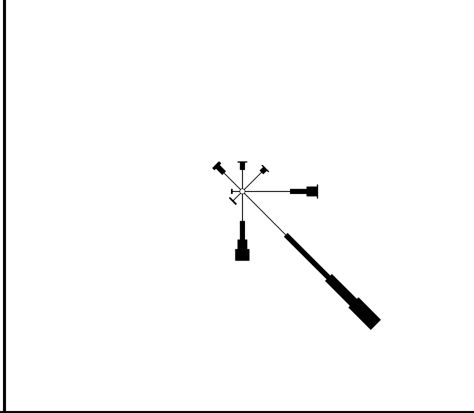
9 am January 484 observations



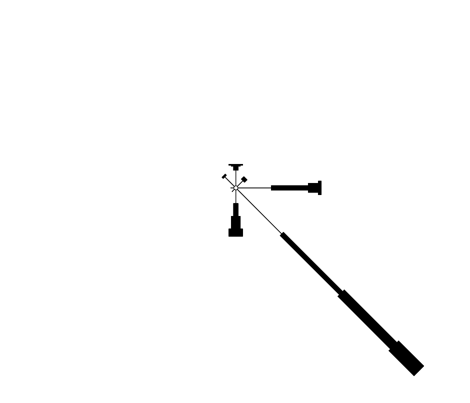
9 am February 448 observations



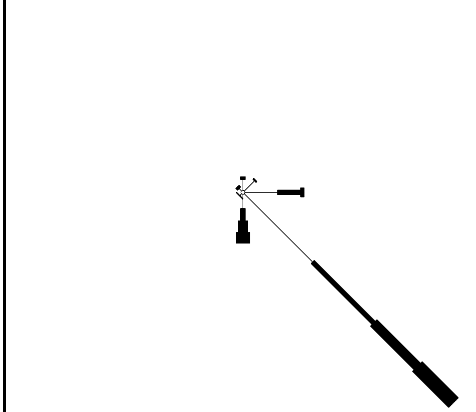
9 am March 466 observations



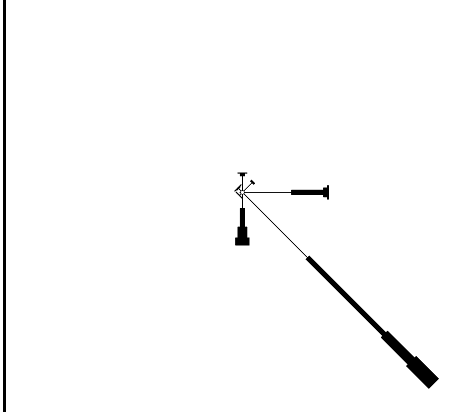
9 am April 458 observations



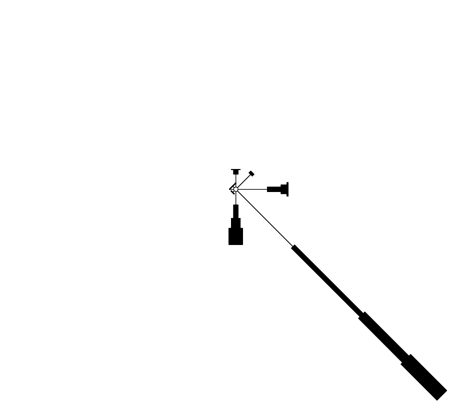
9 am May 467 observations



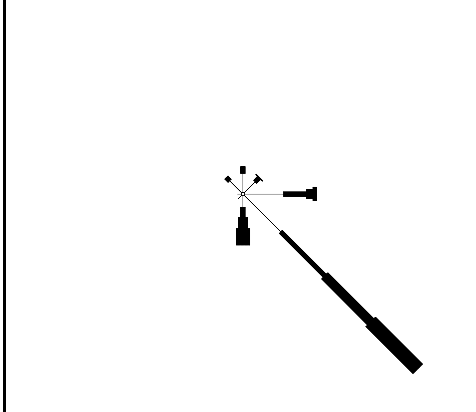
9 am June 456 observations



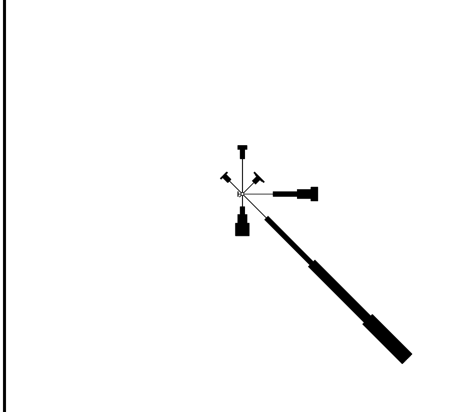
9 am July 462 observations



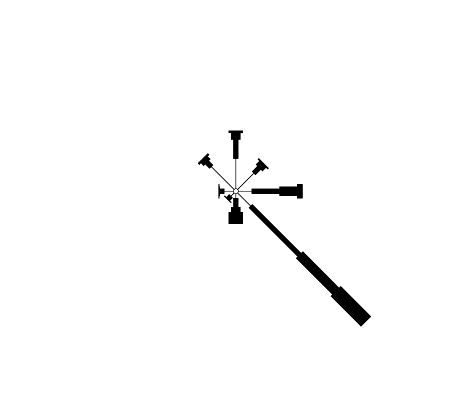
9 am August 482 observations



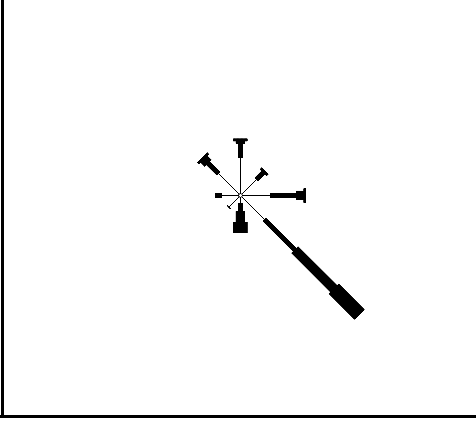
9 am September 446 observations



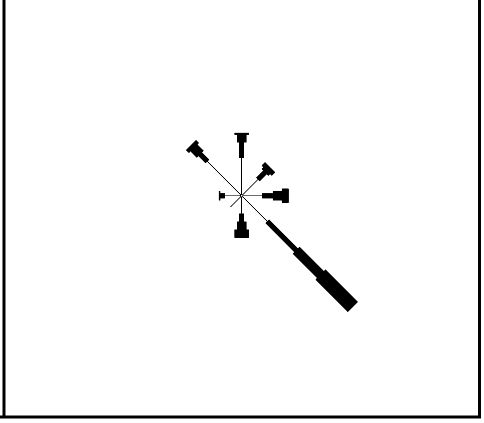
9 am October 454 observations



9 am November 406 observations



9 am December 385 observations



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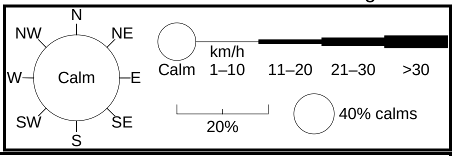
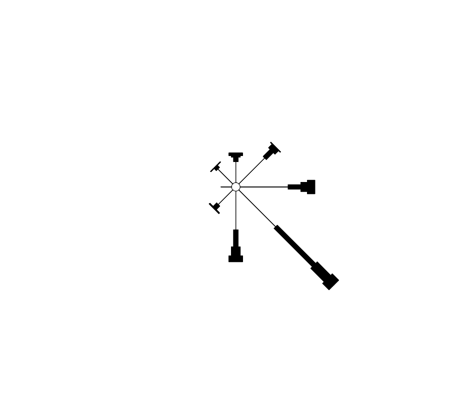
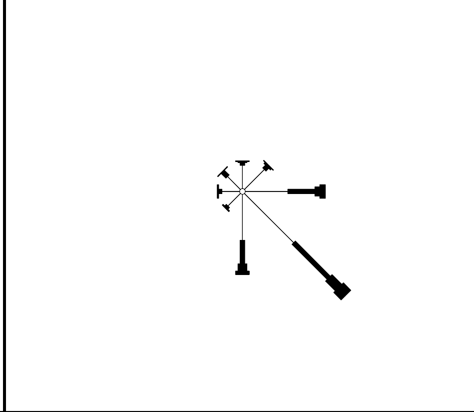


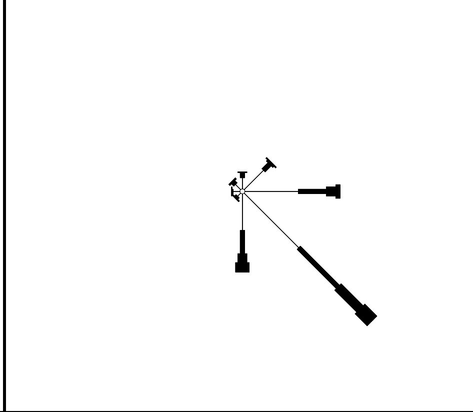
3 pm January 456 observations



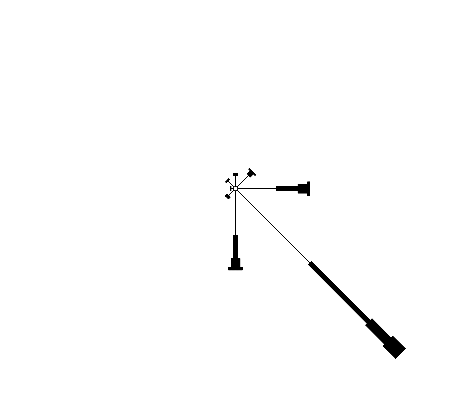
3 pm February 414 observations



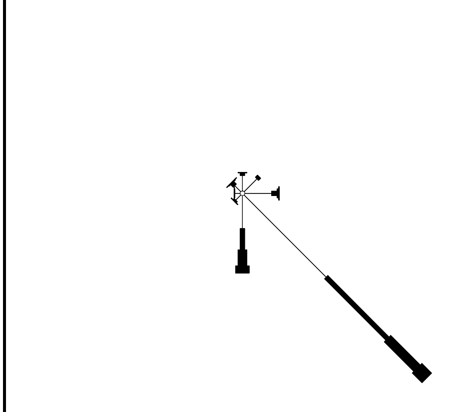
3 pm March 433 observations



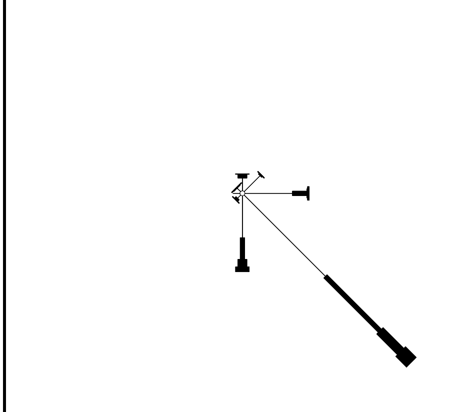
3 pm April 430 observations



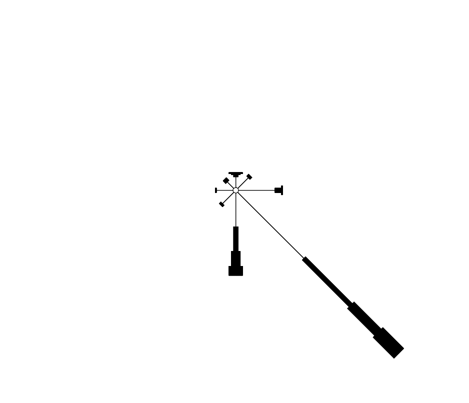
3 pm May 453 observations



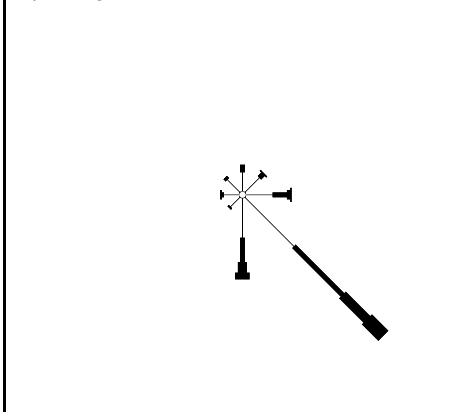
3 pm June 428 observations



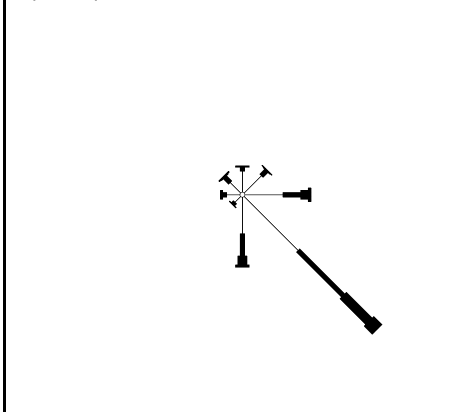
3 pm July 428 observations



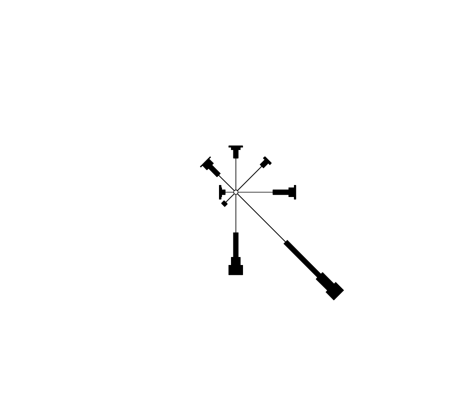
3 pm August 443 observations



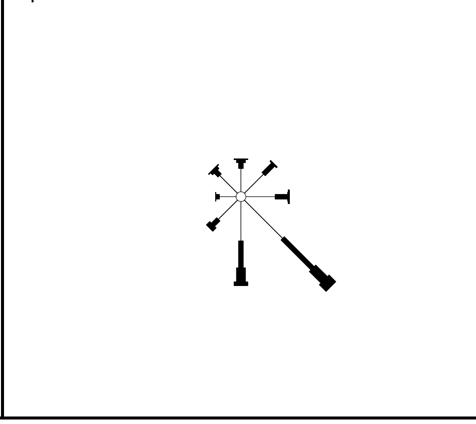
3 pm September 402 observations



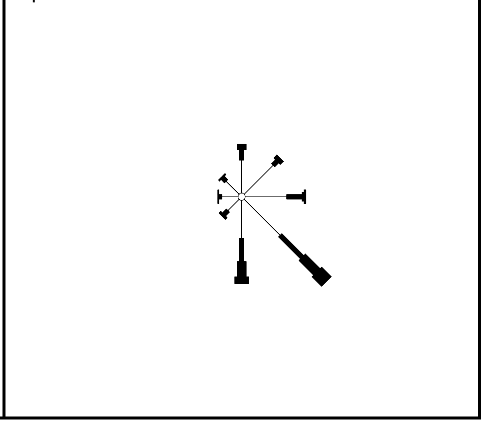
3 pm October 436 observations



3 pm November 390 observations



3 pm December 374 observations



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Wind Roses using data between Jul 1969 and Feb 2009 for
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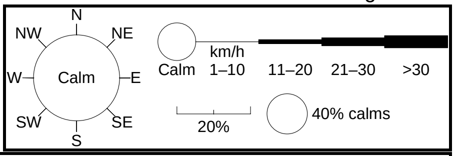
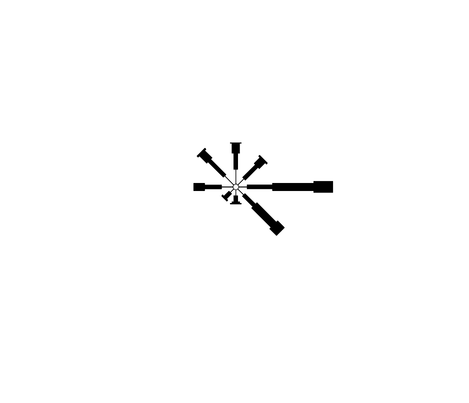
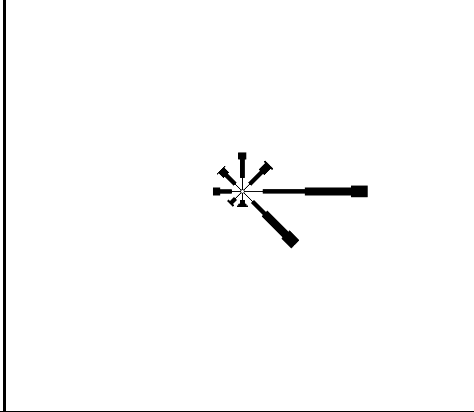
Site Number 015135 • Locality: Barkly South • Opened Jan 1969 • Still Open
Latitude 19°38'32"S • Longitude 134°11'00"E • Elevation 375.7m



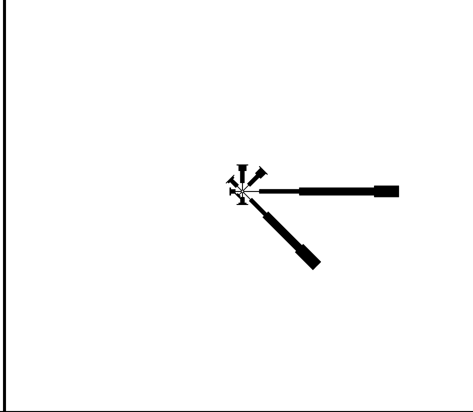
9 am January — 1302 observations



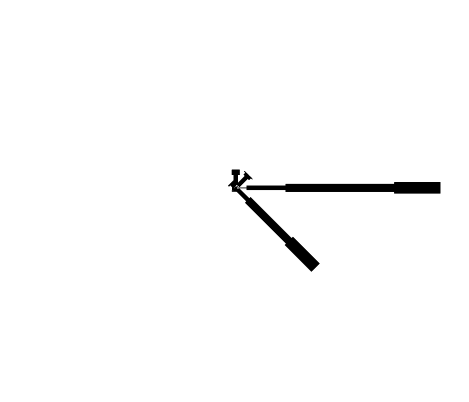
9 am February — 1181 observations



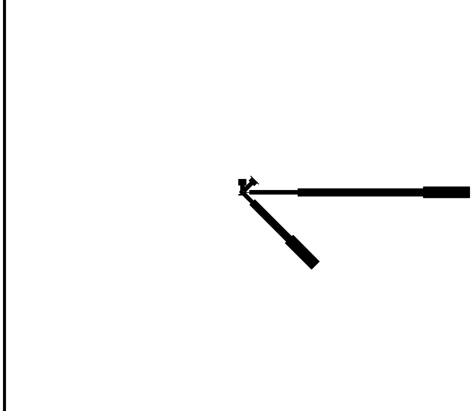
9 am March — 1243 observations



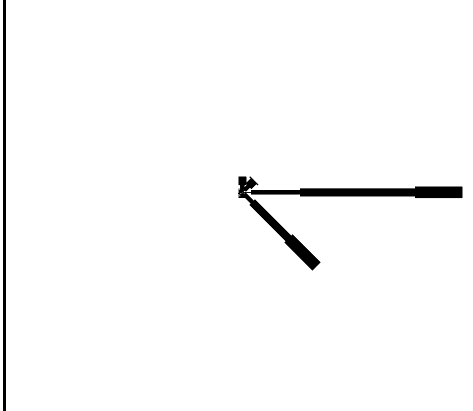
9 am April — 1200 observations



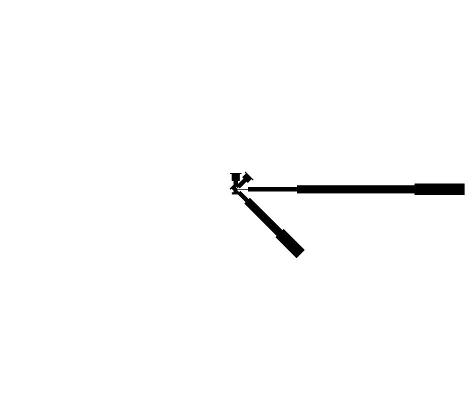
9 am May — 1207 observations



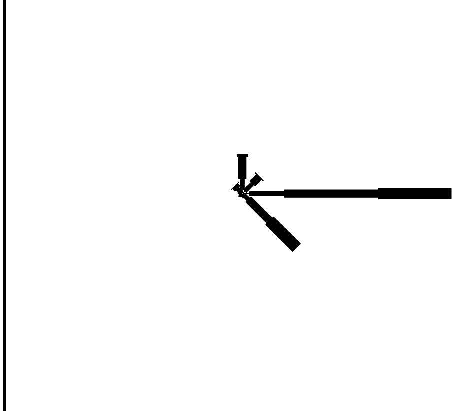
9 am June — 1170 observations



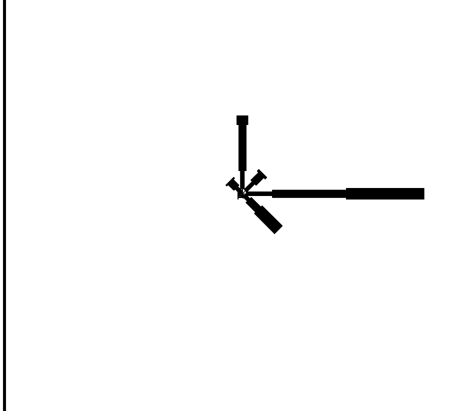
9 am July — 1243 observations



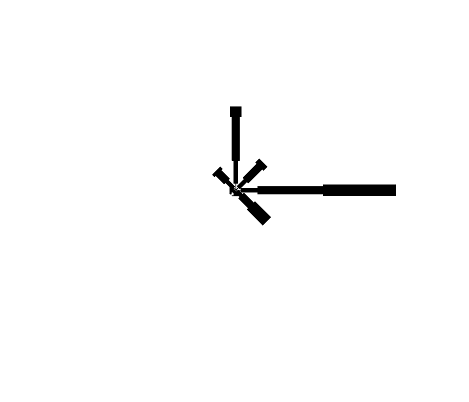
9 am August — 1265 observations



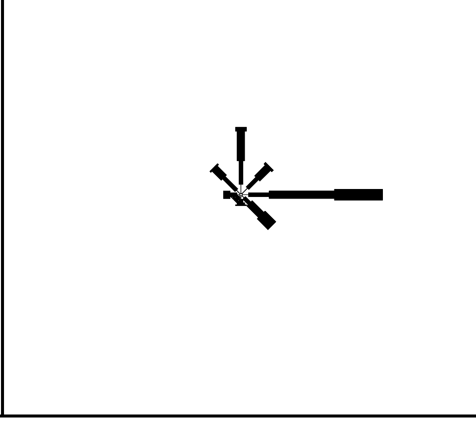
9 am September — 1227 observations



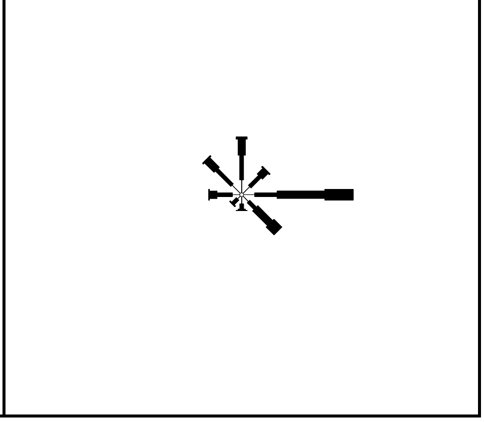
9 am October — 1272 observations



9 am November — 1260 observations



9 am December — 1301 observations



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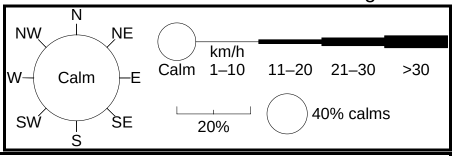
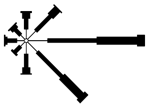
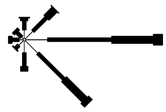


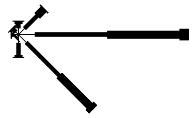
3 pm January — 1301 observations



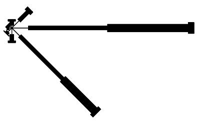
3 pm February — 1163 observations



3 pm March — 1213 observations



3 pm April — 1174 observations



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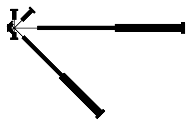

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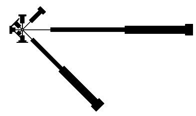

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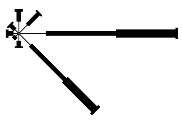
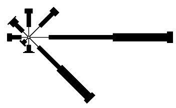


3 pm August — 1253 observations



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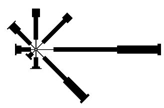

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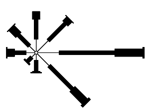

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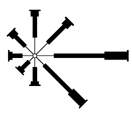
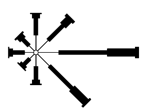


3 pm December — 1289 observations



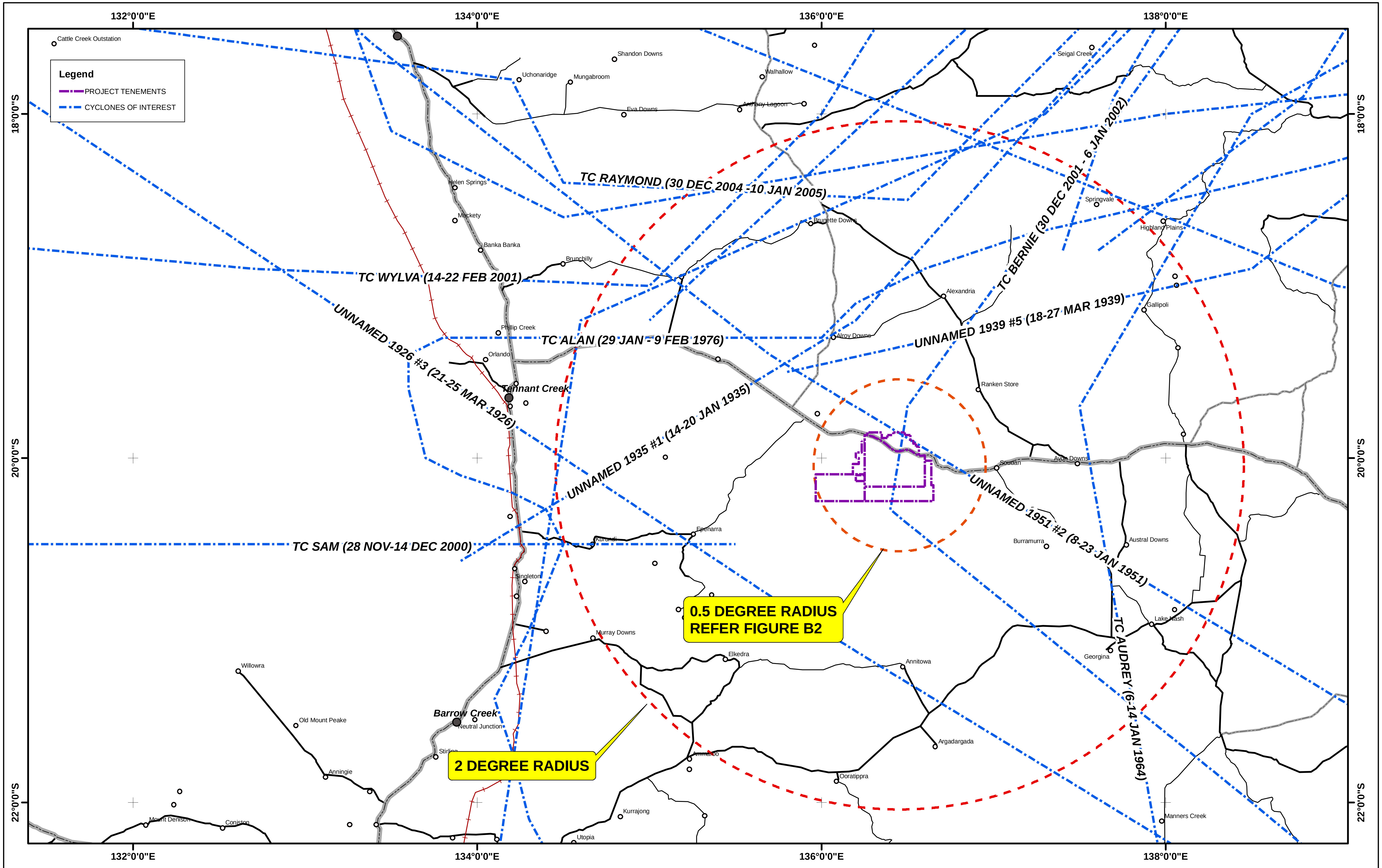
Australian Government
Bureau of Meteorology

Prepared by Climate Services Section in the WA Office of the Bureau of Meteorology. Contact us by phone on (08) 9263 2222, by fax on (08) 9263 2233, or by email on climate.wa@bom.gov.au

Prepared on 24 February 2009

APPENDIX B

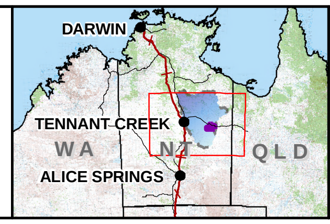
Cyclone Swept Path Analysis



N

0 12,500 25,000 50,000 75,000 100,000 125,000 150,000

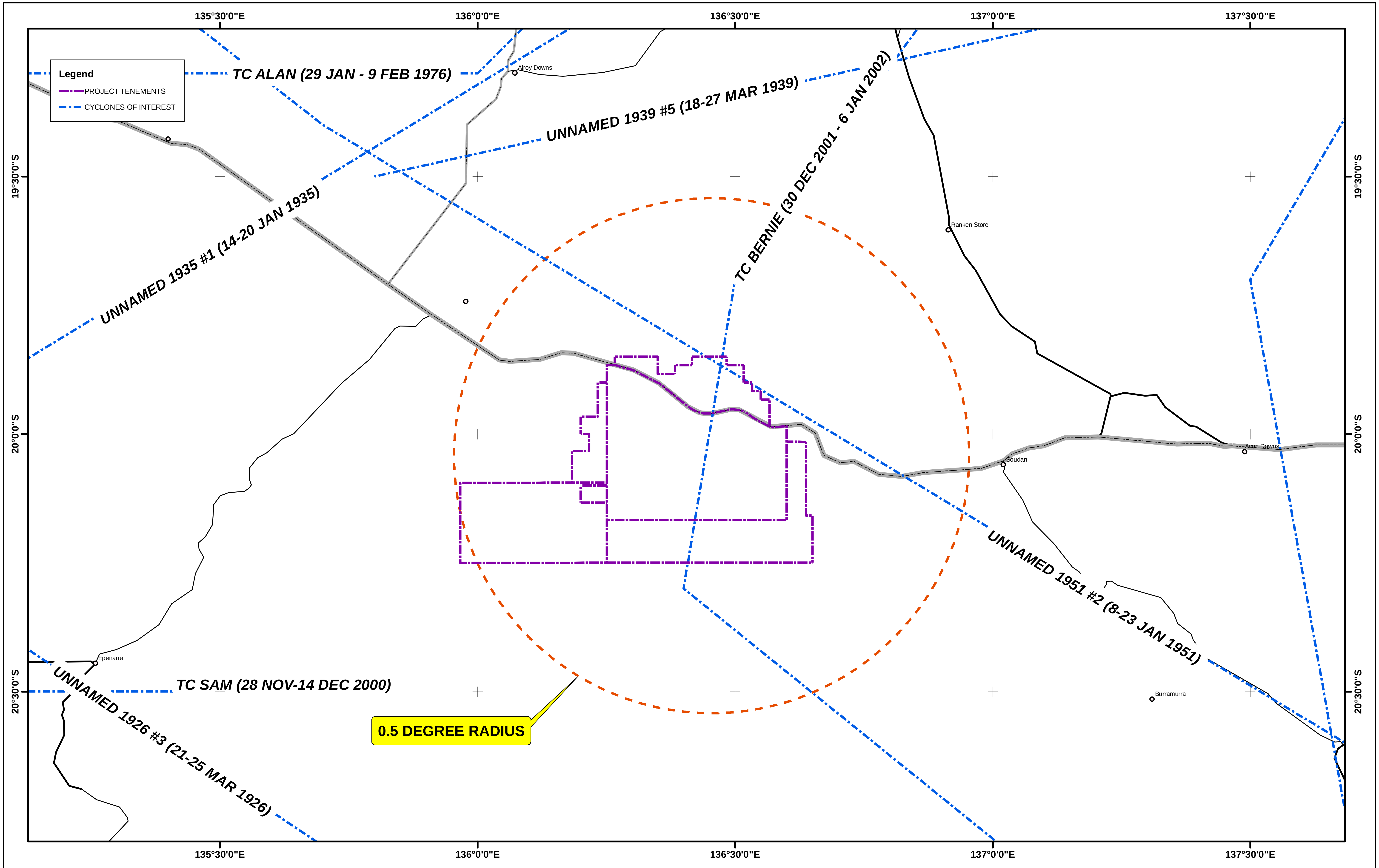
DATUM:GDA94, PROJECTION, MGA94, ZONE53S (Metres)



GROUNDWATER
RESOURCE MANAGEMENT

CLIENT	MINEMAKERS LIMITED		PROJECT	WONARAH PROJECT
DRAWN	DFH	DATE 28.04.2009	TITLE	CYCLONE SWEPT PATH ANALYSIS 2 DEGREE RADIUS
CHECKED	ARL	DATE 30.04.2009		
SCALE	1:2,250,000 @ A3		PROJECT No J090004	FIGURE No B1

File Location : I:\CarrickConsulting\J090004_Wonarah_NT\03_ProjectData\01_Workspace



N

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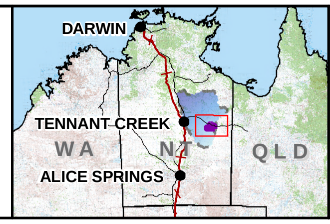
DATUM:GDA94, PROJECTION, MGA94, ZONE53S (Metres)



GROUNDWATER RESOURCE MANAGEMENT

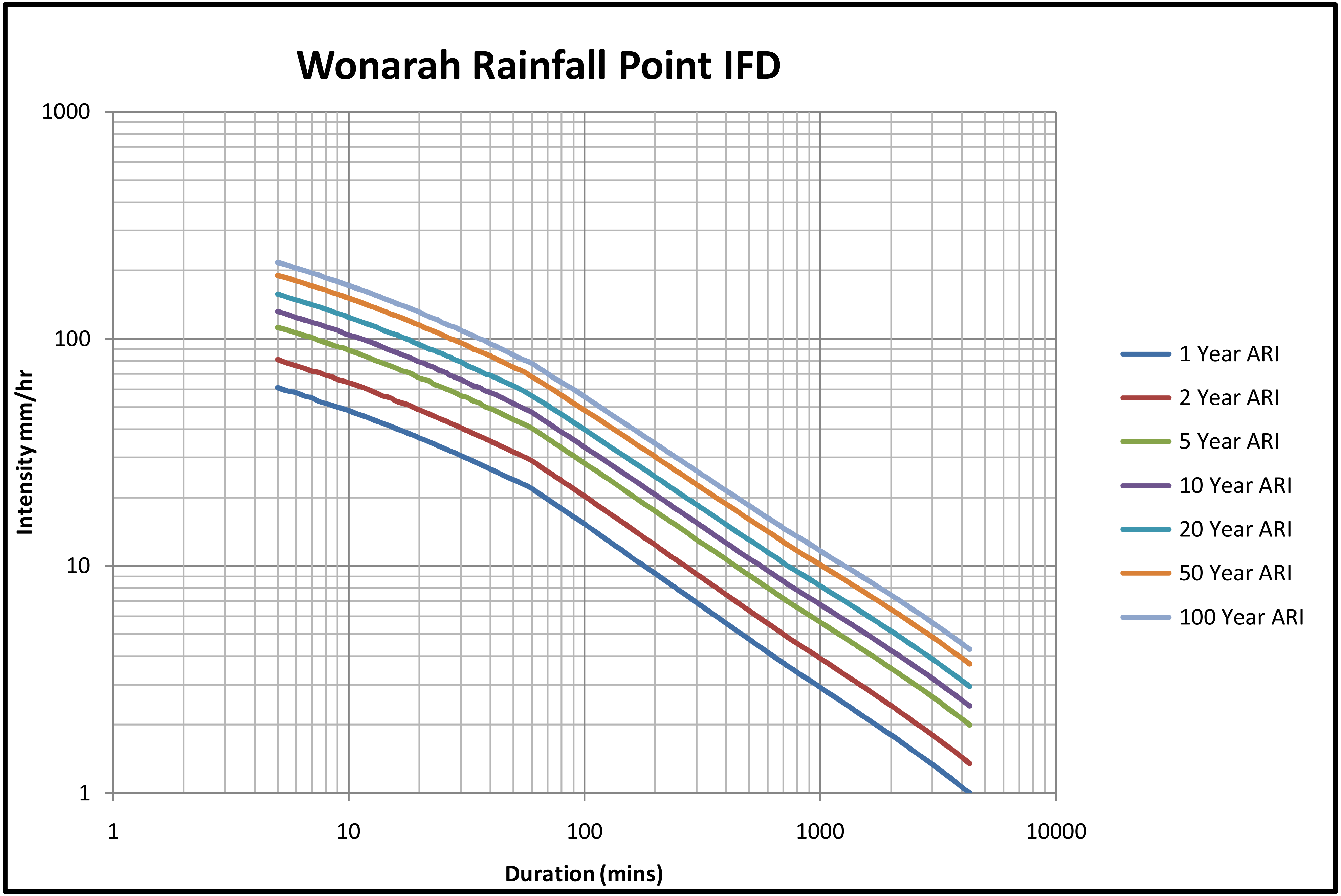
CLIENT: MINEMAKERS LIMITED		PROJECT: WONARAH PROJECT	
DRAWN: DFH	DATE: 28.04.2009	TITLE: CYCLONE SWEPT PATH ANALYSIS 0.5 DEGREE RADIUS	
CHECKED: ARL	DATE: 30.04.2009		
SCALE: 1:750,000	@ A3	PROJECT No: J090004	FIGURE No: B2

File Location : I:\CarrickConsulting\J090004_Wonarah_NT\03_ProjectData\01_Workspace

APPENDIX C

Point Intensity Frequency Duration Relationship for Wonarah

Rainfall Intensity Frequency Duration data for; Wonarah NT							
Geographic Location: , 20.04 , Deg. South, 136.45 , Deg. East							
AUSIFD, Version 2.0, 19 February,2009							
Duration	1 Year ARI	2 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
(mins)	(mm/hour)	(mm/hour)	(mm/hour)	(mm/hour)	(mm/hour)	(mm/hour)	(mm/hour)
5	61	81	112	132	157	190	217
5.5	59	78	109	128	152	185	211
6	58	76	106	124	148	180	205
6.5	56	74	103	121	144	175	200
7	55	72	101	118	141	171	195
7.5	53	71	98	116	138	167	191
8	52	69	96	113	135	164	186
8.5	51	68	94	111	132	160	182
9	50	66	92	109	129	157	179
9.5	49.2	65	91	106	127	154	175
10	48.3	64	89	104	124	151	172
11	46.6	62	86	101	120	146	166
12	45.1	60	83	98	116	141	161
13	43.7	58	80	95	113	137	156
14	42.5	56	78	92	109	133	151
15	41.3	55	76	89	106	129	147
16	40.2	53	74	87	104	126	143
17	39.2	52	72	85	101	123	140
18	38.3	51	71	83	99	120	137
19	37.5	49.6	69	81	96	117	134
20	36.6	48.5	67	79	94	115	131
21	35.9	47.5	66	78	92	112	128
22	35.2	46.6	65	76	90	110	125
23	34.5	45.7	63	75	89	108	123
24	33.8	44.8	62	73	87	106	121
25	33.2	44	61	72	86	104	118
26	32.6	43.3	60	71	84	102	116
27	32.1	42.5	59	69	83	100	114
28	31.6	41.8	58	68	81	99	113
29	31.1	41.2	57	67	80	97	111
30	30.6	40.5	56	66	79	96	109
32	29.7	39.3	55	64	76	93	106
34	28.9	38.2	53	62	74	90	103
36	28.1	37.2	52	61	72	88	100
38	27.4	36.3	50	59	70	86	98
40	26.7	35.4	49.2	58	69	84	95
45	25.2	33.4	46.5	55	65	79	90
50	24	31.8	44.1	52	62	75	85
55	22.9	30.3	42.1	49.5	59	72	81
60	21.9	29	40.3	47.4	56	68	78
75	18.7	24.8	34.6	40.7	48.5	59	67
90	16.5	21.9	30.5	36	42.9	52	60
105	14.8	19.6	27.4	32.3	38.6	47.1	54
120	13.4	17.8	25	29.5	35.2	43	49.1
135	12.3	16.4	23	27.2	32.4	39.6	45.3
150	11.4	15.2	21.3	25.2	30.2	36.9	42.2
165	10.6	14.2	19.9	23.6	28.2	34.5	39.5
180	9.99	13.3	18.7	22.2	26.6	32.5	37.2
195	9.43	12.6	17.7	21	25.1	30.8	35.2
210	8.94	11.9	16.8	19.9	23.9	29.2	33.5
225	8.5	11.3	16	19	22.7	27.9	31.9
240	8.11	10.8	15.3	18.1	21.7	26.6	30.5
270	7.44	9.93	14.1	16.7	20	24.6	28.2
300	6.89	9.2	13	15.5	18.6	22.8	26.2
360	6.04	8.07	11.5	13.6	16.4	20.1	23.1
420	5.4	7.22	10.3	12.2	14.7	18.1	20.8
480	4.9	6.56	9.35	11.1	13.4	16.5	19
540	4.5	6.02	8.61	10.3	12.4	15.2	17.5
600	4.17	5.59	7.99	9.54	11.5	14.2	16.3
660	3.89	5.22	7.47	8.92	10.8	13.3	15.3
720	3.66	4.9	7.03	8.4	10.1	12.5	14.4
840	3.29	4.42	6.35	7.59	9.17	11.3	13.1
960	3.01	4.04	5.81	6.96	8.41	10.4	12
1080	2.77	3.73	5.38	6.44	7.79	9.65	11.1
1200	2.58	3.47	5.01	6.01	7.28	9.02	10.4
1320	2.42	3.25	4.7	5.65	6.84	8.48	9.79
1440	2.27	3.06	4.43	5.33	6.46	8.01	9.25
1800	1.94	2.62	3.81	4.58	5.56	6.92	8
2160	1.71	2.3	3.35	4.04	4.91	6.12	7.08
2520	1.52	2.05	3.01	3.63	4.41	5.5	6.37
2880	1.38	1.86	2.73	3.3	4.01	5.01	5.8
3240	1.26	1.7	2.5	3.02	3.68	4.6	5.33
3600	1.16	1.57	2.3	2.79	3.4	4.25	4.94
3960	1.07	1.45	2.14	2.59	3.16	3.96	4.6
4320	1	1.35	1.99	2.42	2.95	3.7	4.3


Wonarah Rainfall Point IFD
1000
100
10
1
Intensity mm/hr
1
10
100
1000
10000
Duration (mins)
1 Year ARI
2 Year ARI
5 Year ARI
10 Year ARI
20 Year ARI
50 Year ARI
100 Year ARI

APPENDIX C HYDROGEOLOGICAL AND WATER SUPPLY INVESTIGATIONS

REPORT ON

HYDROGEOLOGICAL AND WATER SUPPLY INVESTIGATIONS

WONARAH PHOSPHATE PROJECT

Prepared for

Minemakers Australia Pty Ltd

Level 2, 34 Colin Street

WEST PERTH WA 6005

Report Distribution

No. Copies	
2	Minemakers Australia Pty Ltd (digital copies included with each report)
1	Groundwater Resource Management Pty Ltd

J080028R01 October 2009

A 23 PARRY STREET FREMANTLE WA 6160 P PO BOX 2310 KARDINYA, WA 6163 T (+61 8) 9433 2222 F (+61 8) 9433 2322 ABN 97 107 493 292

EXECUTIVE SUMMARY

Minemakers Australia Pty Ltd (Minemakers) is planning to develop the Wonarah Phosphate Project. Stage 1 involves the mining of direct ship ore (DSO) and is subject to a Bankable Feasibility Study (BFS). Groundwater issues for the BFS relate to estimation of the water demand, identification of a suitable water supply, assessment of the security of the supply and impacts from pumping, assessment of other mining activities' impacts upon the groundwater environment, characterization of the groundwater environment and groundwater quality, and development of an operating strategy.

A water balance for the Project, including supplies for construction, development and mining estimated a maximum combined demand during the initial construction phase of 15 L/s, rising to 67 L/s at the end of development. The demand during mining is predicted to be between 32 and 60 L/s.

A field programme was completed during which four production bores were installed one near Minemakers' camp, one at Arruwurra and two north of Minemakers' tenements. The results of the programme included the following:

- Minor groundwater supplies were found within Minemakers' tenements mostly in the vicinity of the Arruwurra deposit.
- Good groundwater supplies were identified north of Minemakers' tenements with maximum bore yields of about 20 L/s.
- Groundwater quality is fresh to brackish with elevated concentrations of iron and silica in the northern bores and at Arruwurra; boron was also high in the camp bore.
- Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated.

It is planned to develop an initial supply for construction and development from five modest yielding production bores within Minemakers tenements at Arruwurra. The longer term supply will then be developed off Minemakers' tenements to the north, comprising five high yielding production bores. Both short and long-term supplies will make use of the recently completed test production bores.

The combined yield from the five short-term Arruwurra production bores is estimated at about 12.5 L/s, using standard methods.

A numerical model was developed to assess the longer term yield and impacts from the production bores located off tenement. The model results indicate a combined pumping rate of up to 75 L/s can be sustained over the 10 year mine life. Impacts from long-term pumping are expected to be limited to possibly six existing third party users, located within a 10 km radius of the planned production bores. Minemakers has committed to providing an alternative water supply should unacceptable impacts occur at these locations.

A groundwater level survey carried out at the Main Zone and Arruwurra show levels mostly lie below the base of the ore. Dewatering requirements are therefore likely to be negligible, possibly limited to localized sump pumping to manage short-term seepage inflows.

A risk assessment for the Project has identified a number of groundwater related risks. However, all risks were ranked as Low, apart from the risk of groundwater supply failure and unacceptable impacts upon the environment, which were rated as Moderate. The

adequate mitigation of these risks can be achieved through effective control measures, including adequate monitoring, provision of sufficient redundancy in the groundwater supply and installation of additional suitably located bores if required.

The requirement for a suitable operating strategy has been identified which will be presented under a separate cover in a standalone document. A monitoring schedule has been provided that will form part of the strategy.

GLOSSARY OF HYDROGEOLOGICAL TERMS

Aquifer	A saturated geological unit that is permeable enough to yield economic quantities of water.
Aquitard	A geological unit that is permeable enough to transmit water but not sufficient to yield economic quantities.
Aquiclude	A geological unit that is impermeable, *i.e.* cannot transmit water.
Confined Aquifer	An aquifer bounded above and below by an aquiclude, where the water level in the aquifer extends above the aquifer top and is represented by a pressure head, *i.e.* the aquifer is completely saturated.
Leaky Aquifer or Semi-Confined Aquifer	An aquifer with upper and/or lower boundaries as an aquitard, where the water level in the aquifer extends above the aquifer top and is represented by a pressure head. Pumping from the aquifer induces leakage from the neighbouring aquitard units.
Unconfined or Watertable Aquifer	An aquifer that is bounded below by an aquiclude, but is not restricted on its upper boundary, which is represented by the water table.
Hydraulic Conductivity (K) [Permeability]	The volume of water that will flow in a unit time under a unit hydraulic gradient through a unit area. Analogous to the permeability with respect to fresh water (units commonly m/d or m/s).
Transmissivity (T)	The product of the hydraulic conductivity and the saturated aquifer thickness (units commonly m^3/d/m or m^2/d).
Specific Storage (S_s)	The volume of water released from a unit volume of aquifer under a unit decline in hydraulic head, assuming confined aquifer conditions. Water is released because of compaction of the aquifer under effective stress and expansion of the water due to decreasing pressure (units commonly m^{-1}).
Storativity (S)	The volume of water released from a unit area of aquifer, i.e the aquifer column, per unit decline in hydraulic head (dimensionless parameter).
Specific Yield (S_y)	The volume of water released from an unconfined aquifer per unit decline in the water table. The release of water is mostly from aquifer draining. Contributions from aquifer compaction are generally small. Analogous with effective porosity (dimensionless parameter).

Terms referenced from Kruseman GP and deRidder NA (1994) 2nd edition, Analysis and Evaluation of Pumping Test Data. ILRI Publication 47 The Netherlands.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Minemakers Australia Pty Ltd (Minemakers) is planning to develop the Wonarah Phosphate Project located south of the Barkly Highway, about 240 km east of Tennant Creek and 960 km southeast of Darwin in the Northern Territory (Figure 1).

The Project involves the mining of two phosphate deposits, known as Arruwurra and Main Zone. The Project has an inferred JORC compliant resource estimated at 461 Mt at 18.8% phosphate (P_2O_5) that will be developed over two discrete Stages. Stage 1 involves the mining of direct ship ore (DSO). During Stage 1 the Project will comprise a number of open pits, a treatment plant for ore crushing and screening, waste dumps, mine infrastructure and mine camp.

Stage 2 of the Project, which will comprise the mining and beneficiation of lower grade ore, is still being defined and lies outside the scope of the current studies for the Project.

Stage 1 will required a water supply for dust suppression, mining purposes and potable/domestic use. Groundwater levels in the vicinity of the two deposits generally lie below the expected base of the orebodies, therefore the requirement to manage groundwater inflows during mining is expected to be minimal.

This report presents the results of hydrogeological and water supply investigations carried out on behalf of Minemakers by Groundwater Resource Management Pty Ltd (GRM). The investigations comprised:

- The development of a site water balance to estimate the water demand for the Project during Stage 1.
- The identification and assessment of a groundwater supply to meet the anticipated water demand, both in terms of quantity and quality.
- The assessment of the likely impacts upon the groundwater environment from operation of the proposed groundwater supply, including effects upon environmentally sensitive areas and existing groundwater users.
- The assessment of impacts from other mining activities, e.g. storage of mine waste and disposal of waste water.
- The characterisation of the groundwater environment in the mining areas and in the vicinity of the proposed groundwater supply to:
    i. confirm the expected low dewatering requirements in the planned pits;
    ii. identify the main aquifers;
    iii. identify the main recharge and discharge zones.
- The assessment of groundwater quality in the mining areas and in the vicinity of the proposed groundwater supply.
- The development of a groundwater operating strategy, which:
    i. presents a schedule of production and monitoring bores, including the maximum duty rate for each production bore;

ii. identifies environmentally sensitive areas and existing third party groundwater users in the vicinity of the proposed groundwater supply;

iii. presents a suitable groundwater monitoring programme for the Project, both during mining and after closure;

iv. identifies review requirements, assessment criteria and reporting frequencies for the groundwater monitoring data.

2.0 BACKGROUND

2.1 Climate

The climate of much of the Barkly region is semi-arid, merging into an arid zone at the southern limit and into a narrow sub-humid northern strip adjoining the Gulf of Carpentaria[1]. The climate is monsoonal with well-defined wet and dry seasons, with nearly all rain falling between November and March and the greatest incidence during January and February. Light rains are sometimes received during the dry season, but the period between April and September is frequently dry.

Although tropical cyclones may bring heavy rains to the Barkly region, they are erratic in nature and occur relatively infrequently. Typically they track either from east to west or from northwest to southeast. Disturbances following the former track usually develop in the Coral Sea and enter the region after passing across the Cape York Peninsula; those following the latter track usually arise in the Arafura Sea and enter the region after crossing Arnhem Land or the Gulf of Carpentaria.

Day temperatures are high throughout the year, particularly in October, November and December prior to the onset of the wet season. With the occurrence of wetter conditions and slightly lower temperatures, humidity reaches its highest levels during January and February.

Table 1: Rainfall and Evaporation Data

Month	Mean Rainfall (mm)*	Median Rainfall (mm)*	Maximum Rainfall (mm)*	Minimum Rainfall (mm)*	Calculated Evaporation (mm)
January	85.6	61.5	273.6	5.0	313
February	82.9	65.3	270.6	0	254
March	46.1	32.5	312.0	0	258
April	13.4	0.0	156.2	0	240
May	9.5	0.0	127.8	0	206
June	9.0	0.0	102.6	0	164
July	3.9	0.0	46.5	0	180
August	2.2	0.0	83.9	0	221
September	4.2	0.0	66.9	0	276
October	14.2	8.1	101.3	0	340
November	26.7	15.7	118.0	0	324
December	61.9	39.3	430.6	0	338
Total	359.6	222.4	2090	5	3114

Note: * data for the Ranken River meteorological station

[1] Survey of the Barkly Region, Northern Territory and Queensland, 1947-48, C. S. Christian, L. C. Noakes, R. A. Perry, R. O. Slatyer, G. A. Stewart, and D. M. Traves, Land Research Series No.3. CSIRO, Melbourne 1954.

Rainfall averages, maxima and minima for the Ranken River meteorological station (Number 15026), located about 70 km to the east of the Project and considered the most representative due to its proximity and record duration (GRM 2009), are presented in Table 1. Also presented in the table are the calculated mean monthly evaporation rates based on measured values at Brunette Downs meteorological station (Number 15085) and Camooweal meteorological station (Number 37010), located about 170 km northwest and east of the Project respectively.

2.2 Mining Schedule and Project Timing

The timing for the Wonarah Project is based upon an initial production rate of 1 mtpa increasing to 3 mtpa after approximately 1 year. The schedule is summarised below.

i) Construction for 1 mtpa production rate commencing in mid July 2010 and finishing at the end of December 2010.

ii) Pre-stripping at Arruwurra commencing early August 2010 and finishing at the end of October 2010.

iii) Pre-stripping at the Main Zone commencing early August 2010 and finishing at the end of December 2011.

iv) Construction for the 3 mtpa production rate commencing in March 2011 and finishing at the end of December 2011.

2.3 Geology

2.3.1 Regional geology

The Wonarah Project is situated in the central western Georgina Basin, a large late Proterozoic to early Palaeozoic basin that extends from northwestern Queensland through much of the eastern Northern Territory.

Basement rocks in this part of the Georgina Basin comprise Mesoproterozoic sediments and volcanics overlain by the Early Cambrian Peaker Piker Volcanics. A northeast-southwest trending basement high comprising a mag-haematite rich basalt runs through the Wonarah Project area.

The overlying Middle Cambrian sediments, which contain the phosphate mineralisation, are divided into two basin-wide sequences.

- Sequence One comprises clastics, carbonates, organic shales and minor phosphorites. In the vicinity of the Project, basement highs are flanked by onlapping dolomitic rocks equivalent to the Thorntonia Limestone. An unconformity separates this unit from the overlying Sequence Two rocks with remnants of the paleo-erosion surface developing Karstic features in the carbonate sequences.

- Sequence Two is made up of shallow clastics, carbonates, grainstones, peritidal phosphorites and phosphatic limestones. At Wonarah dolostone, mudstone and phosphorite of the lower Middle Cambrian, Upper Gum Ridge Formation overlie Sequence One rocks and basement highs. This formation contains major phosphorite mineralisation and is host to the Arruwurra and Main Zone deposits. This sequence is likely to be stratigraphically equivalent to the Beetle Creek

Formation on the eastern Margin of the basin, which hosts Phosphate Hill and Lady Annie-D-Tree phosphate deposits. The overlying Wonarah Beds comprise Middle Cambrian mudstone, siltstone and dolostones.

Silcrete, ferricrete and calcrete regolith are extensively developed at the Project and large areas are covered by aeolian sand.

2.3.2 Main Zone Geology

The basement lithology in the Main Zone area is dominantly basalt of the Peaker Piker Volcanics. The top of the basalt is extremely weathered; and a ferruginous and manganiferous duricrust is developed locally. Some dolomitic rocks of the Thorntonia Limestone equivalent are present above the basalt at the southeastern extremity of the Main Zone. Further to the east and the south the carbonate rocks are extensively exposed.

The overlying phosphate-bearing Upper Gum Ridge Formation is divided into four main units: basal undifferentiated transitional sediments, chert breccia phosphorite, mudstone phosphorite and convolute mudstone.

The Transition Unit is laterally continuous, 4 to 8 m thick and comprises clay-rich mudstone and siltstone with minor phosphorite, dolomite, sandstone and basal epiclastics. The basal Transitional Phosphorite is a laterally discontinuous high grade porcellinous phosphorite up to 3 m thick developed throughout the eastern and southern part of the Main Zone.

The Chert Breccia Phosphorite forms a distinctive, laterally continuous horizon, 1 to 10 m thick, and comprises yellow, grey or pink friable to indurated low to high grade phosphorite with abundant dark grey chert. The chert content of the horizon averages 50% to 60%.

The Mudstone Phosphorite is the main phosphate-bearing unit at the Project and is comprised of 1 to 10 m of yellow and pink mudstone phosphorite with trace to minor dark grey chert. The mineralogy is dominated by (carbonate) fluorapatite.

The Convolute Mudstone is a 1 to 10 m thick unit of white, light grey and yellow clay rich variably convolute mudstone with minor siltstone and fine sandstone interbeds. It generally contains minor phosphate.

The Wonarah Beds form the hanging wall to the deposit, overlying the Convolute Mudstone, and comprise mudstone and siltstone with minor chert. The Wonarah Beds thicken towards the east and south away from the basement high that defines the western fringe of the Main Zone. East and south of the Main Zone the hanging wall comprises dolomite and dolostone.

The regolith is extensively developed throughout the Main Zone with silcrete and ferricrete present in most drill-holes. Low silcrete ridges are prominent features. Colluvial and alluvial deposits are common with extensive aeolian sands covering much of the regolith.

The phosphatic units thin and peter out towards the basement high which trends in a northeast-southwest direction towards Arruwurra.

2.3.3 Arruwurra Geology

At Arruwurra the phosphate mineralisation occupies a broad northeast-southwest trending shelf sloping gently to the southwest. The shelf drops away sharply at the western end and along the southeastern edge. Mineralisation outcrops in the northeast before petering out against the basement high to the north.

The basement at Arruwurra comprises basalt of the Peaker Piker Volcanics. Thorntonia Limestone equivalent dolomites and dolostones overlay the basalt along the southeastern and southern margin of the deposit. An abrupt change in lithology and depth to basalt basement indicates a probable fault which has thrown the deposit side upwards. A karst surface is present on the dolomite.

The Upper Gum Ridge Formation at Arruwurra is different to the Main Zone. The Transition Unit is thinner and less well developed. Generally the unit comprises 1 to 5 m of mudstone, siltstone and phosphorite.

The laterally continuous chert breccia horizon is absent at Arruwurra. There appears to be some chert-rich domains within the deposit, but chert is generally sparsely and patchily distributed through the Arruwurra Phosphorite. The Phosphorite is white to yellow-brown in colour and ranges from friable to indurated or porcellinous. Chert averages 10% to15% of the Phosphorite unit.

The Arruwurra Phosphorite is overlain by and, near surface, interdigitates with a limestone carbonate unit in the northeastern part of the deposit. Outcropping high grade phosphorites occur in this area. To the southwest the Aruwurra Phosphorite is overlain by the Hangingwall Mudstone unit of the Wonarah Beds, which comprise siltstones and mudstones with variable but minor chert. Towards the southwest this unit thickens and becomes patchy but increasingly ferruginous.

Aeolian sand covers much of the area and is underlain by ferricrete, silcrete, and, above the carbonate unit in the northeast, calcrete and black soil.

2.4 Hydrogeology

The main aquifers on the Barkly tableland comprise cavernous zones that are commonly weathered and fractured, within calcareous units of the Wonarah Formation and Camooweal Dolomite. These aquifers have been used to provide domestic and stock water across the tableland for nearly a century. The majority of the existing bores have not been test pumped preventing reliable estimates of aquifer yields. However, airlift rates of over 5 L/s are common and sometimes over 100 L/s (Read RE, 2007) have been reported.

The volcanic rocks, which form the basement at the Project, have generally low permeability. Groundwater occurrence within the basement rocks is restricted to discrete fractures and zones of higher weathering. Maximum flow rates from the fractures is likely to be less than 5 L/s.

Groundwater recharge is predominantly from rainfall infiltration. Recharge from surface water will occur locally in the vicinity of the major rivers and, after rainfall events, from minor water courses and marshy areas. Rainfall recharge rates have been estimated from water balance calculations at 4 mm/year and from chloride balance methods of between 1.5 and 5 mm/year.

Groundwater levels within Minemakers' tenements are extremely variable, ranging from about 25 to over 100 m bgl. The regional groundwater flow regime is poorly understood. Estimates by NRETAS (Tickel, 2003) suggest there may be a north south groundwater divide along latitude 20S, with groundwater south of this parallel flowing to the southeast and from the northern catchment to the north east towards and discharging to the Gregory River.

Groundwater quality over the tableland is generally fresh to brackish, ranging from 500 to 4,000 mg/L Total Dissolved Solids (TDS).

2.5 Other Groundwater Users and Groundwater Sensitive Areas

The locations of other groundwater users within and north of Minemakers' tenements were sourced from the NRDB1 database managed by NRETAS. The locations of the third party bores are shown on Figure 2, along with the four production bores completed for Minemakers as part of this investigation (Section 3.1.2).

Figure 2 shows the following:

- Ten pre-existing bores lie within the tenement areas, all located either along or north of the Barkly Highway. All seven bores were installed by the Northern Territory Government for construction and/or maintenance of the highway.

- Six pre-existing holes lie within a 10 km radius of the two Minemakers' northern production bores (WNWB003 and 004). All the bores were installed by Dalmore Downs Station for stock watering purposes.

Details of the 16 third party bores located within Minemakers' tenements and within 10 km of the two northern Project production bores are presented in Table 2.

Two environmentally sensitive areas that could be affected by groundwater extraction were identified by Coffey Environmental, sourced from Geoscience Australia. The sensitive areas comprise two marshes, Kerringnew Swamp located about 10 km north east of WNWB003 and Oolgoolgam Swamp located about 37 km east of bores WNWB003 and 004.

Kerringnew Swamp was visited and an environment monitoring bore (WNEM001) installed during the field programme (Section 3.1.2). At the time of the site visit there was no evidence of surface water, although the vegetation suggested inundation may occur after rainfall events. The monitoring bore (completed to 18 m depth) was dry during subsequent visits. These conditions suggest the marsh is an ephemeral surface water feature and not related to groundwater. It would therefore not be expected to be influenced by changes in the underlying groundwater level.

Oolgoolgam Swamp was not visited because of it's distance from the northern bores.

Table 2: Third Party Bores

RN Number	Bore Name	Depth (m)	Compl. Date	Depth (m)	Location MGA Zn 53		Status	Use	SWL (mbgl)	Yield (L/s)
					(mE)	(mN)				
RN000031	4A-132 Barkly Hwy	92.9	ND	92.9	636,226	7,801,919	ND	Not Known	69.1	0.39
RN000301	3A-128 Mile Barkly Hwy	60.9	ND	60.9	641,726	7,798,919	Not in use	None	ND	ND
RN000302	2A-128 Mile Barkly Hwy	ND0	ND	ND	641,726	7,798,919	Not in use	None	ND	ND
RN000370	1A-124 Mile Barkly Hwy	0ND	ND	ND	646,126	7,794,869	Not in use	Not Known	ND	ND
RN001237	No 2 Eagles Nest, Dalmore Downs Stn	81.7	1950	81.7	643,850	7,818,572	ND	Production	51.5	2.6
RN001238	No 3 Blue Bush, Dalmore Downs Stn	88	1951	88	634,207	7,815,614	ND	Production	46.3	2.6
RN001778	Wonarah repeater station, Barkly Hwy	111.5	1958	111.5	640,212	7,799,448	ND	Production	53.9	0.68
RN004087	No 11 Alroy Downs	71	1963	71	634,526	7,825,369	ND	Production	56	2.86
RN006751	No 11 Dalmore Downs Stn	94.5	1970	94.5	634,571	7,825,132	ND	Production	52	3
RN020997	81/1 Barry Caves West, Dalmore Downs Stn	ND	1981	200	648,937	7,792,271	ND	Not Known	ND	0.4
RN020998	81/2 Barry Caves West, Dalmore Downs Stn	125	1981	125	646,026	7,794,669	ND	Not Known	ND	0.25
RN021238	81/3 Barkly Hwy Barry Caves West	145	1981	145	653,526	7,792,769	ND	Not Known	63	0.38
RN021239	81/4 Barkly Hwy Barry Caves West	76	1981	76	652,227	7,795,886	Not in use	Not Known	ND	ND
RN021245	81/5 Barkly Hwy Barry Caves West	134	1981	134	640,230	7,799,600	ND	Not Known	109.8	1.9
RN025678	No 10A 88/37 Dalmore	140	1988	140	645,306	7,825,367	ND	Production	100	5
RN025874	No 10 Dalmore Downs Stn	135.6	1971	135.6	645,320	7,825,391	ND	Production	68.6	1.4

Note: RN number relates to the identifier used in the NRDB1 database, SWL = static water level, mbgl = metres below ground level, ND = no data available.

2.6 Previous Investigations

Previous groundwater investigations carried out in the vicinity of the Wonarah Project were conducted by the Northern Territory Government and Coffey Mining Pty Ltd and included:

- early field investigations carried out by Randall in 1967;
- a regional field programme carried out north and east of the Project for the Department of Lands, Planning and Environment (Territory Groundwater Services, 1998), which comprised the drilling and geophysical logging of 13 bores and the test pumping of nine pre-existing stock and domestic bores;
- a desktop study into the hydrogeology of the Avon Downs and Ranken 1:250,000 Geological Sheets carried out by the Department of Infrastructure, Planning and Environment (2003);
- an assessment of the water resources of the Arruwurru, Wakaya and Warramunga aboriginal land trusts carried out by the Department of Natural Resources, Environment and the Arts (2007), which included the drilling of five holes near the eastern boundary of Minemakers' tenements;
- a desktop investigation carried out by Coffey Mining for Minemakers.

The desktop study carried out by Coffey Mining identified eight Groundwater Exploration Areas (GEAs), comprising GEA1 to GEA7 and Arruwurra, based on historic drilling results, geological interpretation, inferred recharge areas and proximity to the mining area and Barkly Highway. Recommendations from the study included the air-flown geophysical survey of the eight GEAs. The survey was subsequently carried out by Fugro Airborne Surveys and comprised magnetic and electromagnetic surveys. The datasets were processed to provide the following results: total magnetic field, calculated magnetic gradient and apparent conductivity at five frequencies (400, 1800, 8200, 40,000 and 140,000 Hz).

2.7 Regulatory Issues

Groundwater exploration drilling within tenements held by Minemakers is permitted under a Memorandum of Understanding between the Water and Mining Acts. The memorandum states that a mining company is free to drill for groundwater within their mining tenements where the water is to be used for mining related purposes, e.g. dust suppression, processing and dewatering. However, the construction of a production bore for supply of water to mine personnel must still be undertaken by a water bore driller holding a Northern Territory water bore drillers licence.

The water exploration drilling and bore construction carried out north of Minemakers' tenements was carried out under Ministerial Approval provided under Section 182(2) of the Mining Act. A copy of the approval letter is presented in Appendix A.

The drilling of the four Minemakers' production bores completed as part of these investigations (Section 3.1.2) was supervised by suitably licensed water bore drillers. Details of the drilling supervisors are summarised below.

- Production bores WNWB001 and 002 were supervised by Mr Gregory Scott, licence number 23.

- Production bores WNWB003 and 004 were supervised by Mr Dean Johnston, licence number 80.

3.0 FIELD INVESTIGATIONS

Field investigations overseen by GRM at the Project comprised three phases of drilling and a programme of test pumping. The first two drilling phases were restricted to tenements held by Minemakers. The third programme targeted an area north of Minemakers' tenements, which had been identified from the historical drilling record as being prospective in terms of groundwater supply.

The first two drilling phases were carried out by Tom Browne Drilling Services using various reverse circulation drilling rigs. The last phase was completed by Gorey and Cole and direct circulation air-hammer methods. All drilling was overseen by a GRM hydrogeologist, who was responsible for site selection, arranging access and recording of drilling, geological and hydrogeological data. During the programme care was taken to note air-loss to the formation, especially when associated with intersection of cavities.

3.1 Drilling and Bore Construction

Information on the three drilling phases is summarised below.

- Drilling Phase 1 was undertaken between 23 February and 12 April 2009 and comprised the drilling of 28 exploration holes.

- Drilling Phase 2 was undertaken between 19 April and 7 June 2009 and comprised the drilling of 40 exploration holes and the reaming and construction of two production bores.

- Drilling Phase 3 was undertaken between 20 August and 2 September 2009 and comprised the drilling of eight exploration holes, two of which were reamed and constructed as production bores and the remaining six constructed as monitoring/observation bores.

During the drilling programme 76 exploration holes were drilled. Four of the exploration holes were reamed out and completed as production bores and six completed as monitoring/ observation bores.

The first two phases of drilling, confined to tenements held by Minemakers, targeted lineaments identified from the air-flown magnetic survey data and, to a lesser extent, the air-flown EM survey data. Lineaments identified from the air-flown magnetic data relate to magnetic contrasts in the basement rocks, commonly geological structures and lithological contacts, while lineaments interpreted from the EM data reflect changes in the subsurface electrical properties.

As a general rule the air-flown magnetic survey data provided a greater contrast in ground properties, enabling better interpretation of lineaments in the eight surveyed areas. The EM survey data was used to identify a lineament in GEA5, but in the remaining survey areas the air-flown magnetic data was considered more appropriate.

Regional air-flown magnetic survey data was also sourced from the Geoscience Australia online database. However the low resolution of the survey limited the use of the data during the groundwater search, although a reasonable correlation was noted between the high resolution Fugro and the low resolution regional surveys.

3.1.1 Exploration drilling results

Of the 76 holes 68 were drilled on tenements held by Minemakers, 39 at Arruwurra, three in GEA2, eight in GEA3, four in both GEA4 and GEA5, five in GEA6 and five in the camp area. The remaining eight holes were drilled north of Minemakers' tenements.

A summary of the exploration drilling results is presented in Table 3 and the hole locations shown in Figure 3. Graphical bore logs presenting the geological, hydrogeological and bore construction data are presented in Appendix B.

Tenement area drilling results

The results from the holes drilled on tenements held by Minemakers showed that the basin sediments are generally limited in thickness in the Project area, with most completed drill-holes penetrating through to the underlying basaltic basement. A maximum basement depth of 164 m was recorded, although the majority of drill-holes intersected basalt well above 150 m.

Within the tenements groundwater was generally intersected in fractured basement rocks, with only low airlift yields. Cavities within dolomite were identified in about 20 drill-holes, but these were commonly dry or had minimal inflow rates. The poor results were due to the location of the cavities near surface (i.e. above or near the water table) and/or because of infilling with regolith (clay and silt etc).

The most promising results within the tenements were identified at Arruwurra, which comprised the following intersects:

- Drill-holes WNWE005, 012, 018, 019, 052 (converted to production bore WNWB002) and 061; which targeted a major air-magnetic lineament trending approximately north-south (Figure 4). Airlift rates associated with this lineament were generally around 1 to 2 L/s, with a peak flow of 4.5 L/s at hole WNWE005.

- Drill-hole WNWE057 which airlifted 1.5 L/s from fractured basement.

- Drill-hole WE061 and 062 which airlifted around 1.5 L/s from cavities in weathered dolomite.

Significant airlift rates (greater than 1 L/s) were also observed in GEA2 at drill-holes WNWE013 and 015, located near the southern boundary of Minemakers' tenements, and adjacent to the Minemakers' camp (WNWE001 and WNWE051). Groundwater at GEA2 was intersected in fractured quartz and chert at depth, which is consistent with the deepening of the Georgina Basin to the south of the Project area. Although the airlift rates from holes in GEA2 were promising it was noted that the water was highly turbid and construction of a usable production bore at the tested locations would be problematic.

The groundwater intersects near the camp were related to discrete fractures in the basalt basement rocks. Exploration hole WNWE051 was subsequently converted into a production bore (WNWB001) and used to supply water to Minemakers' camp.

A potential groundwater source was also identified in GEA5 where cavities were intersected at depth in drill-holes WNWE049 and 050. Although airlift yields were low, the loss of circulation indicates higher permeabilities at these locations.

The locations of the 68 holes drilled on Minemakers' tenements are presented in Figure 4 (Arruwurra, GEA2 and GEA5) and Figure 5 (GEA3, GEA4, GEA6 and the camp area).

Table 3: Summary of Exploration Drilling Results

Hole ID	Collar Location MGA Zn 53 (mE)	(mN)	Dip	Azimuth	Depth (m)	Max Yield (L/s)	Final EC (mS/cm)	Inflow Depths (m)	Inflow Feature	Date Completed	GEA
WNWE001	652,971	7,789,602	60	90	162	1.2	1.3	78-96, 132-138	Fractured basalt	28/02/09	Camp Area
WNWE002	653,043	7,789,596	60	90	150	Trace	1.3	90-102	Fractured basalt	27/02/09	Camp Area
WNWE003	652,893	7,789,600	60	90	150	Trace	1.3	96-102	Fractured basalt	1/03/09	Camp Area
WNWE004	653,114	7,789,600	60	270	132	1	1.1	84-90, 96-102, 108-114, 129-132	Fractured basalt	4/03/09	Camp Area
WNWE005	642,549	7,777,102	60	313	132	4.5	2	108-114	Fractured basalt	6/03/09	Arruwurra
WNWE006	639,122	7,773,122	60	316	156	Trace	NA	NA	NA	7/03/09	Arruwurra
WNWE007	639,170	7,773,071	60	316	150	Trace	NA	NA	NA	8/03/09	Arruwurra
WNWE008	639,068	7,773,176	60	316	150	0.2	1.2	108, 126-132, 138-144	Fractured basalt	10/03/09	Arruwurra
WNWE009	639,015	7,773,230	60	316	144	Trace	NA	NA	NA	10/03/09	Arruwurra
WNWE010	642,605	7,777,048	60	313	156	Trace	NA	NA	NA	12/03/09	Arruwurra
WNWE011	642,440	7,777,200	60	313	144	2	2	129-130, 135-141	Fractured basalt	13/03/09	Arruwurra
WNWE012	642,495	7,777,149	60	313	120	1.3	1.9	91-96	Fractured basalt	14/03/09	Arruwurra
WNWE013	636,070	7,767,130	60	305	150	2	1.4	90-96, 108-114	Fractured quartzite & chert	16/03/09	GEA2
WNWE014	636,133	7,767,089	60	305	150	1	1.4	96-108	Fractured quartzite & chert	17/03/09	GEA2
WNWE015	636,196	7,767,048	60	305	156	2	1.4	84-102	Fractured siltstone, quartzite & chert	20/03/09	GEA2
WNWE016	641,250	7,775,183	60	270	150	0.5	4.1	100-102, 111	Fractured basalt	23/03/09	Arruwurra
WNWE017	641,335	7,775,188	60	270	156	Trace	4.3	NA	NA	24/03/09	Arruwurra
WNWE018	641,175	7,775,189	60	270	150	1.8	3	94-108, 120-126	Fractured basalt	25/03/09	Arruwurra

Hole ID	Collar Location MGA Zn 53		Dip	Azimuth	Depth (m)	Max Yield (L/s)	Final EC (mS/cm)	Inflow Depths (m)	Inflow Feature	Date Completed	GEA
	(mE)	(mN)									
WNWE019	641,095	7,775,171	60	270	156	1.9	3	96-114, 120-126, 132-138, 144-150	Fractured and weathered basalt	27/03/09	Arruwurra
WNWE020	660,111	7,788,268	60	216	150	Trace	NA	NA	NA	30/03/09	GEA4
WNWE021	660,151	7,788,322	60	216	150	Dry	NA	NA	NA	31/03/09	GEA4
WNWE022	660,196	7,788,379	60	216	156	Trace	NA	NA	NA	1/04/09	GEA4
WNWE023	660,237	7,788,444	60	216	144	Trace	NA	NA	NA	2/04/09	GEA4
WNWE024	664,344	7,779,305	60	329	174	Trace	NA	NA	NA	4/04/09	GEA6
WNWE025	664,371	7,779,250	90	NA	157	Trace	NA	NA	NA	8/04/09	GEA6
WNWE026	664,264	7,779,421	90	NA	151	Trace	NA	NA	NA	9/04/09	GEA6
WNWE027	664,431	7,779,154	90	NA	175	Trace	NA	NA	NA	10/04/09	GEA6
WNWE028	664,482	7,779,072	90	NA	104	Dry	NA	NA	NA	10/04/09	GEA6
WNWE029	641,396	7,773,090	60	300	156	1	3.4	117, 132-138	Fractured basalt	20/04/09	Arruwurra
WNWE030	641,335	7,773,132	60	300	156	1	3.2	138-156	Fractured basalt	21/04/09	Arruwurra
WNWE031	641,463	7,773,057	60	300	150	0.6	2	102-108, 114-120	Fractured basalt	22/04/09	Arruwurra
WNWE032	641,269	7,773,169	60	300	150	0.2	NA	114	Fractured basalt	23/04/09	Arruwurra
WNWE033	641,407	7,773,784	60	270	150	0.2	NA	132	Fractured basalt	24/04/09	Arruwurra
WNWE034	641,264	7,773,786	60	270	150	1.5	3.3	102-108	Fractured basalt	24/04/09	Arruwurra
WNWE035	641,190	7,773,786	60	270	150	0.2	3.2	108	Fractured basalt	25/04/09	Arruwurra
WNWE036	641,333	7,773,783	60	270	150	0.3	3.2	120	Fractured basalt	26/04/09	Arruwurra
WNWE037	641,111	7,773,784	60	270	150	Trace	NA	NA	NA	27/04/09	Arruwurra
WNWE038	641,486	7,773,788	60	270	150	1	1.6	126-132	Fractured basalt	28/04/09	Arruwurra
WNWE039	649,800	7,794,500	60	270	150	Dry	NA	NA	NA	1/05/09	GEA3
WNWE040	649,875	7,794,500	60	270	150	Dry	NA	NA	NA	2/05/09	GEA3
WNWE041	649,725	7,794,500	60	270	150	Trace	NA	NA	NA	2/05/09	GEA3

Hole ID	Collar Location MGA Zn 53		Dip	Azimuth	Depth (m)	Max Yield (L/s)	Final EC (mS/cm)	Inflow Depths (m)	Inflow Feature	Date Completed	GEA
	(mE)	(mN)									
WNWE042	649,588	7,793,757	60	315	150	Dry	NA	NA	NA	3/05/09	GEA3
WNWE043	649,642	7,793,705	60	315	156	1.3	2.4	137, 138-144	Fractured and weathered basalt	3/05/09	GEA3
WNWE044	649,695	7,793,652	60	315	150	Trace	NA	NA	NA	4/05/09	GEA3
WNWE045	649,802	7,793,547	60	315	150	0.3	1.8	130-132	Fractured basalt	5/05/09	GEA3
WNWE046	649,855	7,793,494	60	315	150	Trace	NA	NA	NA	5/05/09	GEA3
WNWE047	647,285	7,771,890	90	0	133	Trace	1.9	NA	NA	7/05/09	GEA5
WNWE048	647,327	7,771,952	90	0	139	Trace	NA	NA	NA	8/05/09	GEA5
WNWE049	647,368	7,772,015	90	0	151	1	1.5	75-82, 87-89, 129	Cavity in dolomite and fractured siltstone & basalt	9/05/09	GEA5
WNWE050	647,410	7,772,077	90	0	133	Trace	1.5	77-79	Cavity in dolomite	9/05/09	GEA5
WNWB001 (WNWE051)	653,043	7,789,600	90	0	150	1		92-93	Fractured basalt	9/05/09	Camp Area
WNWB002 (WNWE052)	642,520	7,777,128	90	0	150	2.5	2.1	109.5-110, 111, 125	Fractured basalt	9/05/09	Arruwurra
WNWE053	642,188	7,775,163	90	0	133	Trace	1.8	NA	NA	25/05/09	Arruwurra
WNWE054	642,257	7,775,171	90	0	150	Trace	NA	NA	NA	26/05/09	Arruwurra
WNWE055	642,340	7,775,165	90	0	150	Trace	NA	NA	NA	27/05/09	Arruwurra
WNWE056	642,407	7,775,161	90	0	150	0.2	2	77	Cavity in dolomite	28/05/09	Arruwurra
WNWE057	642,094	7,775,159	90	0	150	1.5	1.7	117, 132-138, 144-150	Fractured granodiorite	29/05/09	Arruwurra
WNWE058	643,389	7,775,162	90	0	60	Dry	NA	NA	NA	30/05/09	Arruwurra
WNWE059	643,393	7,775,165	90	0	150	0.2	2.1	84-90	Weathered dolomite	31/05/09	Arruwurra

Hole ID	Collar Location MGA Zn 53		Dip	Azimuth	Depth (m)	Max Yield (L/s)	Final EC (mS/cm)	Inflow Depths (m)	Inflow Feature	Date Completed	GEA
	(mE)	(mN)									
WNWE060	643,506	7,775,154	90	0	150	1.3	1.8	60-75	Cavity & weathered dolomite	1/06/09	Arruwurra
WNWE061	643,579	7,775,151	90	0	150	1.4	1.8	69-74	Cavity & weathered dolomite	2/06/09	Arruwurra
WNWE062	643,661	7,775,158	90	0	120	Trace	NA	NA	NA	3/06/09	Arruwurra
WNWE063	643,661	7,775,156	90	0	150	Trace	NA	NA	NA	4/06/09	Arruwurra
WNWE064	643,868	7,775,152	90	0	150	Trace	1.7	NA	NA	4/06/09	Arruwurra
WNWE065	643,959	7,775,156	90	0	150	Trace	1.7	NA	NA	5/05/09	Arruwurra
WNWE066	644,056	7,775,158	90	0	150	Trace	1.7	NA	NA	6/05/09	Arruwurra
WNWE067	641,404	7,775,194	60	270	150	Trace	NA	NA	NA	6/06/09	Arruwurra
WNWE068	641,473	7,775,198	60	270	150	2	4.5	126-144	Fractured quartz porphyry	7/06/09	Arruwurra
WNMB001 (WNWE069)	643,262	7,822,237	90	0	126	>6	2.9	62, 114-126	Fractured/ weathered dolomite	22/08/09	Northern off tenement area
WNWB003 (WNWE070)	643,257	7,822,227	90	0	126	>8	2.5	78, 106-126	Cavity & fractured/ weathered dolomite	24/08/09	Northern off tenement area
WNMB002 (WNWE071)	643,269	7,822,277	90	0	120	6	2.6	60, 108-120	Fractured/ weathered dolomite	26/08/09	Northern off tenement area
WNMB003 (WNWE072)	640,896	7,817,696	90	0	126	5	2.5	90, 108-120	Cavity & fractured/ weathered dolomite	27/08/09	Northern off tenement area
WNWB004 (WNWE073)	640,889	7,817,697	90	0	126	>10	2.2	80, 96-126	Cavity & fractured/ weathered dolomite	28/08/09	Northern off tenement area

Hole ID	Collar Location MGA Zn 53		Dip	Azimuth	Depth (m)	Max Yield (L/s)	Final EC (mS/cm)	Inflow Depths (m)	Inflow Feature	Date Completed	GEA
	(mE)	(mN)									
WNMB004 (WNWE074)	640,937	7,817,691	90	0	126	6	2.2	90-96, 108-126	Fractured/ weathered dolomite	30/08/09	Northern off tenement area
WNMB005 (WNWE075)	651,036	7,824,275	90	0	150	5	2.7	137-150	Fractured/ weathered dolomite	31/08/09	Northern off tenement area
WNEM001 (WNWE076)	651,088	7,826,194	90	0	18	Dry	NA	NA	NA	31/08/09	Northern off tenement area

Note: the maximum airlift yield relates to rates measured during drilling, NA = not applicable.

Northern off-tenement drilling results

Eight holes were drilled north of Minemakers' tenements permitted under Ministerial Approval (Section 2.6). The drill-hole sites were selected in an area known to be prospective in terms of groundwater supply, based upon drilling records held by the Northern Territory Government and available from the online NRETAS database. The historical record shows groundwater is commonly intersected at depths greater than 100 m in weathered and cavernous dolomite. In selecting the sites care was taken to avoid environmentally sensitive areas and, so far as practicable, other groundwater users (Section 2.5).

Initially five possible bore sites were selected with the aim of installing two production bores that could be used to assess aquifer parameters and for subsequent groundwater flow modelling. However high airlift yields were intersected at the first two sites and it was decided to install the two production bores at these locations. Two monitoring/observation bores were also installed at each site, located at radial distances of approximately 10 and 50 m from the production bore.

Drilling at the two production bore sites identified an aquifer within cavernous, fractured and weathered dolomite. The top of the aquifer was intersected at about 100 m depth at both locations. All the drill-holes were terminated early without fully penetrating the aquifer, because of poor ground conditions and loss of circulation. It is therefore likely the aquifer extends beyond the 25 to 30 m intersected during drilling.

A third site (WNWE075, completed as monitoring bore WNMB005) was also drilled to confirm the lateral extent of the dolomite aquifer. Similar groundwater conditions were observed during drilling, although the top of the aquifer was intersected at 137 m depth.

Airlift rates varied from about 5 to greater than 10 L/s. Loss of circulation was generally observed in the lowest yielding holes and it is likely the recorded airlift rates underestimated the maximum potential groundwater supply.

An environmental monitoring bore (WNWE076), completed as monitoring bore WNEM001, was drilled at the Kerringnew Swamp about 9 km east north-east of production bore WNWB003, to investigate groundwater level depths. The bore was drilled dry to 18 m depth. Later attempts to measure groundwater levels in the bore show the bore to be dry.

The locations of the holes drilled north of Minemakers' tenements are shown in Figure 6.

3.1.2 Production and monitoring bore construction

Schedules for the four production bores and six monitoring bores are presented in Tables 4 and 5 respectively.

Table 4: Production Bore Schedule

Bore ID	Collar Location MGA Zn 53		Depth Drilled (m)	Cased Depth (m)	Casing Type	Slotted Interval (mbgl)	Stick-up (magl)	SWL (mbtc)	SWL Date	Max Yield (L/s)	Final EC (mS/cm)
	(mE)	(mN)									
WNWB001	653,043	7,789,600	150	124.7	155mm ND uPVC Class 9	64.7-124.7	0.1	55.62	23/05/2009	1.5	1.6
WNWB002	642,520	7,777,128	150	125.4	155mm ND uPVC Class 9	65.4-125.4	0.1	24.58	19/05/2009	3	2.1
WNWB003	643,257	7,822,227	126	122	155.6mm ID/168.3mm OD Steel	98-122	0.4	50.86	24/08/2009	>8	2.5
WNWB004	640,889	7,817,697	126	102	155.6mm ID/168.3mm OD Steel	102-126	0.5	48.64	28/08/2009	5	2.2

Note: the maximum airlift yield relates to rates measured during development, mbgl= metres below ground level, magl = metres above ground level, SWL = static water level, mbtc = metres below top of casing.

Table 5: Monitoring Bore Schedule

Bore ID	Collar Location MGA Zn 53		Depth Drilled (m)	Cased Depth (m)	Casing Type	Slotted Interval (mbgl)	Stick-up (magl)	SWL (mbtc)	SWL Date	Max Yield (L/s)	Final EC (mS/cm)
	(mE)	(mN)									
WNMB001	643,262	7,822,237	126	118	50mm ND uPVC Class 9	64-118	0.6	50.85	23/08/2009	>6	2.9
WNMB002	643,269	7,822,277	120	101	50mm ND uPVC Class 9	47-101	0.6	50.91	28/08/2009	6	2.6
WNMB003	640,896	7,817,696	126	101	50mm ND uPVC Class 9	47-101	0.6	48.73	29/08/2009	5	2.5
WNMB004	640,937	7,817,691	126	126	50mm ND uPVC Class 9	66-126	0.8	48.7	30/08/2009	6	2.2
WNMB005	651,036	7,824,275	150	150	50mm ND uPVC Class 9	108-150	0.5	64.55	31/08/2009	5	2.7
WNEM001	651,088	7,826,194	18	18	50mm ND uPVC Class 9	2-18	0.5	Dry	31/08/2009	Dry	NA

Note: the maximum airlift yield relates to rates measured during development, mbgl= metres below ground level, magl = metres above ground level, SWL = static water level, mbtc = metres below top of casing.

The two production bores completed by Tom Browne Drilling Services within Minemakers' tenements (WNWB001 and 002) were constructed using 155 mm nominal diameter (ND) uPVC casing with an annular formation stabiliser.

The two production bores constructed by Gorey and Cole north of Minemakers tenements (WNWB003 and 004) were completed using schedule 20, 150 mm steel casing. Formation stabiliser was not used to construct the two northern bores, which reduced reaming diameters from 250 mm to 200 mm and also reduced well loss during pumping.

All monitoring bores were constructed using 50 mm ND uPVC casing. Bore locations are shown on Figure 4 (Arruwurra, GEA2 and GEA5), Figure 5 (GEA3, GEA4, GEA6 and the camp area) and Figure 6 (northern off tenement area).

3.2 Test Pumping

Test pumping was carried out on three of the four production bores by McMinns Bore Services between 3 and 13 September 2009. The two higher yielding bores (WNWB003 and 004) were tested using a Southern Cross SC50-10 15kW 6 inch electrical submersible pump with a capacity of about 13 L/s at 80 m head. The lower flow bore (WNWB002) was tested using a Southern Cross SC8-15 2.2kW 4 inch submersible pump with a capacity of about 2.2 L/s at 60 m head.

Bore WNWB001 was not tested, because of its low yield and current use as the water supply bore for the Minemakers' camp. It should be noted that the bore has been operated continuously since May 2009.

Testing comprised both step and 48-hour constant rate tests. The step test was used to identify a suitable rate for the constant rate test and is not reported here. The pumping and drawdown data for the constant rate test were used to estimate aquifer properties of storativity and transmissivity, using standard analytical methods. The drawdown curves were also assessed to identify aquifer boundary conditions and aquifer type (unconfined, confined and leaky).

The results of the constant rate test are presented in Table 6 and the analysis shown in Appendix C. The results show the following:

- A modest aquifer transmissivity at WNWB002 of about 15 m^2/d, with an unconfined response. The results are consistent with a moderately low yielding production bore.

- Very high transmissivities at WNWB003 during early time, but an increase in the drawdown rate after about 2,000 minutes (1.4 days) indicating a lower transmissivity boundary condition. Late time data still indicate good transmissivities in the order of 350 to 500 m^2/d consistent with a short-term duty rate of between 15 and 20 L/s.

- High transmissivities at WNWB004 of between 700 and 900 m^2/d consistent with a short-term duty rate of between 15 and 20 L/s.

Table 6: Summary of Test Pumping Results

Production Bore	Monitor Bore	Cooper-Jacob				Theis Recovery T (m^2/d)	Radial Distance (m)	Constant Test Rate (L/s)	Final Drawdown (m)	Description
		Early Time	Late Time	Early Time	Late Time					
		T (m^2/d)		S						
WNWB002	WNWB002	15		NA		13	NA	2.5	12.91	Unconfined response, curve matched to late time data
WNWB003	WNWB003	1,100	340	NA		1500	NA	12	2.04	Confined late and early time responses, barrier boundary after 2,000 minutes
WNWB003	WNMB001	960	370	4.00E-05	4.00E-02	NA	11.2	12	1.27	Confined late and early time responses, barrier boundary after 2,000 minutes
WNWB003	WNMB002	1700	500	8.00E-05	6.00E-03	NA	51.4	12	0.8	Confined late and early time responses, barrier boundary after 200 minutes
WNWB004	WNWB004	690		NA		370	NA	12	5.11	Leaky response, curve mated to late time data
WNWB004	WNMB003	800		3.00E-18			7.1	12	4.5	Leaky response, curve mated to late time data
WNWB004	WNMB004	900		4.00E-06			48.4	12	1.17	Leaky response, curve mated to late time data

Note: T = transmissivity, S = storativity, NA = not applicable.

3.3 Groundwater Level Surveys

3.3.1 Groundwater levels in mining areas

A groundwater level survey was carried out at Arruwurra and the Main Zone using the resource drill-holes. The survey data were used to identify if the water table extends into the ore zones and hence the likely dewatering requirements during mining.

A total of 51 holes were visited at the Main Zone and 29 holes at Arruwurra (Table 7 and Figure 10). At both deposits the drill-holes were mostly dry. However, 14 of the holes at the Main Zone and seven of the holes at Arruwurra did register a water level.

Measured groundwater levels at the Main Zone varied from 3.11 to 63.39 m bgl, but only two of the holes had levels above 50 m depth. Both the holes with recorded shallow groundwater levels were plumbed and found to be blocked just below the measured water level. It is therefore almost certain the elevated levels in these holes are atypical and probably reflect a shallow, isolated and perched groundwater body.

The remaining 12 wet holes at the Main Zone were further investigated to assess the groundwater elevation with respect to the depth of mineralization and hence likely pit floor level. The results of the assessment showed the ore zone in the 12 holes lie at least 3 m below the measured groundwater level.

Similarly at Arruwurra 4 of the 7 wet holes were blocked just below the recorded groundwater level, and the depth of the ore zone in one of the remaining 3 wet holes was found to lie well below the measured water level. The two other wet holes did contain appreciable groundwater depths, 6.2 m in WNRC202 and 8.12 m in WNRC209. The reason for the anomalous levels is not known, but is expected to be localized.

The results show the water table at Arruwurra and the Main Zone lies below the base of the ore bodies.

Table 7: Mineral Exploration Hole Water Level Measurements

Hole ID	Collar Location MGA Zn 53		SWL (mbgl)	Plumbed Depth (m)	Sat. Thickness (m)	Measurem't Date	Base of Mineralisat'n (mbgl)	Deposit
	(mE)	(mN)						
WNRC470	658,249	7,790,496	3.11	4.86	1.75	7/04/09	NA	Main Zone
WNRC871	655,507	7,791,628	25.17	26.6	1.43	14/09/09	NA	Main Zone
WNRC678	654,253	7,791,486	50.82	52.4	1.58	14/09/09	49	Main Zone
WNRC795	654,252	7,788,000	51.17	51.17	0	14/09/09	43	Main Zone
WNRC604	651,757	7,790,755	52	53.5	1.5	14/09/09	45	Main Zone
WNRC663	653,750	7,791,252	52.45	54.5	2.05	14/09/09	NM	Main Zone
WNRC796	654,500	7,787,379	52.98	57	4.02	14/09/09	45	Main Zone
WNRC672	654,241	7,789,999	53.88	55.5	1.62	14/09/09	45	Main Zone
WNRC656	653,492	7,790,493	54.08	55.4	1.32	14/09/09	NM	Main Zone
WNRC684	653,500	7,786,629	55.15	55.15	0	14/09/09	42	Main Zone
WNRC869	655,501	7,791,128	56.65	59	2.35	14/09/09	48	Main Zone
WNRC901	655,999	7,792,871	58.83	62	3.17	14/09/09	NM	Main Zone
WNRC926	656,749	7,792,123	60.67	62.5	1.83	14/09/09	50	Main Zone

Hole ID	Collar Location MGA Zn 53		SWL (mbgl)	Plumbed Depth (m)	Sat. Thickness (m)	Measurem't Date	Base of Mineralisat'n (mbgl)	Deposit
	(mE)	(mN)						
WNRC564	657,248	7,788,750	63.39	68.42	5.03	14/09/09	61	Main Zone
WNRC132	656,623	7,789,205	D	63	NA	7/04/09	NA	Main Zone
WNRC143	656,629	7,790,674	D	69	NA	7/04/09	NA	Main Zone
WNRC277	652,250	7,786,376	D	47.52	NA	14/09/09	NA	Main Zone
WNRC313	655,003	7,789,501	D	55.4	NA	14/09/09	NA	Main Zone
WNRC324	655,499	7,789,755	D	57.4	NA	14/09/09	NA	Main Zone
WNRC354	651,000	7,786,752	D	42.1	NA	14/09/09	NA	Main Zone
WNRC360	650,506	7,785,996	D	41.9	NA	14/09/09	NA	Main Zone
WNRC385	650,998	7,787,750	D	45.5	NA	14/09/09	NA	Main Zone
WNRC404	656,500	7,790,498	D	24	NA	14/09/09	NA	Main Zone
WNRC459	658,254	7,790,250	D	70	NA	7/04/09	NA	Main Zone
WNRC469	657,997	7,790,497	D	64	NA	7/04/09	NA	Main Zone
WNRC471	658,248	7,790,747	D	58	NA	7/04/09	NA	Main Zone
WNRC472	658,005	7,790,746	D	5	NA	7/04/09	NA	Main Zone
WNRC483	655,499	7,788,003	D	54.6	NA	14/09/09	NA	Main Zone
WNRC485	657,996	7,791,001	D	1	NA	7/04/09	NA	Main Zone
WNRC488	657,252	7,791,000	D	1	NA	7/04/09	NA	Main Zone
WNRC567	658,000	7,788,751	D	68.3	NA	14/09/09	NA	Main Zone
WNRC567	658,000	7,788,751	D	68.3	NA	14/09/09	NA	Main Zone
WNRC576	657,248	7,788,000	D	20	NA	14/09/09	NA	Main Zone
WNRC579	658,000	7,788,001	D	64.5	NA	14/09/09	NA	Main Zone
WNRC579	658,000	7,788,001	D	64.5	NA	14/09/09	NA	Main Zone
WNRC591	653,000	7,787,244	D	46.5	NA	14/09/09	NA	Main Zone
WNRC600	652,748	7,791,754	D	45.3	NA	14/09/09	NA	Main Zone
WNRC602	650,752	7,791,752	D	42	NA	14/09/09	NA	Main Zone
WNRC607	650,750	7,789,752	D	42	NA	14/09/09	NA	Main Zone
WNRC637	653,004	7,788,750	D	49.4	NA	14/09/09	NA	Main Zone
WNRC646	651,998	7,788,000	D	50.5	NA	14/09/09	NA	Main Zone
WNRC655	656,748	7,789,754	D	43.5	NA	14/09/09	NA	Main Zone
WNRC675	654,256	7,790,755	D	55	NA	14/09/09	NA	Main Zone
WNRC830	655,004	7,790,376	D	45.5	NA	14/09/09	NA	Main Zone
WNRC833	655,000	7,791,129	D	52	NA	14/09/09	NA	Main Zone
WNRC856	655,249	7,792,376	D	ND	NA	14/09/09	NA	Main Zone
WNRC873	655,501	7,792,125	D	60	NA	14/09/09	NA	Main Zone
WNRC875	655,503	7,792,630	D	56	NA	14/09/09	NA	Main Zone
WNRC897	656,002	7,791,877	D	55	NA	14/09/09	NA	Main Zone
WNRC899	656,008	7,792,371	D	58	NA	14/09/09	NA	Main Zone
WNRC925	656,754	7,791,872	D	61.5	NA	14/09/09	NA	Main Zone
WNDD10	640,745	7,775,129	D	18	NA	24/05/09	NA	Arruwurra
WNDD28	640,745	7,775,129	21.68	22.5	0.82	24/05/09	14.9	Arruwurra
WNRC108	641,200	7,775,692	D	21	NA	25/05/09	NA	Arruwurra

Hole ID	Collar Location MGA Zn 53		SWL (mbgl)	Plumbed Depth (m)	Sat. Thickness (m)	Measurem't Date	Base of Mineralisat'n (mbgl)	Deposit
	(mE)	(mN)						
WNRC197	639,747	7,774,750	3.97	4	0.03	24/05/09	NA	Arruwurra
WNRC202	640,000	7,775,245	12.8	19	***6.2***	24/05/09	NA	Arruwurra
WNRC204	640,038	7,774,747	D	25	NA	24/05/09	NA	Arruwurra
WNRC205	640,029	7,774,504	2.12	2.5	0.38	24/05/09	NA	Arruwurra
WNRC209	640,252	7,775,503	4.88	13	***8.12***	24/05/09	NA	Arruwurra
WNRC211	640,241	7,774,997	D	24	NA	24/05/09	NA	Arruwurra
WNRC218	640,498	7,775,247	D	24	NA	24/05/09	NA	Arruwurra
WNRC227	640,740	7,774,996	D	24	NA	25/05/09	NA	Arruwurra
WNRC230	640,995	7,775,996	D	18	NA	25/05/09	NA	Arruwurra
WNRC231	640,996	7,775,751	D	18	NA	25/05/09	NA	Arruwurra
WNRC233	640,999	7,775,247	D	23	NA	25/05/09	NA	Arruwurra
WNRC235	640,738	7,774,753	D	28	NA	25/05/09	NA	Arruwurra
WNRC236	640,749	7,774,498	D	27	NA	24/05/09	NA	Arruwurra
WNRC241	640,246	7,774,490	D	25	NA	24/05/09	NA	Arruwurra
WNRC243	640,250	7,774,248	D	25	NA	24/05/09	NA	Arruwurra
WNRC246	639,498	7,774,001	D	31	NA	24/05/09	NA	Arruwurra
WNRC251	639,249	7,773,746	D	34	NA	24/05/09	NA	Arruwurra
WNRC252	638,999	7,774,001	D	33	NA	24/05/09	NA	Arruwurra
WNRC256	639,246	7,774,497	D	31	NA	24/05/09	NA	Arruwurra
WNRC261	638,745	7,773,500	D	39	NA	24/05/09	NA	Arruwurra
WNRC264	638,485	7,774,000	3.61	4	0.39	24/05/09	NA	Arruwurra
WNRC267	638,750	7,774,498	3.5	5	1.5	24/05/09	NA	Arruwurra
WNRC269	641,252	7,774,746	D	35	NA	24/05/09	NA	Arruwurra
WNRC271	641,251	7,774,494	D	32	NA	25/05/09	NA	Arruwurra
WNRC272	639,998	7,774,253	D	34	NA	25/05/09	NA	Arruwurra
WNRC274	641,249	7,775,249	D	23	NA	25/05/09	NA	Arruwurra

Note: SWL = static water level, NA = not applicable, NM = not mineralized, values in bold/italics are anomalous, mbgl = metres below ground level.

3.3.2 Regional groundwater levels

Regional groundwater levels were measured in production and monitoring bores (Tables 4 and 5 respectively) and within Minemakers' tenement at some groundwater exploration drill-holes (Table 8).

The groundwater level data show levels in the area north of Minemakers' tenements measured during the last phase of drilling are reasonably consistent, lying between 48.64 and 50.86 m bgl in the vicinity of production bores WNWB003 and 004, and falling to 64.55 m bgl at WNMB005 located about 8 km east northeast of WNWB003. This reasonably flat lying groundwater level is in keeping with the presence of a well connected aquifer system within the cavernous and weathered dolomite.

The groundwater levels measured within Minemakers' tenements show a higher degree of variability, ranging from 24.58 m bgl in WNWB002 to 103.29 m bgl in WNWE027. This variance suggests a heterogeneous groundwater system, with poor hydraulic connections between aquifers.

Table 8: Groundwater Exploration Hole Water Level Measurements

Hole ID	Collar Location MGA Zn 53		Hole Dip	Hole Depth (m)	SWL (mbtc)	SWL Date
	(mE)	(mN)				
WNWE025	664,371	7,779,250	90	157	102.88	1/05/09
WNWE027	664,431	7,779,154	90	175	103.29	1/05/09
WNWE047	647,285	7,771,890	90	133	66.59	7/05/09
WNWE054	642,257	7,775,171	90	150	63.15	27/05/09
WNWE055	642,340	7,775,165	90	150	63.55	28/05/09
WNWE056	642,407	7,775,161	90	150	63.78	29/05/09
WNWE057	642,094	7,775,159	90	150	63.15	30/05/09
WNWE060	643,506	7,775,154	90	150	65.75	5/06/09
WNWE061	643,579	7,775,151	90	150	65.73	5/06/09
WNWE063	643,661	7,775,156	90	150	65.89	5/06/09
WNWE064	643,868	7,775,152	90	150	>100	6/06/09
WNWE065	643,959	7,775,156	90	150	66.36	6/06/09
WNWE066	644,056	7,775,158	90	150	66.7	6/06/09

Note: SWL = static water level, mbtc = metres below top of casing.

4.0 GROUNDWATER QUALITY

Groundwater samples were collected from the test production bores at the end of the 48-hour constant rate tests; and from WNWB001 when the bore was first used to supply camp water. All samples were submitted to a suitably accredited laboratory for analysis. Field testing, comprising measurements of electrical conductivity (EC) and pH, was also routinely carried out during the constant rate tests to identify any effects on general water quality from groundwater extraction.

Table 9: Water Quality Analysis Results

Analyte	Units	WNWB001	WNWB002	WNWB003	WNWB004
Conductivity	µS/cm	ND	2100	2700	2400
TDS (evap 180C)	mg/L	780	1300	1800	1500
pH		8	7.4	7.1	7
TSS	mg/L	ND	<5	10	8
Turbidity	NTU	ND	<1	2	7
Turbidity filtered 0.45µm	NTU	ND	<1	<1	<1
Colour	PCU	ND	<5	<5	<5
Total Hardness	mg/L $CaCO_3$	170	ND	ND	ND
Calcium	mg/L	59	25	140	140
Magnesium	mg/L	6.5	34	97	88
Sodium	mg/L	ND	450	330	290
Potassium	mg/L	ND	29	53	46
Strontium	mg/L	ND	0.35	1.7	1.5
Barium	mg/L	0.065	<0.01	0.02	<0.01
Total Iron	mg/L	ND	<0.02	0.11	0.31
Manganese	mg/L	0.055	<0.005	0.51	0.059
Carbonate	mg/L $CaCO_3$	ND	<1	<1	<1
Bicarbonate	mg/L $CaCO_3$	ND	640	420	460
Sulphate	mg/L	ND	120	330	230
Chloride	mg/L	ND	310	550	450
Nitrate	mg/L	0.01	14	5.8	0.4
Fluoride	mg/L	1.2	1.4	1.2	1.1
Silica	mg/L	ND	46	17	19
Arsenic	mg/L	0.0026	ND	ND	ND
Cadmium	mg/L	<0.0001	ND	ND	ND
Lead	mg/L	<0.001	ND	ND	ND
Selenium	mg/L	0.0049	ND	ND	ND
Antimony	mg/L	<0.05	ND	ND	ND

Analyte	Units	WNWB001	WNWB002	WNWB003	WNWB004
Boron	mg/L	1.4	ND	ND	ND
Chromium	mg/L	<0.002	ND	ND	ND
Copper	mg/L	<0.002	ND	ND	ND
Molybdenum	mg/L	<0.01	ND	ND	ND
Nickel	mg/L	<0.005	ND	ND	ND
Total Mercury	mg/L	<0.001	ND	ND	ND
Total Cyanide	mg/L	<0.005	ND	ND	ND

Note: ND = not determined.

The results of the laboratory analysis are summarised in Table 9, which show the following:

- The groundwater at WNWB001 (camp bore) is fresh and slightly brackish at the other three bores.
- pH ranges from neutral to slightly alkaline.
- Total suspended solids (TSS) and turbidity at the two northern bores, which were constructed without filter pack, are slightly elevated; but below detection in WNWB002 which was constructed with a filter pack.
- The dominant ions in water from WNWB002 are sodium and bicarbonate/chloride, and in the northern bores sodium and chloride.
- Iron concentrations were elevated in the two northern bores.
- High silica values were measured in WNWB002 and high to moderate values in the northern bores.
- High boron values were detected in WNWB001.

It should be noted that drinking water will be treated by reverse osmosis, therefore elevated concentrations of metals should not enter the potable supply.

The water quality field measurements are presented as time series graphs in Figures 7 to 9. The graphs show both EC and pH are steady in the three production bores tested. The EC values in the northern production bores range from about 2.4 to 2.8 mS/cm, roughly equivalent to a salinity of 1.4 to 1.7 mg/L TDS. The EC of the groundwater at WNWB002 is slightly lower at about 2.2 mS/cm (1.3 mg/L TDS). The pH of the water in the three bores ranged from 7 to 7.5 (neutral to slightly alkaline).

5.0 GROUNDWATER CONTAMINATION RISKS

Groundwater contamination risks from mining operations are normally associated with seepage from tailings storage facilities. However, the current investigation is associated with the first stage of the project development, which relates to the mining of direct ship ore (DSO) requiring no processing beyond ore crushing and screening. The DSO option removes the requirement for a processing plant and hence a tailings storage facility.

The risks of groundwater contamination are therefore associated with management of hazardous materials storage areas, e.g. chemicals and hydrocarbons, in particular rainfall runoff from these areas. The design of runoff control measures have been identified by GRM in the surface water management report for the Wonarah Project (GRM, 2009).

6.0 WATER BALANCE MODELLING

A dynamic water balance was developed for the Project to estimate the water demand during construction and over the ten year mine life. The water balance was developed using the generic systems modelling package GoldSim, which is well suited to simulating dynamic systems such as water balances.

The various components making up the Project water demand are summarised below.

- Construction phase:
  1. water for material conditioning during road construction;
  2. dust suppression water for the roads;
  3. construction water for the plant and village;
  4. potable water demand.
- Demand during mining:
  1. dust suppression water for the roads;
  2. dust suppression water for the mining areas;
  3. water for plant operations;
  4. potable water demand.

For the purposes of the water balance it was assumed the construction phase will commence on 15 July 2010 and run for approximately five months. Pre-stripping is expected to commence at the start of August 2010 and mining to start at the beginning of October 2010. The current life of mine is expected to be 10 years, i.e. finishing in late 2020.

6.1 Construction Water Demand

The total volumetric water requirement for road construction was calculated from first principles, based upon the following relationship for each of the road construction components (sub-grade, base coarse and sub-base). Information used in the estimation of the construction water requirements was sourced from GHD Pty Ltd and 4D Geotechnics Pty Ltd.

$Q = L \times W \times T \times P_s \times (M_2 - M_1) / P_w$

Where:

Q = the total volumetric water requirement.

L = the linear lengths of the roads (32.3 and 4.3 km for major and minor roads respectively).

W = the road widths (7 m).

T = the thickness of the road construction materials (300, 200 and 200 mm for the sub-grade, base coarse and sub-base respectively).

P_s = the density of the road construction materials (1.8 tonne/m^3).

M_2 = the desired moisture content for the road construction materials (10%, allowing for a 2% loss from seepage and evaporation during construction).

M_1 = the ambient moisture content for the road construction materials (4% for all materials).

P_w = the density of water.

The water demand rate for road construction was calculated by pro-ratering the volumetric demand over the five month construction period.

The road dust suppression water demand during construction was calculated by pro-ratering the total road dust suppression demand (i.e. the total demand during mining – Section 6.2) over the five month construction period. For example at the start of construction the dust suppression demand will be 0 L/s and at the end of construction the demand will be equivalent to the full dust suppression requirement.

The water demand for construction of the plant and village (2 L/s) was provided by GHD.

The potable water demand was calculated from the expected number of personnel on site required during construction (100 personnel) and a daily per capita demand of 350 L/day per person.

6.2 Mining Water Demand

The dust suppression water requirement for the roads during mining was calculated using the surface area of the roads, the calculated monthly evaporation rate (Section 2.1) and a road usage factor. The road usage factor was varied to represent the road utilization and therefore the frequency of road watering. The following utilization factors were adopted:

- for minor roads a factor of 0.25 of the pan evaporation rate;
- for major roads a factor of 1 of the pan evaporation rate.

The dust suppression demand for the mining areas was calculated in a similar manner, using a combined mining area provided by AMC Consultants. These areas comprise the active pit floors, roads within the pit footprint and the ROM pad. A utilization factor of 0.25 was adopted for the mining area dust suppression.

The water demand at the crushing and screening plant is expected to be minimal and a nominal flow of 5 L/s was used, based on discussions with Minemakers.

The potable water demand during mining was calculated from the expected number of personnel on site required during pre-stripping and for mining (100 and 150 personnel respectively) and a daily per capita demand of 350 L/day per person.

6.3 Water Balance Results

The various water demands and the combined water demand for the Project are shown as a time-series graph in Figure 11.

The figure shows the following:

- The total water demand during construction rises from zero in mid July 2010 to about 15 L/s in mid August 2010.
- The peak water demand of around 67 L/s is at the end of construction when mining has already commenced.
- After the completion of the construction phase the water demand varies from about 32 L/s during the winter months to 60 L/s in summer when evaporation rates are highest.

7.0 PROJECT WATER SUPPLY

The Project water demand was calculated using the site water balance (Section 6.0). To meet the predicted demand a two stage supply is planned. The first stage will provide approximately 10 to 15 L/s for the start of construction, using lower yielding bores at Arruwurra, and the camp bore for potable water.

During this initial period the longer term supply (stage 2) will be developed, which will consist of a northern borefield located off Minemakers' tenements in the area of existing production bores WNWB003 and 004. The development will comprise drilling and construction of the additional northern production bores and installation of pumping infrastructure (pipelines, pumping stations etc.) to enable the transfer of water from the borefield to the mine and village. The expected time to install the borefield pipeline is around 3 months.

7.1 Initial Construction Water Supply

Initially construction water will be drawn from nominally five lower yielding bores in the Arruwurra area. These bores will comprise existing production bore WNWB002 and four new bores located near wet groundwater exploration holes WNWE056, WNWE057, WNWE061 and WNWE068 (Section 3.1.1).

Based upon the drilling results the new production bores are expected to have similar hydraulic properties to those at existing bore WNWB002 (Section 3.2). The test pumping results for WNWB002 have therefore been adopted as being representative of the new Arruwurra bores.

It is anticipated the Arruwurra production bores will be needed for up to three months before the northern borefield is available. The sustainability of the five production bores over this period has been assessed using standard analytical curve-matching methods by extending the elapsed time on the test pumping results for WNWB002 (Figure 12). The resultant curve shows the expected drawdown after 3 months will be about 18 m (43 m bgl), well above the main aquifer zone which lies below 109 m bgl .

7.2 Long-term Water Supply

The longer term project water supply will be sourced from a northern borefield located in the vicinity of existing production bores WNWB003 and 004. Groundwater at these locations is drawn from a cavernous, weathered dolomite aquifer that is judged to extend regionally to the north, east and west.

Based upon the water balance results the long-term demand is likely to be between 35 and 60 L/s, varying seasonally with evaporation rates. For the purposes of the BFS a constant rate of 75 L/s has been adopted to provide some redundancy to the supply. The sustainability and impact of the borefield operation has been assessed using a numerical groundwater flow model. The configuration of the numerical model and the modelling results are discussed in the following sections.

7.2.1 Conceptual groundwater model

The conceptual model for the northern borefield area, used in development of the numerical model, recognises four hydrogeological units; HU1 to 4, which are described below.

- HU1 comprises the dolomite aquifer intersected in the northern bores WNWB003 and 004. The unit is overlain by low permeability sedimentary rocks (HU2) and underlain by low permeability basement or sedimentary rocks (HU3). Based on the results from the last phase of drilling the top of the unit has been set at 100 m below surface.

- HU2 comprises the near surface sedimentary deposits overlying the HU1 dolomite aquifer. The deposits are characterised by low permeabilities and, most likely, moderate aquifer storage. The upper and lower extents of the unit comprise the ground surface and the top of the dolomite aquifer respectively.

- HU3 comprises the low permeability unit underlying the HU1 dolomite aquifer. The lithology of the unit is unknown as the dolomite aquifer was not fully penetrated during the last phase of drilling because of poor ground conditions.

- HU4 comprises the low permeability sedimentary and basement rocks that occur in the Wonarah Project area. The unit extends to the north and forms the southern boundary of the HU1 to 3 sequence north of the Barkly Highway.

The actual thickness and depth of the dolomite aquifer is no known, but the drilling results indicate a minimum thickness of about 25 m.

Similarly the lateral extent of the aquifer is also not well understood, although the historical drilling data, sourced from the NRETAS database, suggests the aquifer stretches tens of kilometres to the north, east and west (Section 2.4). Results from the first two phases of drilling show the aquifer does not continue as far south as the Project area which is characterised as a basement high within the Georgina Basin (Section 2.3.1), but the location of its southern boundary is unknown. Conservatively it has been assumed to coincide with the southern boundaries of the Dalmore Downs and Alroy Stations.

Groundwater levels in the dolomite aquifer lie around 50 m bgl. Water levels in the overlying low permeability sediments are likely to be marginally higher, resulting in downward vertical groundwater flows and aquifer recharge.

Rainfall recharge rates are expected to be low, consistent with the semi-arid climate and exacerbated by the low permeability of the HU2 sediments. Recharge from surface water will occur locally in the vicinity of the major rivers and, after rainfall events, from minor water courses and marshy areas. Although recharge rates are likely to be low, long-term groundwater production should be supported by the high transmissivity of the dolomite aquifer.

A schematic of the conceptual model is presented in Figure 13.

7.2.2 Numerical Flow Model

Groundwater flow modelling for the area north of Minemakers' tenements was developed to assess the requirements, impacts and sustainability of a borefield supply from the dolomite aquifer. The model was developed using the MODFLOW finite difference code and the pre- and post-processor Groundwater Vistas.

The model was based upon a conceptual model of the groundwater system (Section 7.2.1), which was developed using the data collected during the last phase of the drilling programme and the test pumping results, along with information sourced from the NRETAS bore database.

Numerical model set-up

The model comprises two layers (representing the near surface sediments and dolomite aquifer) and 196 rows by 248 columns. The model cell sizes range from 5 m by 5 m in the area of the production bores to 500 m by 500 m along the model's lateral boundaries. The model domain covers an area of about 7,260 km^2.

The upper and lower surfaces of the two model layers are flat and horizontal. The upper surface of the top layer (Layer 1) was set at 50 m bgl, equivalent to the expected groundwater level in the near surface sediments (HU2). The base of Layer 1 was set at 100 m depth, coincidental with the top of the dolomite aquifer (HU1) in the conceptual model. The base of Layer 2 was set at 125 m depth, giving an aquifer thickness of 25 m.

The HU4 aquitard was not included in the model. The southern model boundary Is defined as the adopted southern limit of the dolomite aquifer, thereby removing the requirement to directly model the unit.

The model grid is presented in Figure 14 and the model set-up summarised in Table 10.

Table 10: Summary of Numerical Model Set-up

Layer	Hydrogeological Unit	Layer Top (m depth)	Layer Base (m depth)
1	HU2 - Near surface sediments (aquitard)	50	100
2	HU1 - Dolomite aquifer	100	125

Note: model set-up assumes the ground surface is flat and horizontal.

Hydraulic parameters

The hydraulic parameters used to simulate the dolomite aquifer for the base case were founded on the transmissivities and storativities estimated from the test pumping results (Section 3.2), assuming isotropic conditions. The adopted values were consistent with the lower estimates for aquifer parameters to maintain a conservative modelling approach.

The parameters for the overlying sediments were consistent with low permeability sedimentary rocks.

In addition to the base case a number of sensitivity analysis runs were completed (Section 7.2.3) to investigate the influence of variation in the following poorly understood parameters:

- vertical and horizontal hydraulic conductivity in Layer 1;
- specific yield in Layer 1;
- vertical hydraulic conductivity in Layer 2.

The parameter values used in the numerical model are summarised in Table 11 for the base case and the three sensitivity runs (SR1 to SR3).

Table 11: Numerical Model Hydraulic Parameters

Model Run	Layer	Kh (m/d)	T (m^2/d)	Kv (m/d)	Sc (m-1)	Sy	Comments
Base case	1	0.001	NA	0.001	1.00E-05	0.01	Expected condition
	2	10	250	10	1.00E-06	0.1	
SR1	1	0.0001	NA	0.0001	1.00E-05	0.01	Reduced hydraulic conductivity in Layer 1
	2	10	250	10	1.00E-06	0.1	
SR2	1	0.001	NA	0.001	1.00E-05	0.005	Reduced specific yield in Layer 1
	2	10	250	10	1.00E-06	0.1	
SR3	1		NA	0.001	1.00E-05	0.01	Reduced vertical hydraulic conductivity in Layer 2
	2	10	250	1	1.00E-06	0.1	

Note: Kh = horizontal hydraulic conductivity, T = transmissivity (assuming fully saturated conditions), Sc = confined storage and Sy = specific yield.

Groundwater abstraction

Five production bores were used to model groundwater production from the borefield, comprising the two existing bores and three future bores. The locations of the bores are shown in Figure 6 and their coordinates presented in Table 12.

Table 12: Modelled Production Bore Locations

Bore ID	Collar Location MGA Zn 53		Comments
	(mE)	(mN)	
WNWB003	643,257	7,822,227	Existing production bore
WNWB004	640,889	7,817,697	Existing production bore
WNWB005	641,955	7,819,849	Future production bore
WNWB006	640,871	7,822,232	Future production bore
WNWB007	643,021	7,817,782	Future production bore

Pumping from the bores was simulated using MODFLOW's Well Package. A constant pumping rate of 15 L/s per production bore was adopted over the 10 year model run time, drawing water exclusively from Layer 2. This gives a combined extraction of 75 L/s.

Model boundary conditions

The boundary conditions adopted in the model comprised the following:

- The lateral model boundaries to the north, east and west were set as constant heads, with groundwater levels at 50 m below surface, consistent with the groundwater level used in the conceptual model and the initial water levels in the active model area.

- The southern lateral model boundary, coincidental with the adopted southern limit of the dolomite aquifer, was defined as a no flow boundary. This provides a conservative approach as some groundwater flows across this contact would be expected should drawdowns extend that far.

The base of Layer 2, which is coincidental with the base of the dolomite aquifer, was set as a no flow boundary. Again this is a conservative approach, removing any potential inflows from HU3 that could assist in sustaining groundwater extraction from the production bores.

It was assumed that there will be no rainfall recharge over the 10 year model run time.

Layer 1 was defined as an unconfined MODFLOW layer type, using calculated transmissivities and storativities. Layer 2 was defined as a confined/ unconfined layer type, again with calculated transmissivities and storativities.

Vertical flows between layers were calculated using adopted vertical permeabilities in the two layers.

7.2.3 Numerical model predictions

The numerical model was run for 10 years, based upon the current life of mine. The predicted groundwater level drawdowns in the two model layers for the base case after 10 years are presented as contour plots in Figures 15 and 16 for Layers 1 and 2 respectively. The predicted drawdowns for the three sensitivity runs are also presented as contour plots in the following figures:

- Figures 17 and 18 (Layers 1 and 2 respectively for Sensitivity Run 1);
- Figures 19 and 20 (Layers 1 and 2 respectively for Sensitivity Run 2);
- Figures 21 and 22 (Layers 1 and 2 respectively for Sensitivity Run 3).

The base case drawdown contours have also been included in the sensitivity run plots to facilitate comparison of results.

In addition to the drawdown contours, time series graphs of the predicted drawdowns in Layer 2 at the locations of the five production bores have also been prepared (Figures 23 to 25). The time graphs show the results for the base case and three sensitivity runs.

The modelling results are summarised below.

- The modelling indicates a combined production rate of 75 L/s over the 10 year mine life is readily achievable. Maximum drawdowns at the bores in Layer 2 range from 14.3 m (for the base case and sensitivity run 3) to 16.9 m for sensitivity run 2.
- The predicted drawdown in Layer 1 at the two environmentally sensitive areas identified within the model domain are as follows:
  - less than 0.2 m at Oolgoolgam Swamp for all model runs;
  - between 1.5 and 3 m at Kerringnew Swamp.
- Only six stock bores (RN025678, 025874, 004087, 006751, 001237 and 001238) lie within the 5 m drawdown contour for Layer 2 after 10 years, based upon the results from the base case and all sensitivity runs.

- Only one stock bore (RN001237) lies within the 10 m drawdown contour for Layer 2 after 10 years, based upon the results from the base case and all sensitivity runs.

It should be noted that groundwater level monitoring at bore WNEM001, located at Kerringnew Swamp has identified the swamp as a perched surface water feature (Section 3.3). Therefore groundwater level drawdowns in the near surface sediments are not expected to impact upon the swamp water budget.

Comparison of the base case and sensitivity analysis show:

i. The highest rate of drawdown at the start of groundwater production occurs in sensitivity run 2 (reduced vertical hydraulic conductivity in Layer 1).

ii. In the longer term the model is most sensitive to the specific yield in Layer 1 (sensitivity run 1), both in terms of drawdowns at the bores and the lateral drawdown extent.

iii. The model is insensitive to changes in the vertical hydraulic conductivity in Layer 2.

In viewing the numerical modelling results it should also be noted that the model set-up reflects a conservative condition with the exclusion of rainfall recharge and adoption of the lower range in hydraulic conductivity for the dolomite aquifer.

8.0 DEWATERING

The dewatering requirements for the Wonarah Project relate to management of groundwater inflows and of seepage from surface water that could be stored within natural topographic depressions in the vicinity of the Arruwurra Pits following high rainfall events. The Main Zone Pits lie within a topographic high preventing flood water accumulation.

8.1 Groundwater Inflow Management

A comprehensive groundwater level survey at Arruwurra and the Main Zone was carried out by GRM during the recent field programme (Section 3.3.1). The survey identified that groundwater levels almost always lie below the ore zones at the two mining areas. A small number of drill-holes did contain elevated groundwater levels extending into the ore. However, these water levels are believed to reflect small, isolated, and most likely perched, groundwater bodies.

Based upon this assessment any groundwater inflows into the pits are expected to be minor (1 to 2 L/s) and short-lived with a duration of a few weeks or days. It is possible the discharge will evaporate on the pit floor or infiltrate to the underlying water table. If flows persist they should be readily manageable with a locally excavated sump and small sump pump.

8.2 Surface Water Seepage Management

Seepage inflows from stored surface water may occur at Arruwurra, based on surface water studies (GRM, 2009). The likely limit of the stored water is presented in Figure 26. The figure shows the water covers an area of about 180 ha, extending along a 500 m width adjacent to the Arruwurra Pits. The stored surface water is conservatively estimated to lie about 100 m from the pit crests. The maximum elevation of the stored water is 257 m AHD, some 20 m above the base of the adjacent Arruwurra Pits.

The potential seepage rates from the stored surface water have been calculated using Darcy's groundwater flow equation, presented below.

$Q = A \times K \times (dh/dx)$

Where:

Q = seepage rate into the Arruwurra Pit.

A = cross sectional area perpendicular to the flow direction, calculated as the extent of the water body adjacent to the pit crests (500 m) multiplied by the depth of the Arruwurra Pits (20 m).

K = hydraulic conductivity.

dx = difference in head, calculated as the difference between the surface water level and the base of the Arruwurra Pit (20 m).

dx = flow path length, assumed to be the distance from the stored surface water body to the Arruwurra Pit crests (100 m).

A schematic diagram of this conceptual model is presented in Figure 27.

Seepage rates were calculated for two conditions, expected and worst case, based upon variation in the hydraulic conductivity of the near surface sedimentary rocks. For the expected case an hydraulic conductivity of 0.001 m/d was adopted (consistent with the value used in the numerical model) and for the worst case a value of 0.01 m/d was used.

The calculated seepage rates ranged from about 0.02 L/s to 0.2 L/s. The seepage rates are low in comparison to the likely incidental rainfall into the pits that would be associated with a significant rainfall event. The impacts of seepage upon the overall dewatering requirement following a major storm event are therefore likely to be negligible.

9.0 BOREFIELD EQUIPPING AND OPERATING STRATEGY

9.1 Borefield Equipping and Operation

Recommended pumping rates for the three production bores tested are presented in Table 13, along with the recommended pump inlet setting and available drawdown.

Table13: Bore Equipping Recommendations

Bore ID	Maximum Pumping Rate		Pump Inlet Setting (mbgl)	SWL (mbtc)	Available Drawdown (m)	Total Bore Depth (mbgl)	Recommended Pumping Rate	
	(m^3/hr)	(L/s)					(m^3/hr)	(L/s)
WNWB002	9	2.5	100	24.58	75	125.4	9	2.5
WNWB004	72	20	95	50.86	44	122	54	15
WNWB005	72	20	95	48.64	46	126	54	15

Note: mbgl = metres below ground level, SWL = static water level, mbtc = metres below top of casing

The recommended pumping rates comprise:

- the maximum duty rate, based upon the test pumping results (Section 3.2);
- the recommended long-term pumping rates based upon the sustainable yield of the aquifer resource, which have been estimated using the numerical groundwater flow model (Section 7.2.2).

For the purposes of this study it is assumed the three planned new northern borefield bores will have the same characteristics as existing bores WNWB003 and 004. Similarly the four planned new Arruwurra production bores will be similar to existing bore WNWB002. This provides a combined recommended pumping rate of 75 L/s from the northern borefield and 12.5 L/s from the Arruwurra production bores.

9.2 Operating Strategy

9.2.1 Strategy overview

Operation of the Arruwurra production bores and northern borefield will require a suitable operating strategy to help:

- maintain adequate water supply to the Project;
- identify unacceptable impacts upon other groundwater users;
- identify unacceptable impacts upon the groundwater environment.

The strategy should:

i) Describe the borefield and monitoring system, including a schedule of production and monitoring bores.

ii) Identify other users in the vicinity of the borefield and environmentally sensitive areas.

iii) Present a copy of the approvals under which groundwater extraction is permitted, including any conditions related to the approvals.

iv) Identify the persons responsible for operation of the borefield, and present their contact details.

v) Detail the monitoring requirements for the borefield.

vi) Detail the routine data assessment programme, including frequency, reporting commitments and trigger values used to identify possible unacceptable impacts upon the groundwater environment.

vii) Detail action and contingency plans that may be required should unacceptable impacts upon the groundwater environment be identified.

It is intended that the strategy will be prepared under a separate cover as a stand-alone document and therefore is not included in this report. However, the proposed monitoring schedule for the Wonarah Project has been developed and is presented in the following section.

9.2.2 Monitoring schedule

The recommended monitoring schedule for the Arruwurra production bores and northern borefield is presented in Table 14.

Table 14: Recommended Monitoring Schedule

Monitoring Site	Parameter	Frequency	Comments
	Arruwurra and Camp Area		
Production Bores	Groundwater level depth	Monthly	
	Cumulative pumping volume	Monthly	
	EC, temperature and pH	Monthly	Measured in the field using a calibrated hand-held meter
	Northern Borefield		
Production Bores	Groundwater level depth	Monthly	
	Cumulative pumping volume	Monthly	
	EC, temperature and pH	Monthly	Measured in the field using a calibrated hand-held meter
	Water quality laboratory analysis	Annual	Analytes: pH, TDS, EC, major ions, NO3 and Fe
Monitoring Bores	Groundwater level depth	Monthly	
	Regional Sites		
Environmental monitoring bore (WNEM001)	Groundwater level depth	Monthly	
Nearby stock bores	Groundwater level depth	Monthly	

The locations of the existing Arruwurra and Camp Bore (WNWB001 and 002) are shown on Figures 4 and 5. The northern borefield bores are shown on Figure 6 along with the corresponding monitoring bores and regional stock bores.

Regional monitoring of third party users is recommended in six stock bores (RN025678, 025874, 004087, 006751, 001237 and 001238), identified from the numerical modelling as being within the 5 m drawdown contour after ten years of operation for the base case condition (Section 7.2.3). The locations of the stock bores are presented in Figure 16 and the bore details in Table 2.

10.0 RISK ASSESSMENT

A primary risk analysis workshop was carried out on 20 August 2009, facilitated by AMC. The risk analysis methodology and the workshop findings are presented in Section 19 of the Wonarah Project Bankable Feasibility Study report (AMC, 2009).

The following sections outline the risks relating to groundwater and a copy of the current risk register (Rev 1.0) presenting a summary of the groundwater related risks is provided in Appendix D.

10.1 Risk of Groundwater Supply Failure

The risk of groundwater supply failure relates to the failure of the Arruwurra production bores at the start of construction; and/or failure of the northern borefield at the end of construction or during development and mining. The probability of water supply failure is considered unlikely (Level 2), given the successful groundwater intersections north of Minemakers' tenements and the five potential production bore locations already identified at Arruwurra (Section 3.1). The consequence is considered moderate (Level 3), because of possible delays to construction (particularly of the roads); and mining and haulage should there be insufficient water for dust suppression, which is the main water use once operations commence. The adopted likelihood/consequence matrix gives a risk rating of Low.

Controlling strategies to assist in mitigation of the risk comprise adequate monitoring of groundwater levels and pumping rates; and assessment of the monitoring data to provide early warning of possible supply failure. In addition, provision of sufficient redundancy in the borefield to allow enough time for additional production bores to be installed should they be needed.

10.2 Unacceptable Reduction in Groundwater Supply Quality

The risk of an unacceptable reduction in groundwater supply quality relates to changes in the groundwater quality with time (i.e. seasonally or due to pumping). The probability of unacceptable quality water is unlikely (Level 2) and the consequence minor (Level 2), giving a risk rating of Low. Regional groundwater quality data show groundwater salinities range from 500 to 4,000 mg/L TDS. It is therefore unlikely pumping will draw in lower quality saline groundwater into production bores. This is supported by the extensive use of groundwater across the Barkly Tableland for stock watering purposes. It should also be noted that the majority of the water will be used for dust suppression, which is relatively insensitive to changes in water quality. It is also planned to treat potable water by reverse osmosis, minimizing the risk to health from elevated concentrations of metals and other toxic ions.

Controlling strategies to assist in mitigation of the risk comprise adequate monitoring of groundwater quality and assessment of the monitoring data. This should provide early warning of possible reductions in groundwater quality and enable installation of additional production bores away from the area affected or discussions with regulators to relax water quality use conditions.

10.3 Pit Dewatering from Groundwater

The risk of pit inundation from groundwater inflow is low. This is based on a probability of rare (Level 1) and a consequence Level of 1 (rare). As discussed in Section 8.1, a survey of groundwater levels in the vicinity of Arruwurra and the Main Zone have identified water table levels below the base of the ore, apart from a few isolated locations that show evidence of minor perched water bodies.

Controlling strategies comprise ongoing assessment of potential elevated groundwater conditions during resource drilling and installation of a suitable dewatering system should higher than expected groundwater levels be encountered. In addition, the maintenance of adequate ore stockpiles to provide sufficient time to dewater the pit(s) should this be necessary.

10.4 Pit Dewatering from Infiltrating Rainfall

The risk of pit flooding from infiltrating rainfall, relates to seepage inflows from stored surface water at Arruwurra (Section 8.2). The likelihood of occurrence is rated as possible (Level 3) and the consequence as insignificant (Level 1). Because the Arruwurra Pit lies in a topographic low some storage of runoff water within topographic depressions is possible (depending upon the severity of the storm event), which may result in seepage into the pit. However, the seepage rates will be low (0.02 to 0.2 L/s) in comparison to the potential flooding in the pit from incidental rainfall, and should therefore be readily managed by the flood management infrastructure (internal drainage system, sumps and sump pumps).

Controlling strategies comprise installation of suitable flood management infrastructure and the maintenance of adequate ore stockpiles to provide sufficient time to dewater the pit(s) should this be necessary.

10.5 Unacceptable Environmental Impacts from Groundwater Production

The risk of unacceptable impacts upon the environment relate to drying up of the two marshes identified 10 and 37 km north east and east of the proposed northern borefield (Section 2.5). The likelihood of occurrence is rated as rare (Level 1) and the consequence as moderate (Level 3). This results in a Moderate risk level. Groundwater modelling results indicate drawdowns of less than 3 m at the nearest marsh after 10 years of pumping, which is considered to be negligible considering the ambient groundwater depth of around 50 m. In addition, monitoring results indicate the marshes are surface water features and will therefore be unaffected by changes in the underlying groundwater level.

Controlling strategies to assist in mitigation of the risk comprise adequate monitoring of groundwater levels and pumping rates; and assessment of the monitoring data to provide early warning of unacceptable impacts upon the marshes. If unacceptable impacts are identified, additional production bores located away from the proposed northern borefield and from the sensitive areas will be installed, thereby reducing interference effects from groundwater production.

10.6 Unacceptable Impacts on Other Users from Groundwater Production

The risk of unacceptable impacts on other users relates to lowering of regional groundwater levels in the vicinity of the northern borefield. No third party users have been identified at

Arruwurra. The probability of occurrence is rated at unlikely (Level 2) and the consequence as minor (Level 2), resulting in a low risk result based upon AMC's matrix.

Groundwater modelling results show six bores lie within the 5 m drawdown contour and only one bore lies within the 10 m drawdown contour after 10 years groundwater production. This provides significant redundancy, given the available drawdown in the aquifer system (approximately 50 m).

Controlling strategies to assist in mitigation of the risk comprise adequate monitoring of drawdown extents in the regional bores and monitoring bore WNMB005. In addition, Minemakers has committed to maintaining existing water supplies, where monitoring indicates pumping from the proposed northern borefield has had an unacceptable impact.

11.0 COST ESTIMATE

Cost estimates have been prepared covering:

- drilling and construction of four new production bores at Arruwurra;
- drilling and construction of three new production bores at the northern borefield;
- drilling and construction of three monitoring/observation bores adjacent to the new northern borefield production bores;
- completion of step and 48-hour constant rate tests on the seven new production bores;
- supply of suitable submersible pumps and associated infrastructure (rising main, electrical cable, control box with cabinet, head works, flow meter, gate valve, sample tap and pressure gauge) for five production bores at Arruwurra and four production bores at the northern borefield.

The estimated drilling and bore construction costs are presented in Table 15. The costs are based upon rates provided by Gorey and Cole, who undertook the last drilling phase, and the following assumptions.

- Production and monitoring bore depths of 144 m.
- Construction of the production bores using 155.6mm ID/168.3mm OD mild steel blank and slotted casing.
- Construction of the monitoring bores using 50 mm nominal diameter class 9 uPVC blank and slotted casing.
- Formation stabiliser or filter pack is not required for either production or monitoring bores.
- All drill-holes can be completed using direct circulation air hammer.

Table 15: Estimated Drilling and Bore Construction Costs

Item	Unit	Rate ($)	Qty	Amount ($)
Mobilisation / Demobilisation	Item	4,000	1	4,000
Drilling				
Drill to accept 200mm surface casing	m	145	42	6,090
Drill 203 mm hole	m	105	1,008	105,840
Drill to accept 150mm surface casing	m	105	18	1,890
Drill 152 mm hole	m	65	432	28,080
Casing				
Supply of 200 mm NB steel casing (8")	m	85	60	5,100
Supply of 150 mm NB blank steel casing (6")	m	65	672	43,680
Supply of 150 mm NB slotted steel casing (6")	m	120	336	40,320
Supply of 50 mm NB PVC blank casing (2")	m	7	288	2,016
Supply of 50 mm NB PVC slotted casing (2")	m	12	144	1,728
Miscellaneous				
Work time (Run casing, Bore development etc)	Hour	700	119	83,300
Standby Time -	Hour	550	10	5,500
Consumables				
Cement	bag	20	40	800
Quickfoam	Ltr	4.50	200	900
Diesel Fuel	Ltr	1.25	17,000	21,250
TOTAL				**350,494**

Note: all costs provided are exclusive of Goods and Services Tax (GST).

Costs for test pumping of the new bores and supply of submersible pumps and associated infrastructure were provided by McMinns Bore Services, who completed the test pumping programme for the current study. The estimated costs are summarised in Table 16 (test pumping costs) and Table 17 (supply of pumps and infrastructure).

Table 16: Estimated Bore Testing Costs

Item	Unit	Rate ($)	Qty	Amount ($)
Mobilisation / Demobilisation	Item	4,600	1	4,600
Install and remove pump	hr	800	7	5,600
Carry out step rate test	hr	160	28	4,480
Carry out constant rate test	hr	80	336	26,880
Carry out recovery test	hr	80	28	2,240
TOTAL				**43,800**

Note: all costs provided are exclusive of GST.

In estimating the cost of submersible pumps and associated infrastructure it has been assumed that the pump purchased by Minemakers for the test pumping of WNWB003 and 004 will be available for use when the borefield is commissioned.

Table 17: Estimated Bore Pump Supply Costs

Item	Unit	Rate ($)	Qty	Amount ($)
4 inch pump Southern Cross SC8 18 3kW motor, complete with rising main, electrical cable, control box with cabinet, head works, flow meter, gate valve, sample tap and pressure gauge	Item	9,610	5	48,050
6 inch pump, Southern Crosssc 65-10 18.5kW, complete with rising main, electrical cable, control box with cabinet, head works, flow meter, gate valve, sample tap and pressure gauge	Item	24,230	4	96,920
TOTAL				**144,970**

Note: all costs provided are exclusive of GST, costs do not include freight or installation costs.

Performance data for the pumps specified in Table 17 are presented in Appendix E.

12.0 SUMMARY AND CONCLUSIONS

Minemakers Australia Pty Ltd (Minemakers) is planning to develop the Wonarah Phosphate Project. Stage 1 involves the mining of direct ship ore (DSO) and is subject to a Bankable Feasibility Study (BFS). Groundwater issues for the BFS relate to estimation of the water demand, identification of a suitable water supply, assessment of the security of the supply and impacts from pumping, assessment of other mining activities' impacts upon the groundwater environment, characterization of the groundwater environment and groundwater quality, and development of an operating strategy.

A water balance for the Project, including supplies for construction, development and mining estimated a maximum combined demand during the initial construction phase of 15 L/s, rising to 67 L/s at the end of development. The demand during mining is predicted to be between 32 and 60 L/s, varying seasonally with evaporation rates. The largest water users are road construction (construction phase) and dust suppression during development and mining.

An extensive field programme was carried out, including drilling, bore construction, test pumping and groundwater level surveys. Four production bores were installed one near Minemakers' camp, one at Arruwurra and two north of Minemakers' tenements.

The results of the programme included the following:

- Minor groundwater supplies were found within Minemakers' tenements mostly in the vicinity of the Arruwurra deposit.
- Good groundwater supplies were identified north of Minemakers' tenements with maximum bore yields of about 20 L/s.
- Groundwater quality is fresh to brackish with elevated concentrations of iron in the northern bores and silica at Arruwurra and in the northern bores; boron was also high in the camp bore.
- Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated.

A two stage approach was developed to meet the predicted Project water requirement. The first stage involves the development of five modest yielding bores at Arruwurra to meet the initial demands during construction (nominally for three months). During this initial period a further three high yielding production bores will be installed in the area north of Minemakers' tenements. These along with the two existing northern bores will form the northern borefield and provide the long-term supply (second stage) to the Project.

The security of the supply from the two stages was assessed using analytical methods (first stage) and numerical modelling (second stage). The outcomes from the two assessments show:

– Maximum drawdowns of about 18 m in the Arruwurra bores after 3 months pumping at a combined rate of 12.5 L/s.

– Maximum drawdowns of about 14 m at the northern borefield after 10 year groundwater production (equivalent to the current life of mine), using expected hydraulic parameter values and a combined pumping rate of 75 L/s.

- Maximum drawdowns of about 17 m at the northern borefield after 10 years using likely worst case values for hydraulic parameters and a combined pumping rate of 75 L/s.

These outcomes indicate a suitable water supply can be provided during construction, development and mining.

The numerical modelling was also used to estimate long-term impacts from pumping upon groundwater levels near environmentally sensitive areas and upon third party groundwater users.

Two sensitive sites were identified in the vicinity of the northern borefield, which comprised marshes located at distances of about 10 and 37 km. Maximum predicted drawdowns in the water table at the closest marsh range from 1.5 m for the expected aquifer conditions to 3 m for the worst case conditions. It is important to note that field investigations at the closest marsh found no connection between it and the underlying groundwater system. It is therefore considered unlikely that any changes in the water table will impact upon the marsh.

The numerical modelling indicated six existing production bores lie within the 5 m drawdown contour and therefore maybe adversely affected by the northern borefield. This risk has been mitigated by a commitment by Minemakers to provide a suitable alternative supply should it be necessary.

The dewatering requirements in the Main Zone and Arruwurra Pits is expected to be negligible, based upon the measured water table depths at the two deposits. Any inflows are likely to be associated with isolated groundwater bodies that can be readily managed with local sumping. There is also the possibility of seepage inflows from stored surface water runoff at Arruwurra following a major storm event. However, seepage estimates using Darcy's equation indicate small inflow rates of 0.2 L/s or less. Again these rates should be readily manageable via inpit sumping.

A risk assessment for the Project has identified a number of groundwater related risks. However, all risks were ranked as Low, apart from the risk of groundwater supply failure and unacceptable impacts upon the environment, which were rated as Moderate. The adequate mitigation of these risks can be achieved through effective control measures, including adequate monitoring, provision of sufficient redundancy in the groundwater supply and installation of additional suitably located bores if required.

The requirement for a suitable operating strategy has been identified which will be presented under a separate cover in a standalone document. A monitoring schedule has been provided that will form part of the strategy.

Estimated costs associated with the groundwater aspects of the Project have been prepared, which comprise:

- installation of additional production and monitoring bores (approximately $350,000);
- test pumping of additional production bores (approximately $44,000); and
- supply of bore pumps and associated infrastructure (approximately $145,000).

Groundwater Resource Management Pty Ltd.

R. Garnham

Robert Garnham **Peter Mayers**

PRINCIPAL HYDROGEOLOGIST **SENIOR HYDROGEOLOGIST**

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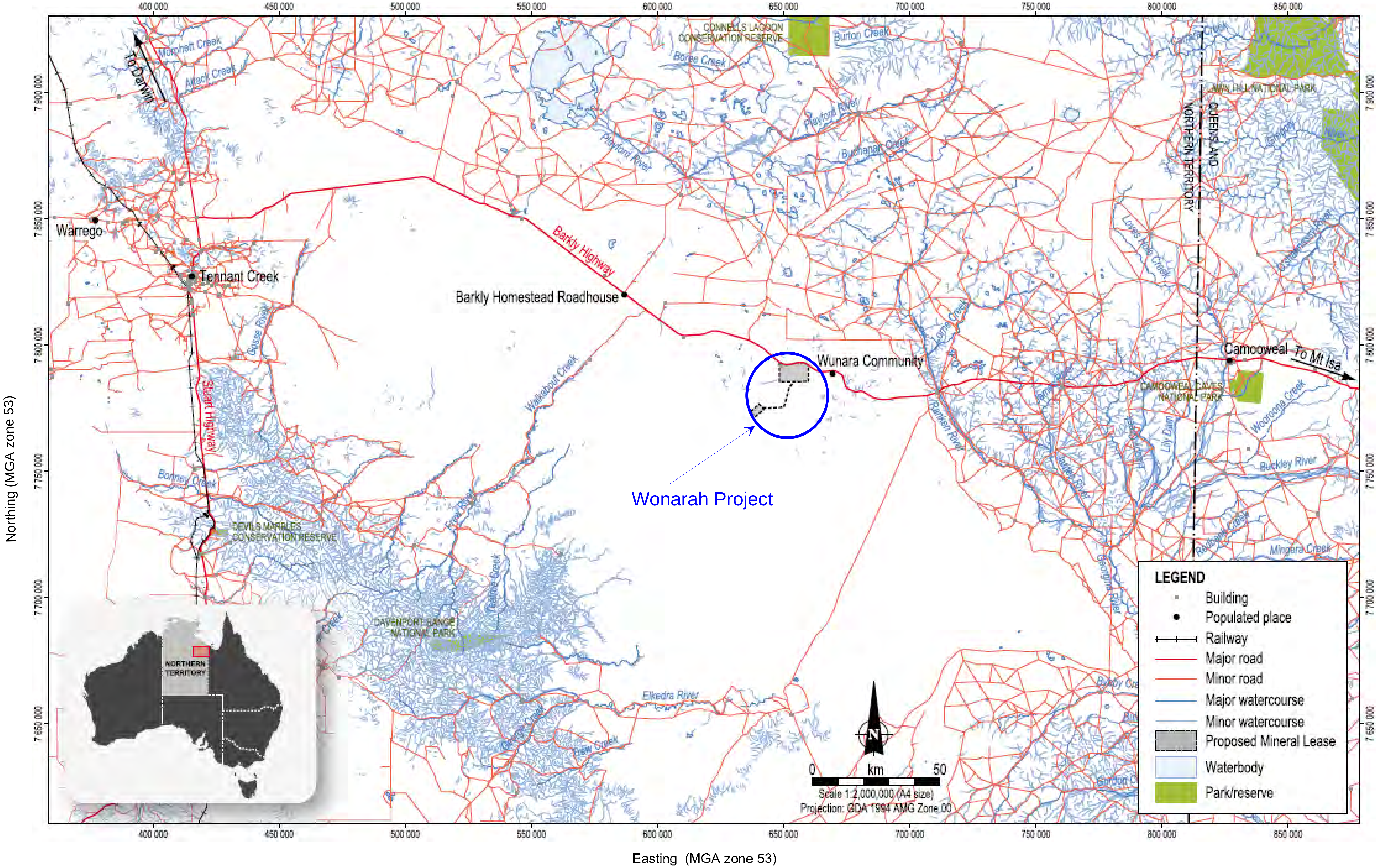

Figure Copied from Notice of Intent For Public Display, March 2009.Report prepared for Minemakers Ltd by Coffey Natural Systems Pty Ltd

Wonarah BFS (J090028)			PROJECT LOCATION PLAN	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
PM	Oct 09	FIGURE 1		

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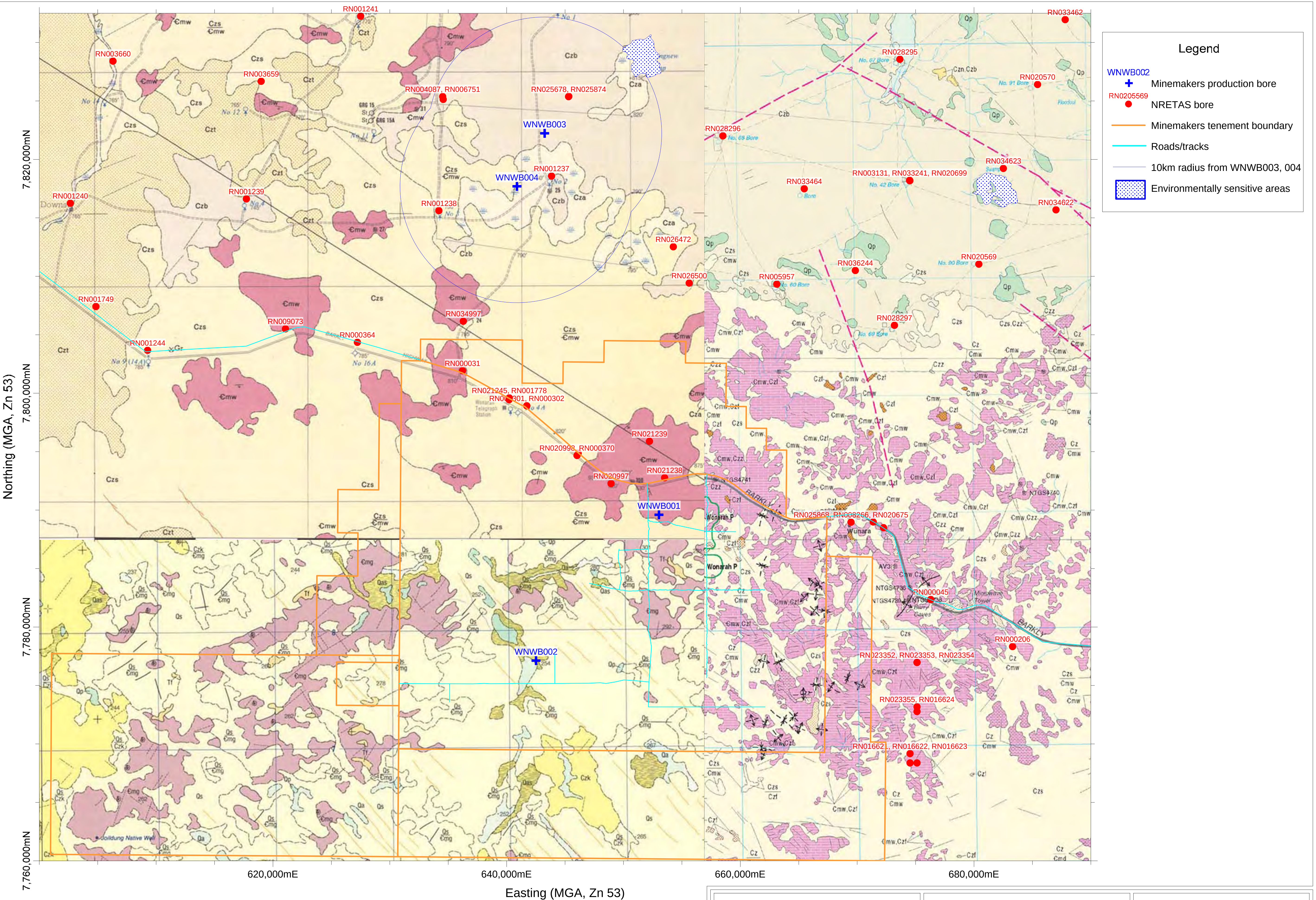

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Wonarah BFS (J00028R01)		NRETAS REGIONAL BORES & ENVIRONMENTALLY SENSITIVE AREAS	GROUNDWATER RESOURCE MANAGEMENT
Minemakers			
RG	Aug 09	FIGURE 2	

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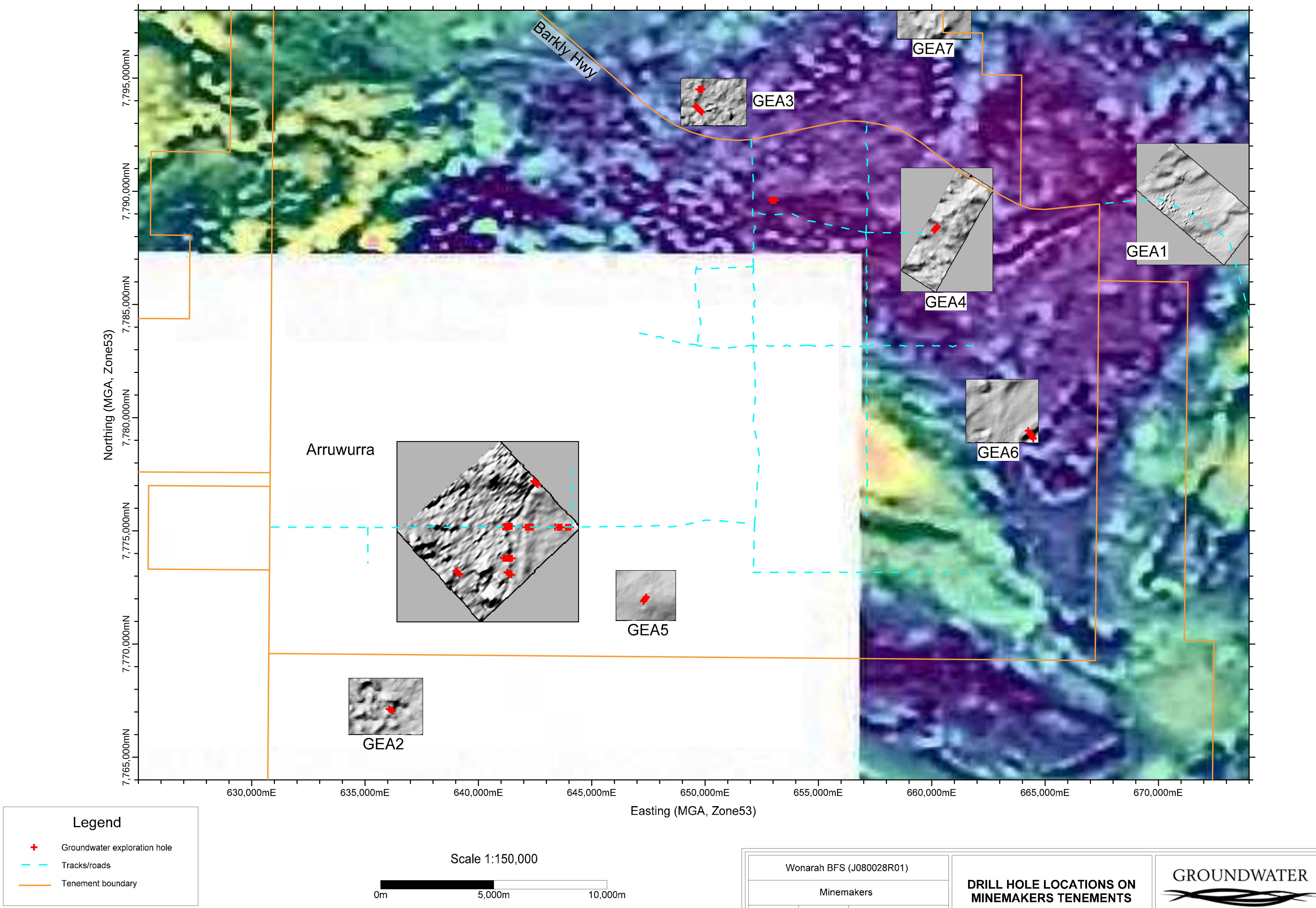
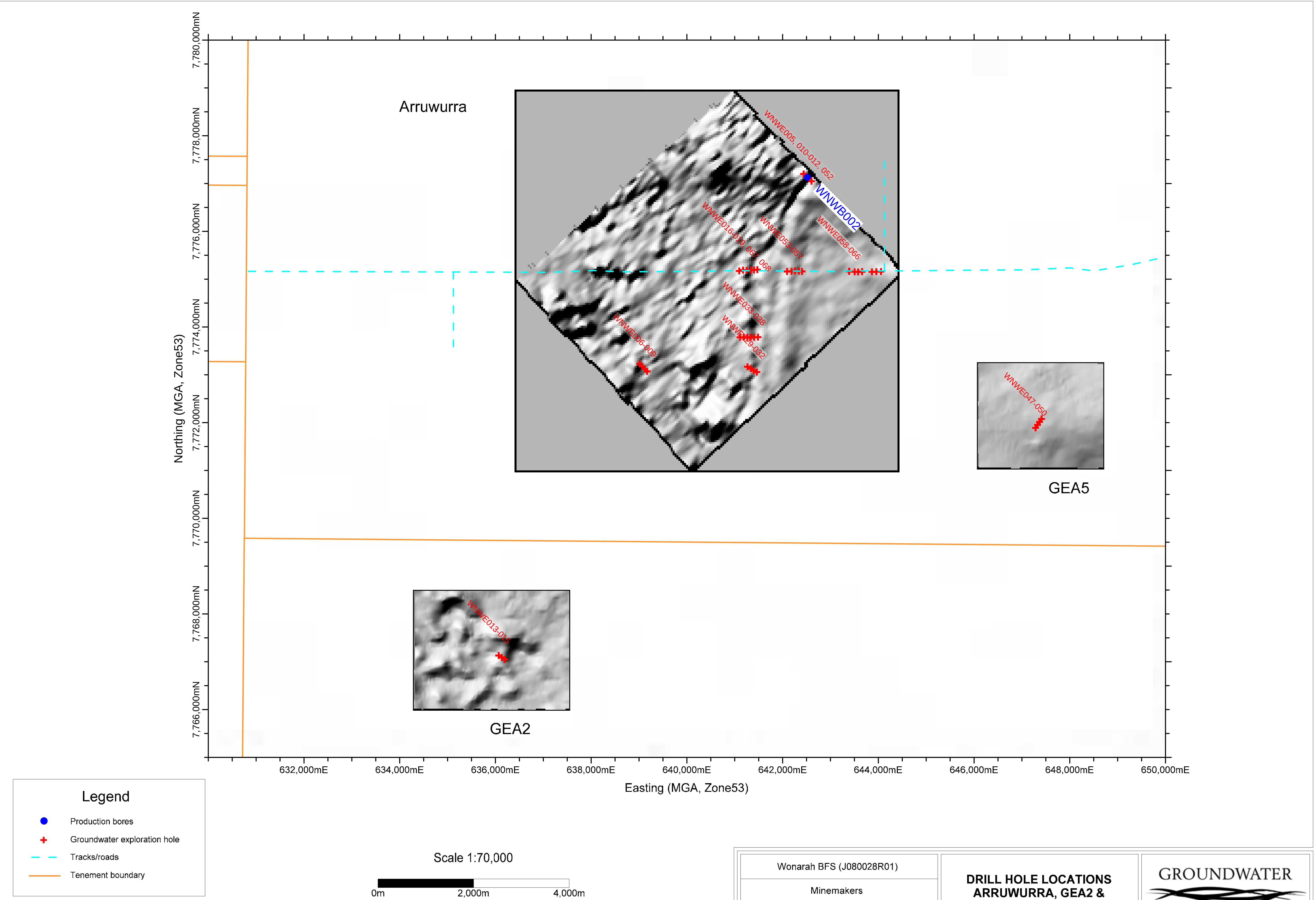


Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 3**

DRILL HOLE LOCATIONS ON MINEMAKERS TENEMENTS

GROUNDWATER RESOURCE MANAGEMENT

J080028/figures/surfer/J080028R01Surfer/HoleLocPlan.srf



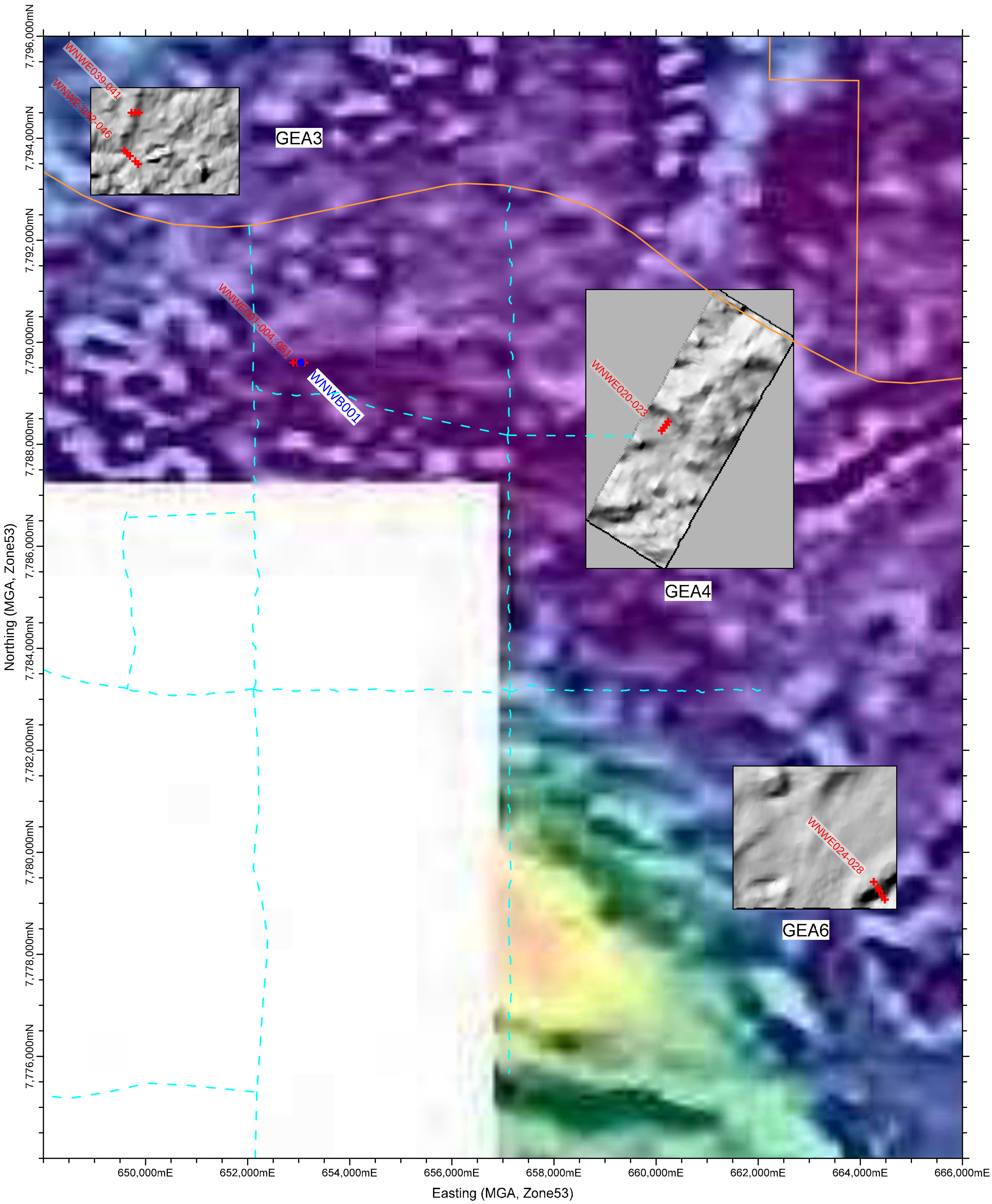
Wonarah BFS (J080028R01)	
Minemakers	
RG	Sep 09

FIGURE 4

DRILL HOLE LOCATIONS ARRUWURRA, GEA2 & GEA5

GROUNDWATER RESOURCE MANAGEMENT

J080028/figures/surfer/J080028R01Surfer/HoleLocPlan.srf



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0m 2,000m 4,000m

Legend

- Production bores
- Groundwater exploration hole
- Tracks/roads
- Tenement boundary

Wonarah BFS (J080028R01)			DRILL HOLE LOCATIONS GEA3, 4, 6 AND IN THE CAMP AREA	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
RG	Sep 09	**FIGURE 5**		

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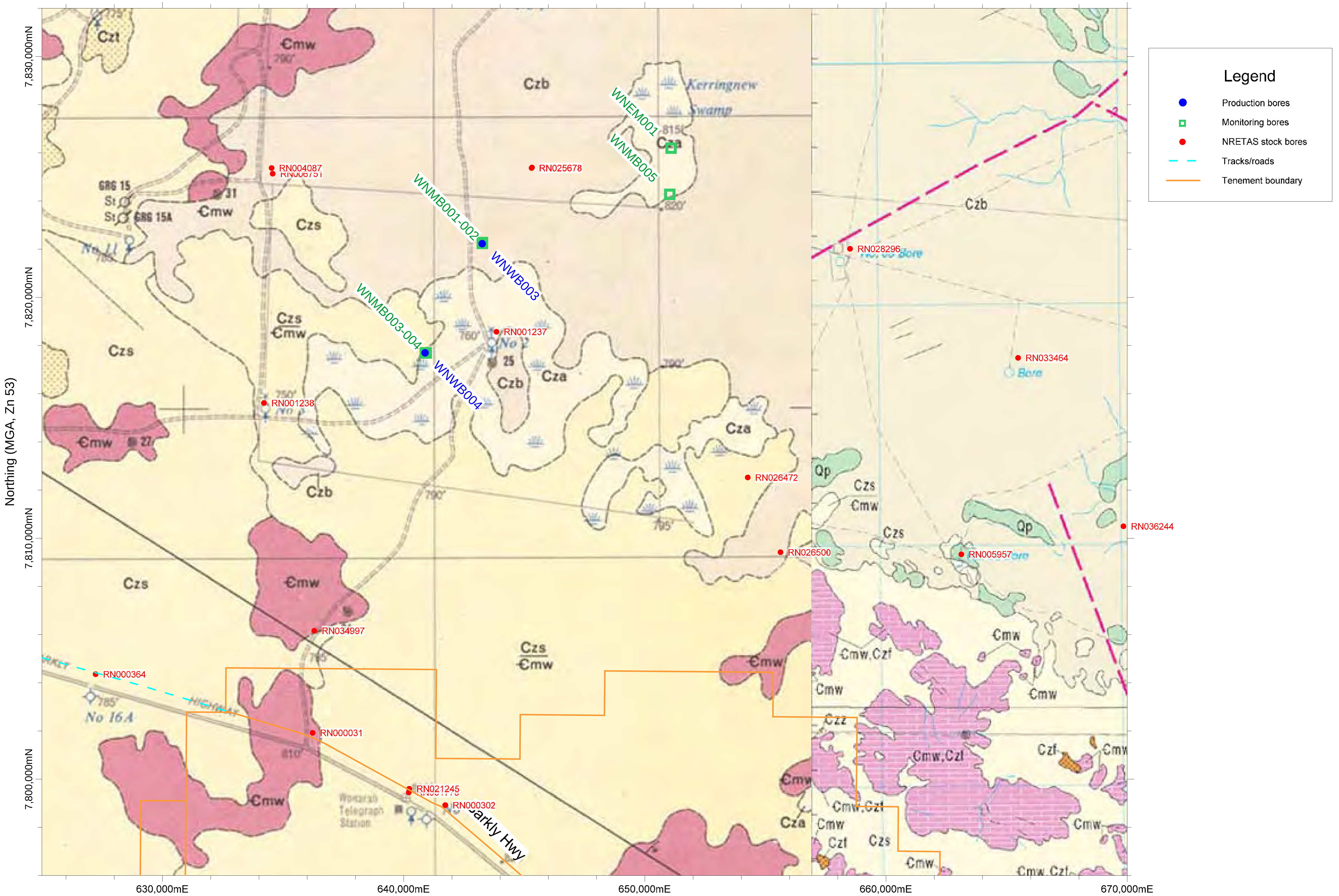

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Wonarah BFS (J080028R01)	TEST PRODUCTION BORE LOCATIONS	GROUNDWATER RESOURCE MANAGEMENT
Minemakers		
RG / Sep 09 / FIGURE 6		

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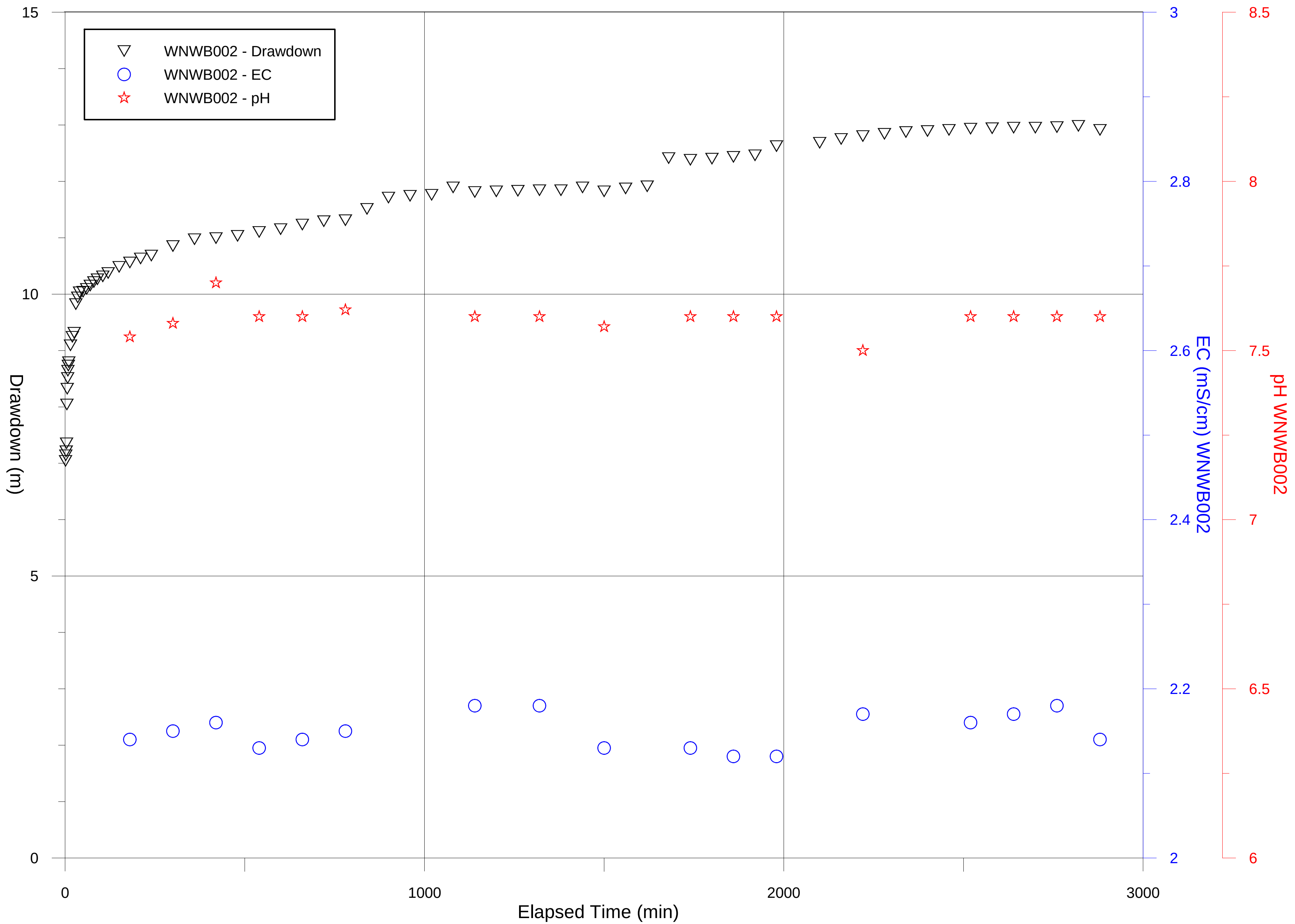

Wonarah BFS (J080028R01)

Minemakers

SMW

Sep 09

FIGURE 7

TEST PUMPING DATA
WNWB002 (2.5L/s)

GROUNDWATER RESOURCE MANAGEMENT

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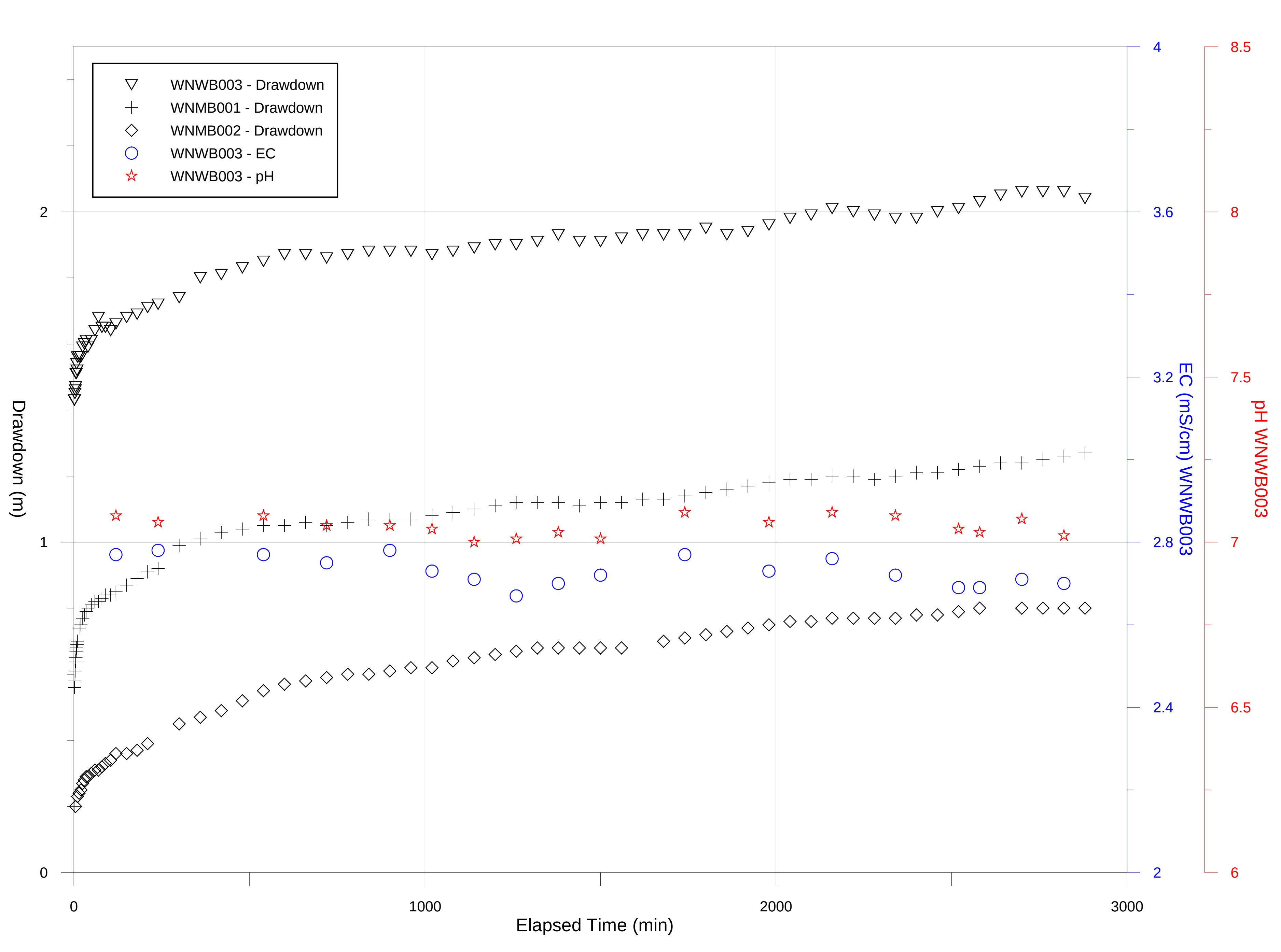

FIGURE 8

TEST PUMPING DATA
WNWB003 (12L/s)

Wonarah BFS (J080028R01)

Minemakers

SMW

Sep 09

GROUNDWATER
RESOURCE MANAGEMENT

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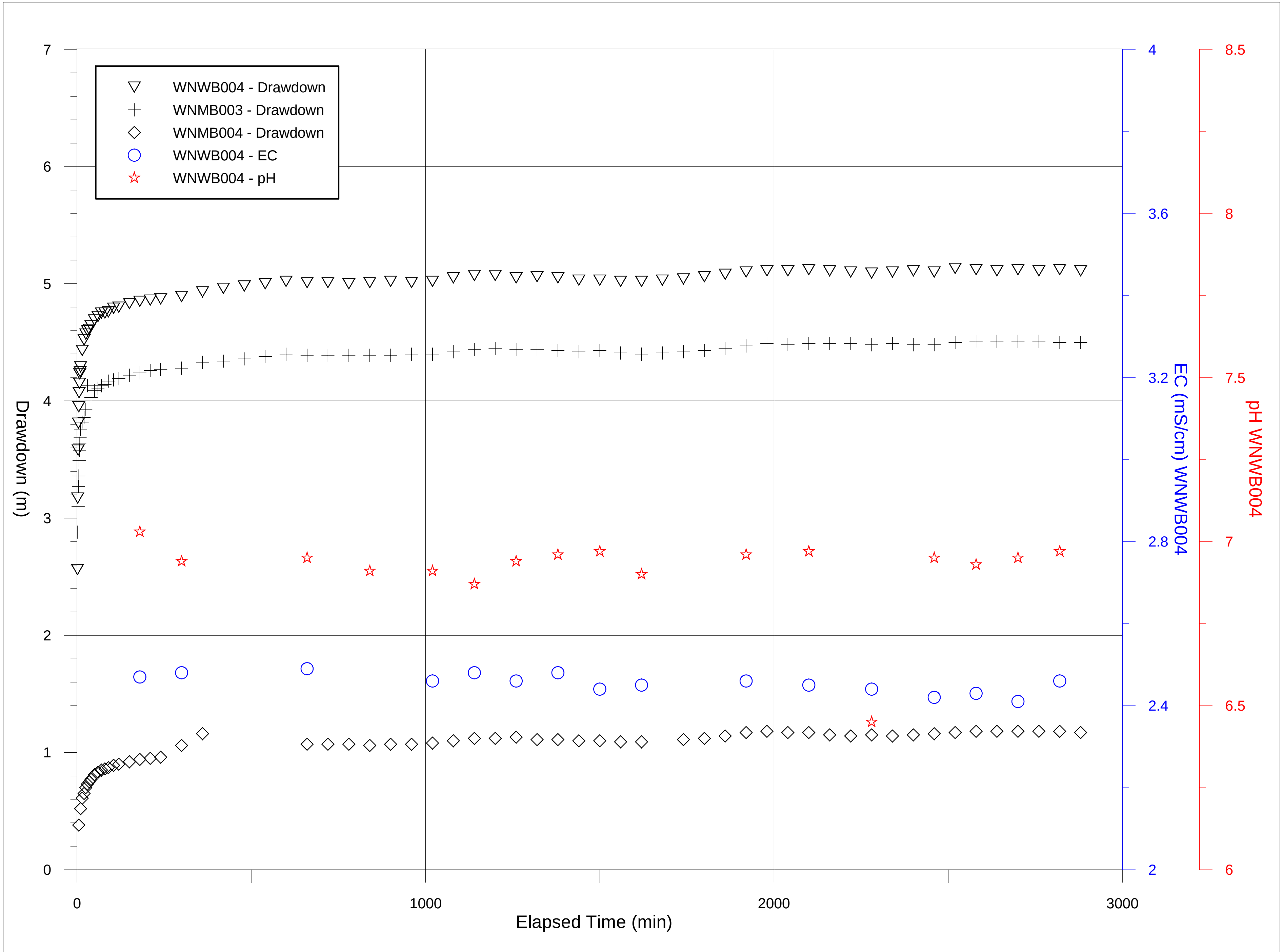

Wonarah BFS (J080028R01)

Minemakers

SMW

Sep 09

FIGURE 9

TEST PUMPING DATA
WNWB004 (12L/s)

GROUNDWATER
RESOURCE MANAGEMENT

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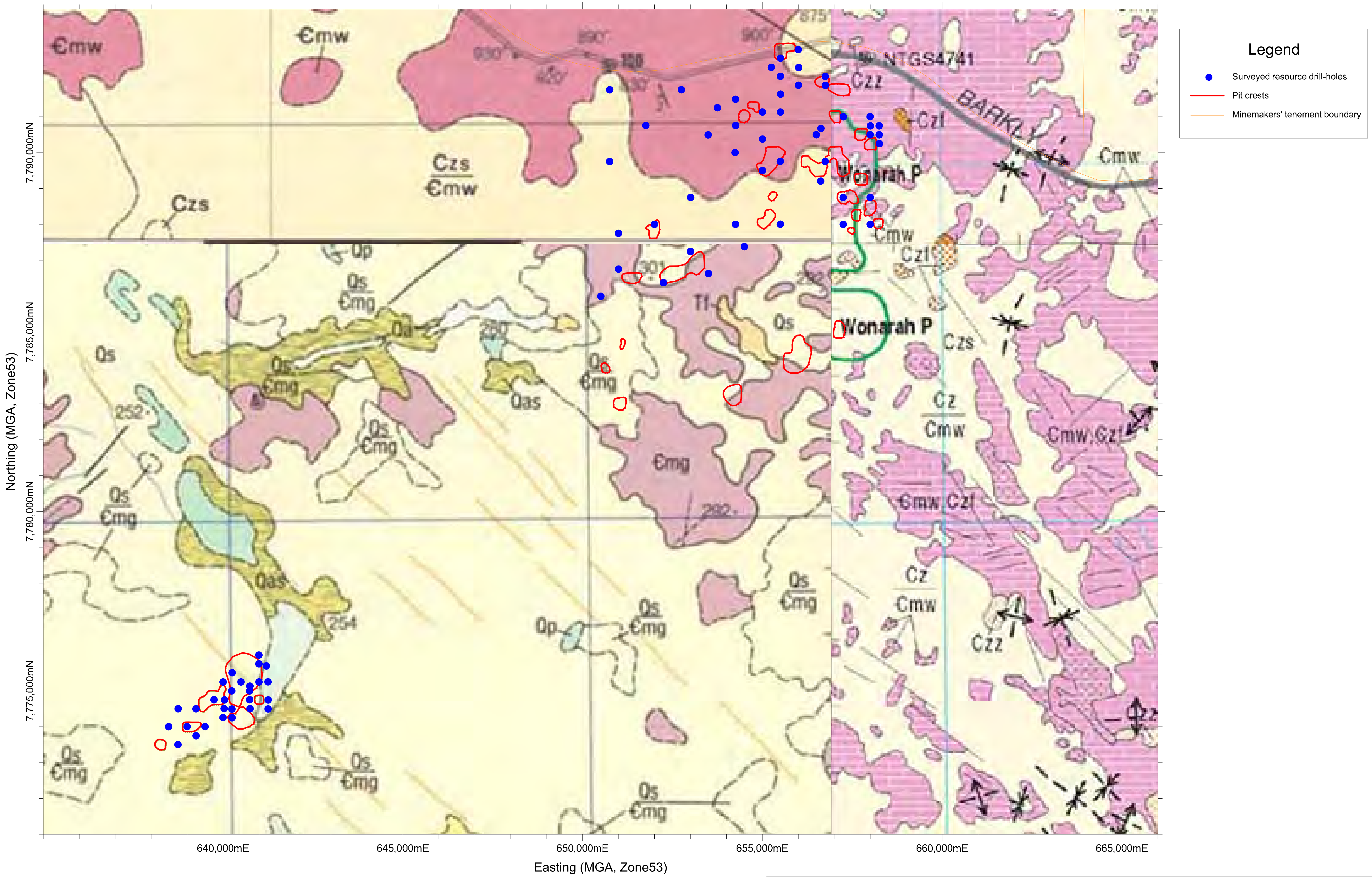

Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 10**

GROUNDWATER LEVEL SURVEY DRILL-HOLES

GROUNDWATER RESOURCE MANAGEMENT

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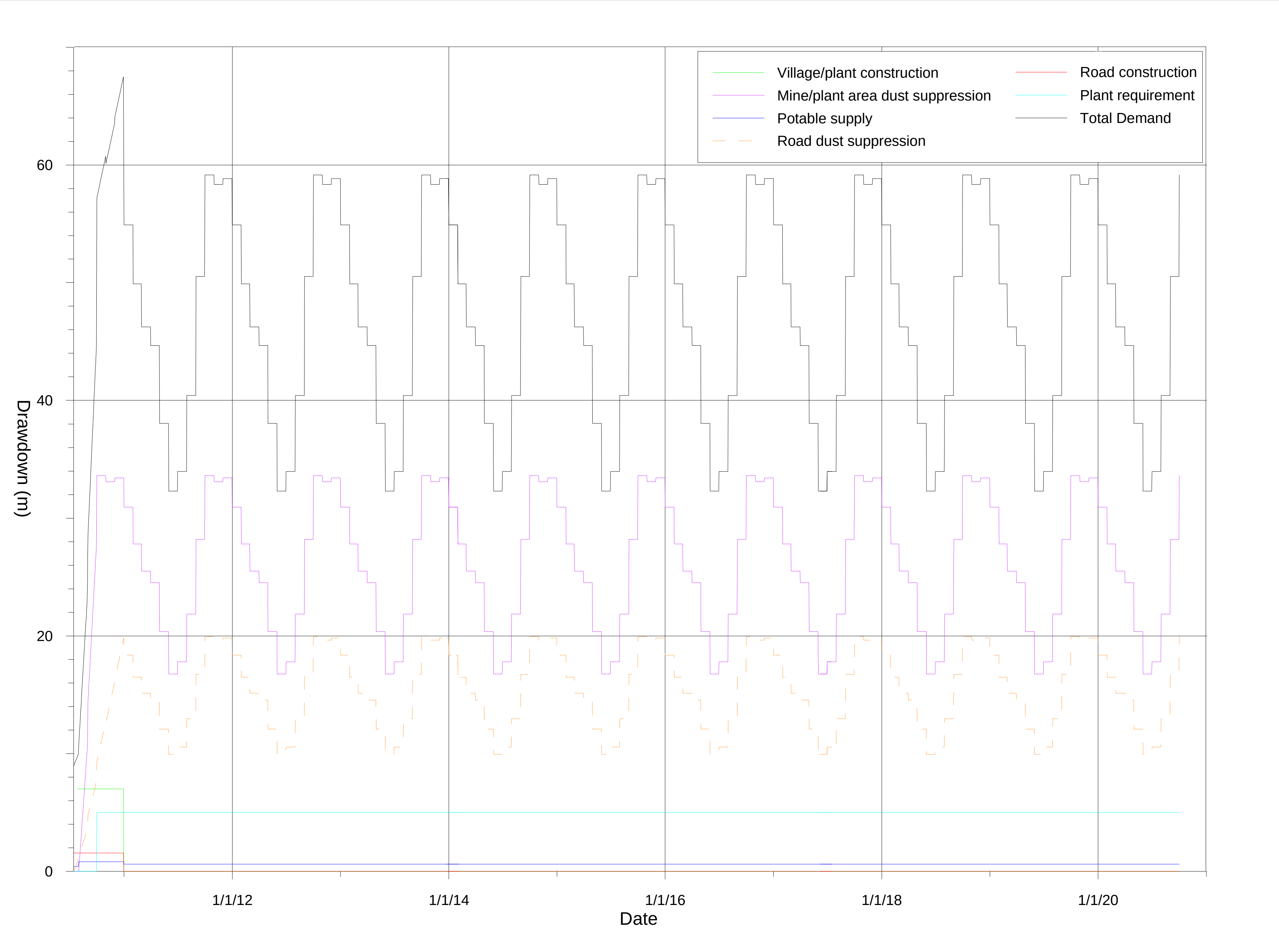

FIGURE 11

WATER BALANCE RESULTS

Wonarah BFS (J080028R01)

Minemakers

RG

Sep 09

GROUNDWATER RESOURCE MANAGEMENT

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Wonarah BFS (J080028R01)

Minemakers

SMW

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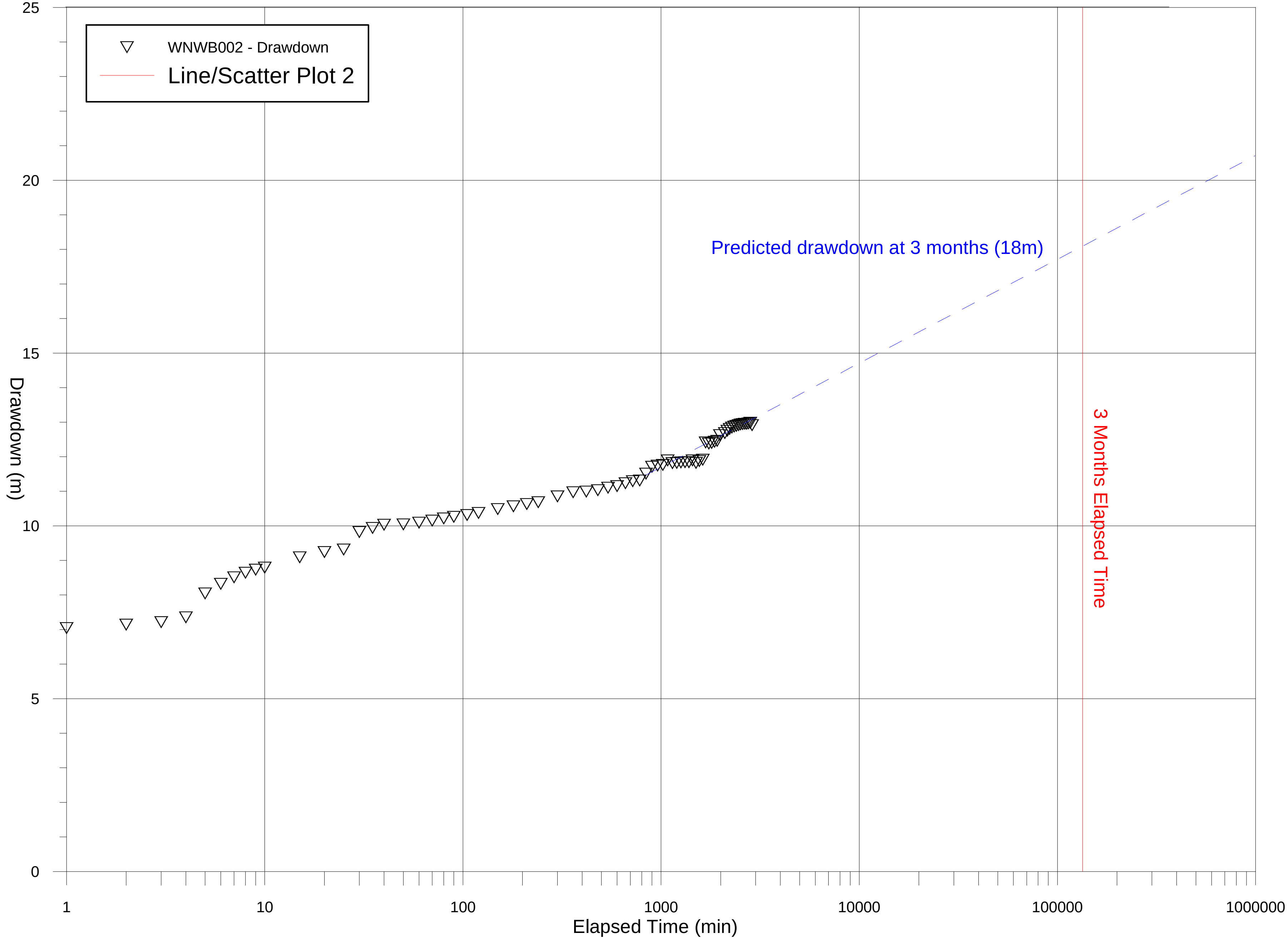
FIGURE 12

PREDICTED DRAWDOWN AFTER 3 MONTHS WNWB002

GROUNDWATER
RESOURCE MANAGEMENT



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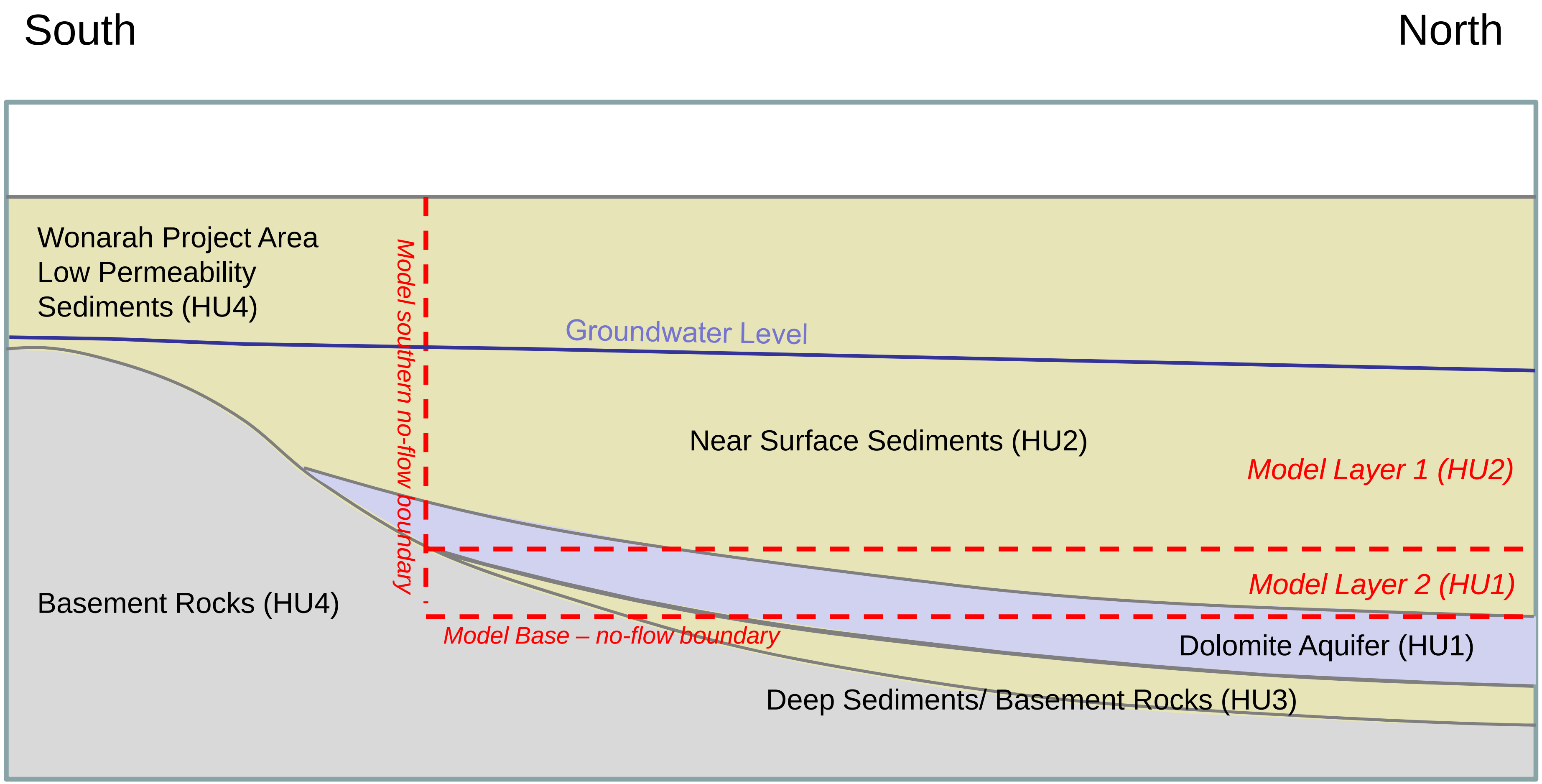

Wonarah BFS (J080028R01)			CONCEPTUAL HYDROGEOLOGICAL MODEL	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
RG	Sep 09	**FIGURE 13**		

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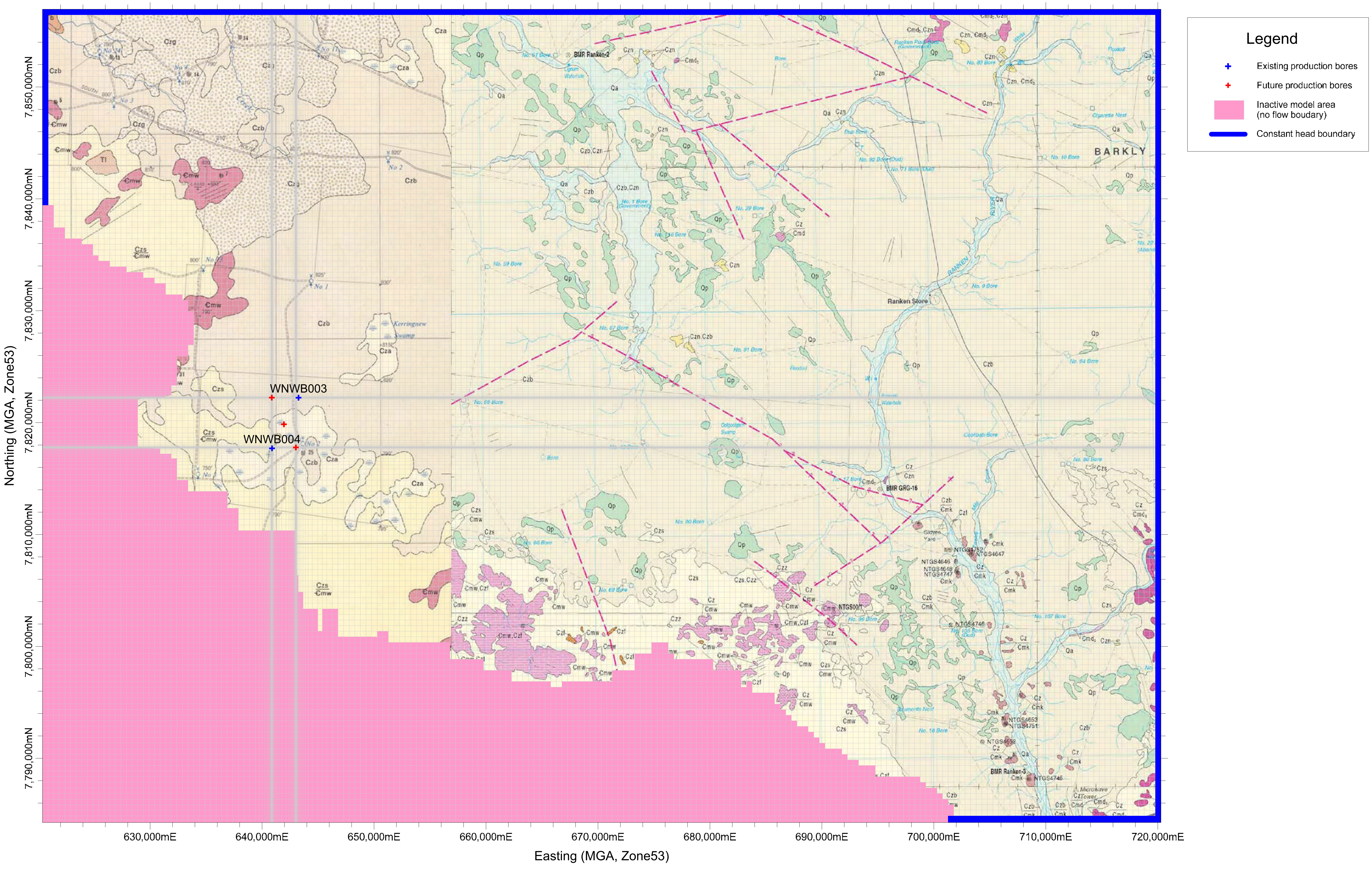

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Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 14**

NUMERICAL MODEL SET-UP

GROUNDWATER RESOURCE MANAGEMENT

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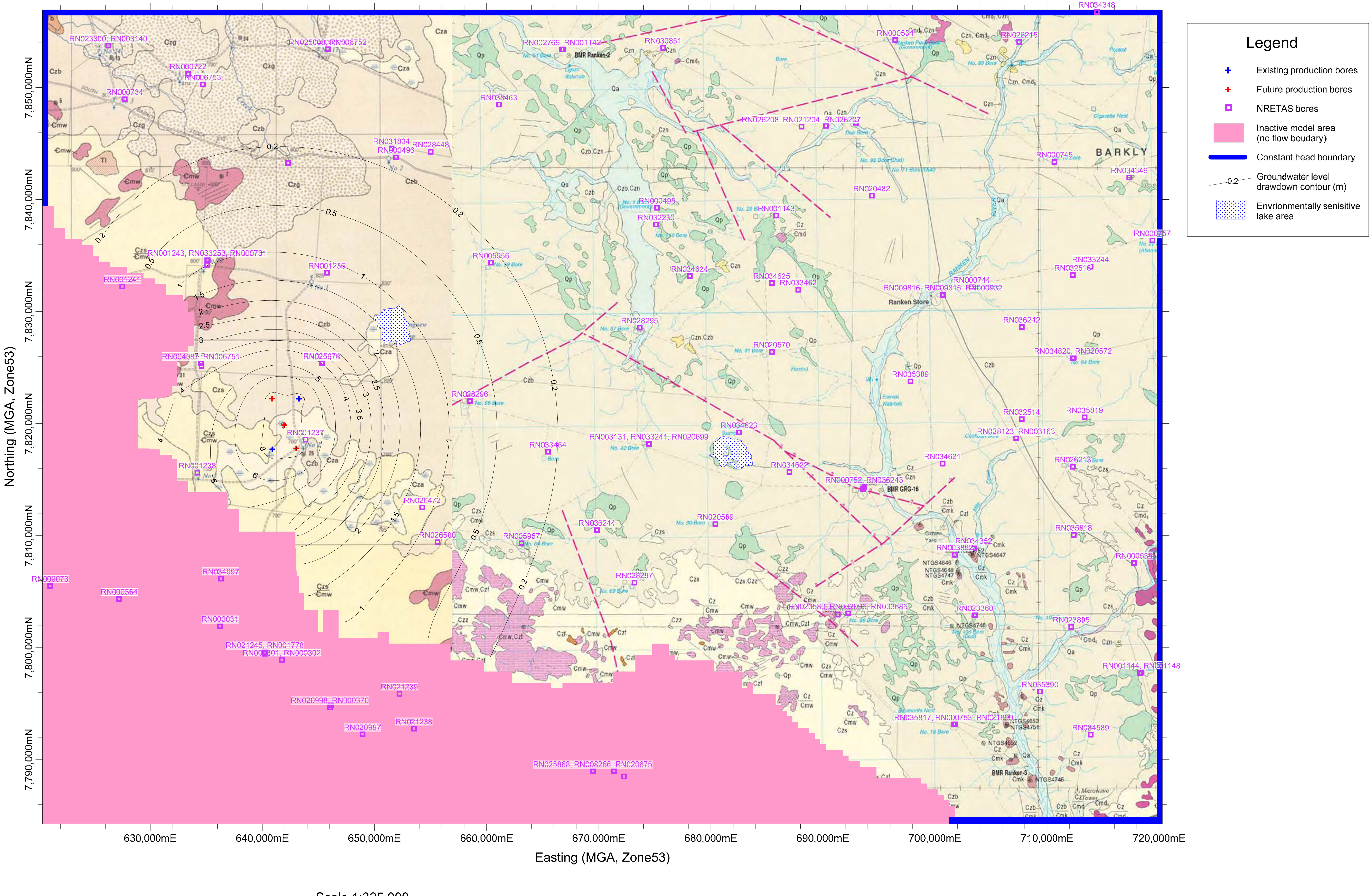

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Wonarah BFS (J080028R01)			BASE CASE GROUNDWATER LEVEL DRAWDOWN AFTER 10 YEARS LAYER 1	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
RG	Sep 09	FIGURE 15		

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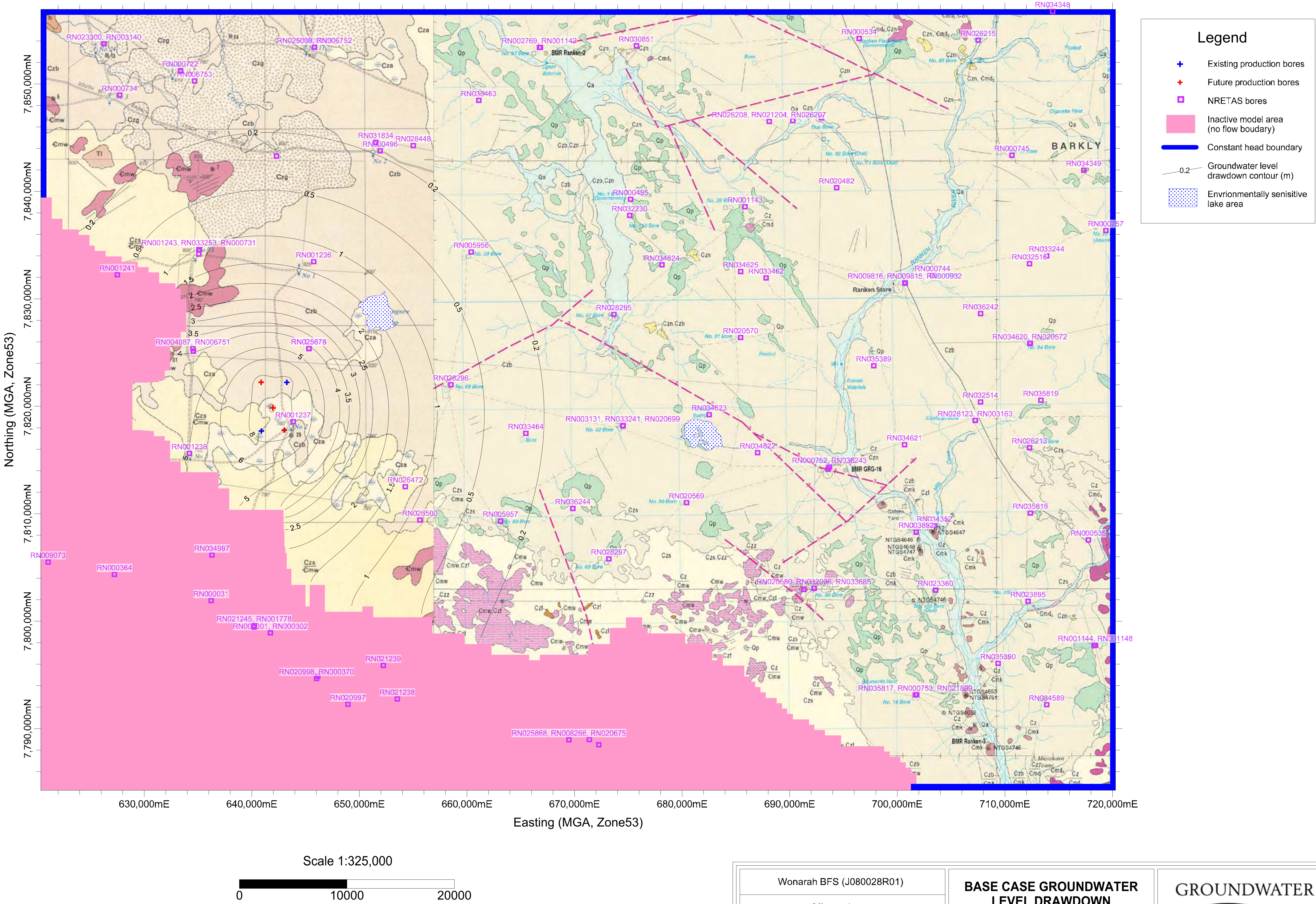
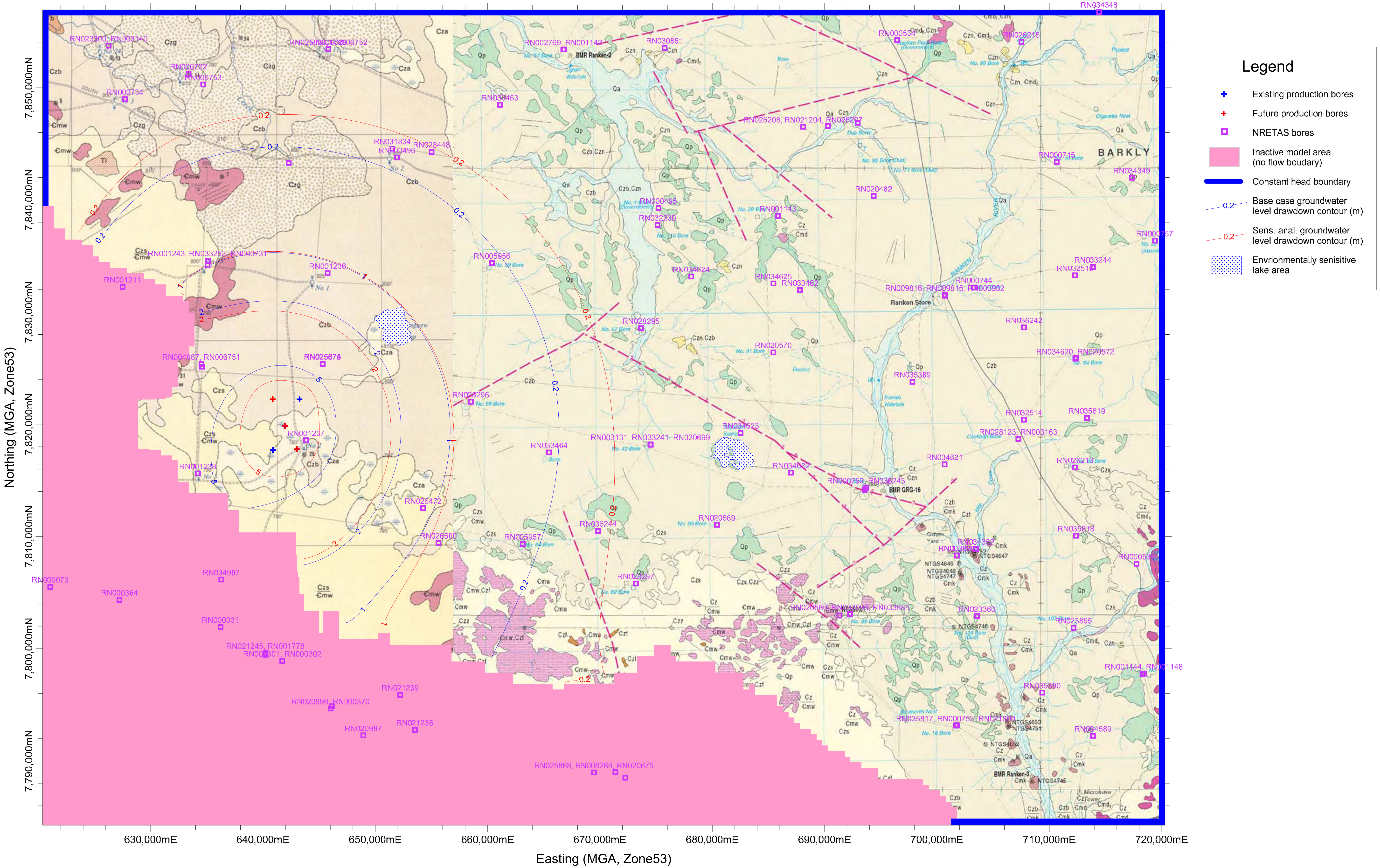


Wonarah BFS (J080028R01)			BASE CASE GROUNDWATER LEVEL DRAWDOWN AFTER 10 YEARS LAYER 2	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
RG	Sep 09	**FIGURE 16**		

J080028/figures/surfer/J080028R01Surfer/BaseCaseDrawdownL2.srf



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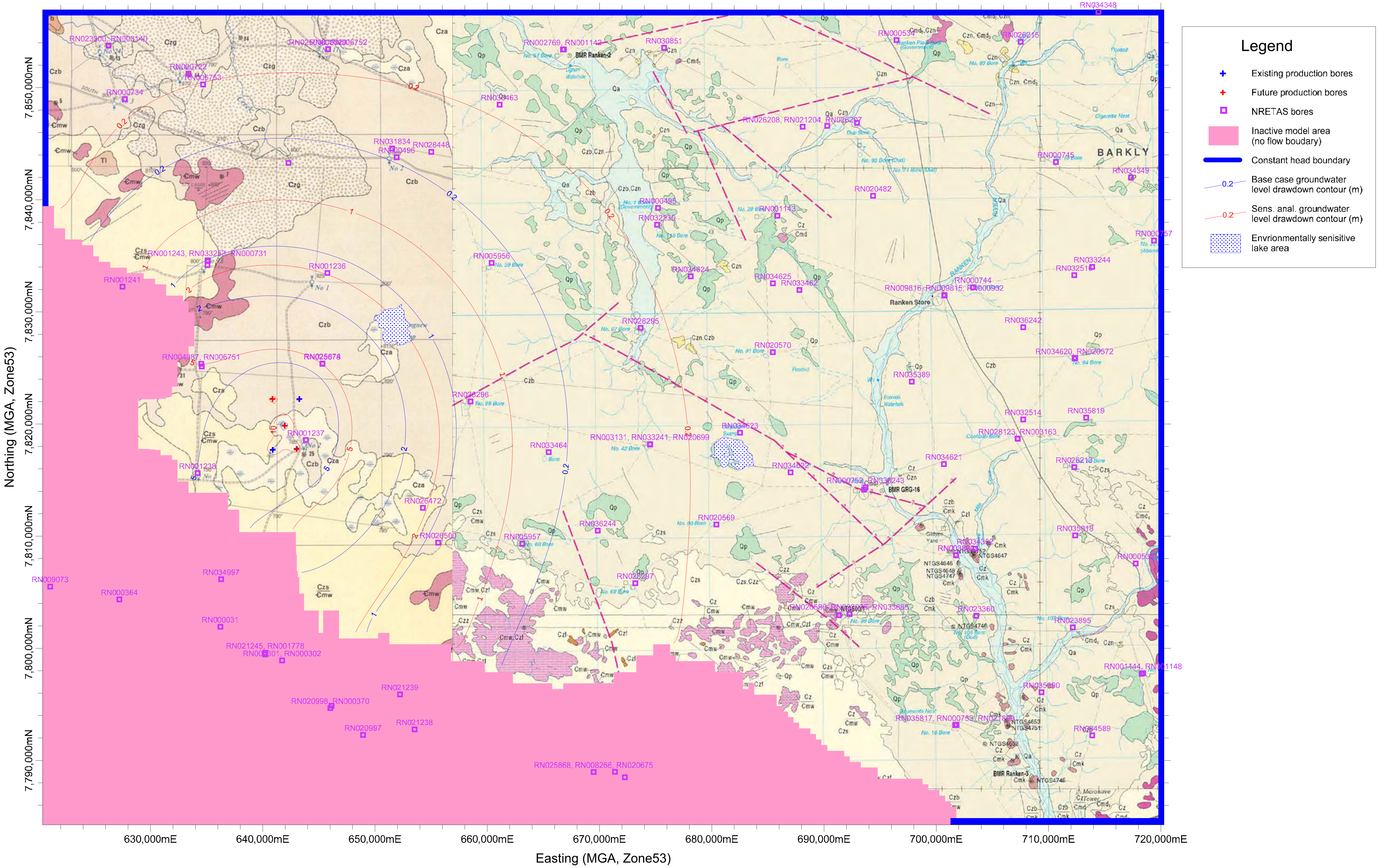
Wonarah BFS (J080028R01)			BASE CASE & SENSITIVITY RUN 1 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 1	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
RG	Sep 09	**FIGURE 17**		

J080028/figures/surfer/J080028R01Surfer/SR1DrawdownL1Comparison.srf



Scale 1:325,000

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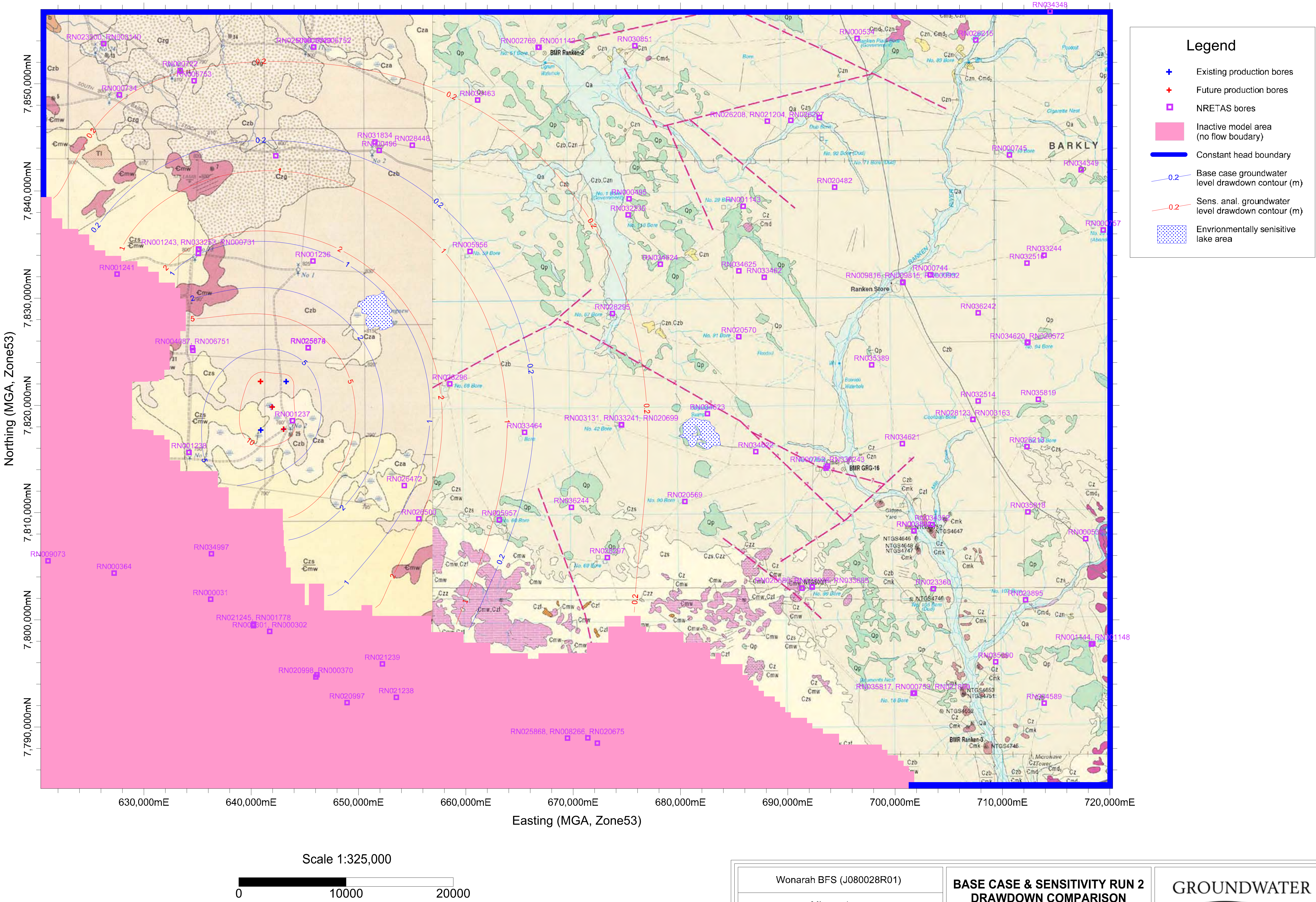
Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 18**

BASE CASE & SENSITIVITY RUN 1 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 2

GROUNDWATER RESOURCE MANAGEMENT

J080028/figures/surfer/J080028R01Surfer/SR1DrawdownL2Comparison.srf



Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 19**

BASE CASE & SENSITIVITY RUN 2 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 1

GROUNDWATER RESOURCE MANAGEMENT

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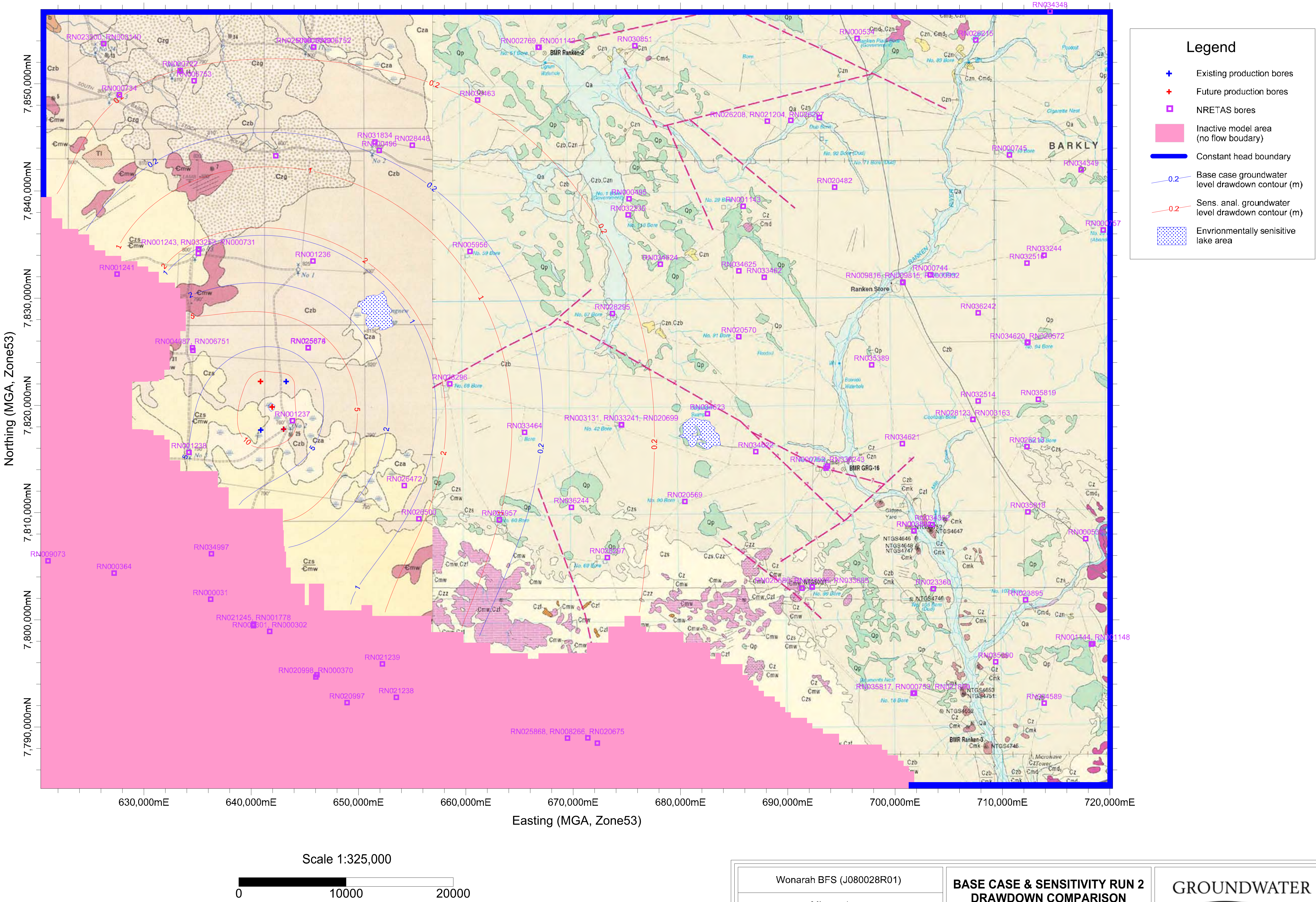
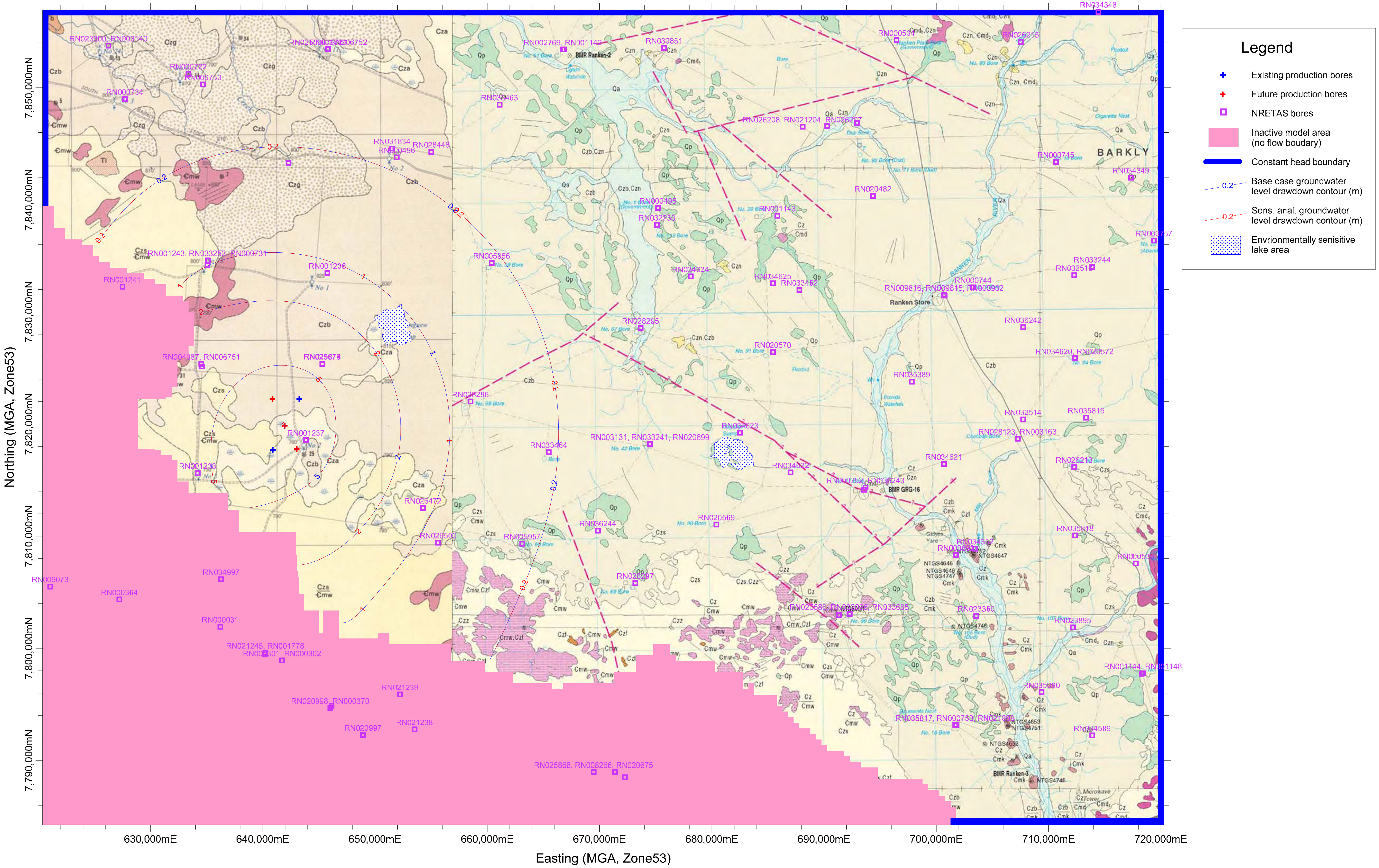


Wonarah BFS (J080028R01)		BASE CASE & SENSITIVITY RUN 2 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 2	GROUNDWATER RESOURCE MANAGEMENT
Minemakers			
RG	Sep 09	FIGURE 20	

J080028/figures/surfer/J080028R01Surfer/SR2DrawdownL2Comparison.srf



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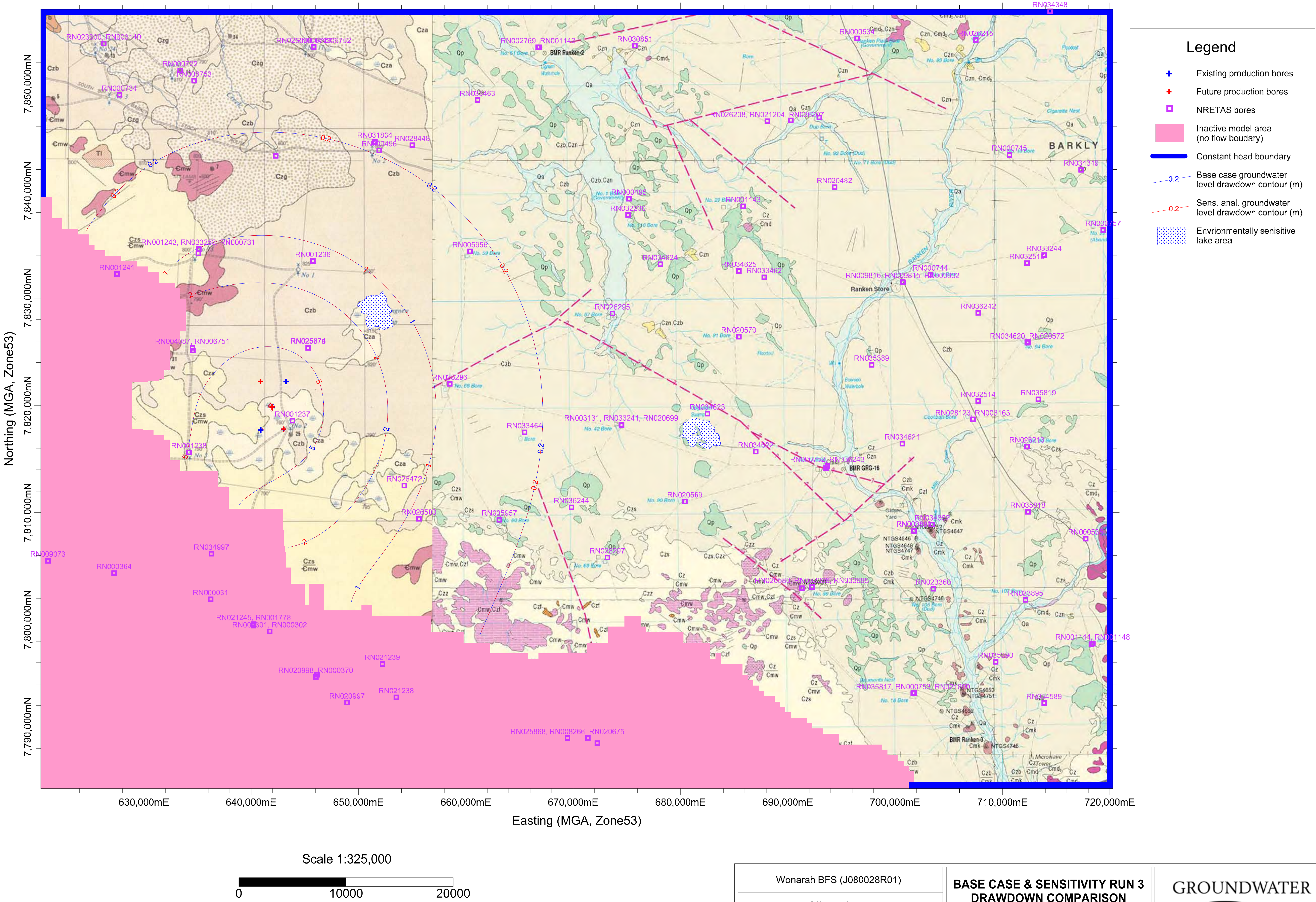
Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 21**

BASE CASE & SENSITIVITY RUN 3 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 1

GROUNDWATER RESOURCE MANAGEMENT

J080028/figures/surfer/J080028R01Surfer/SR3DrawdownL1Comparison.srf

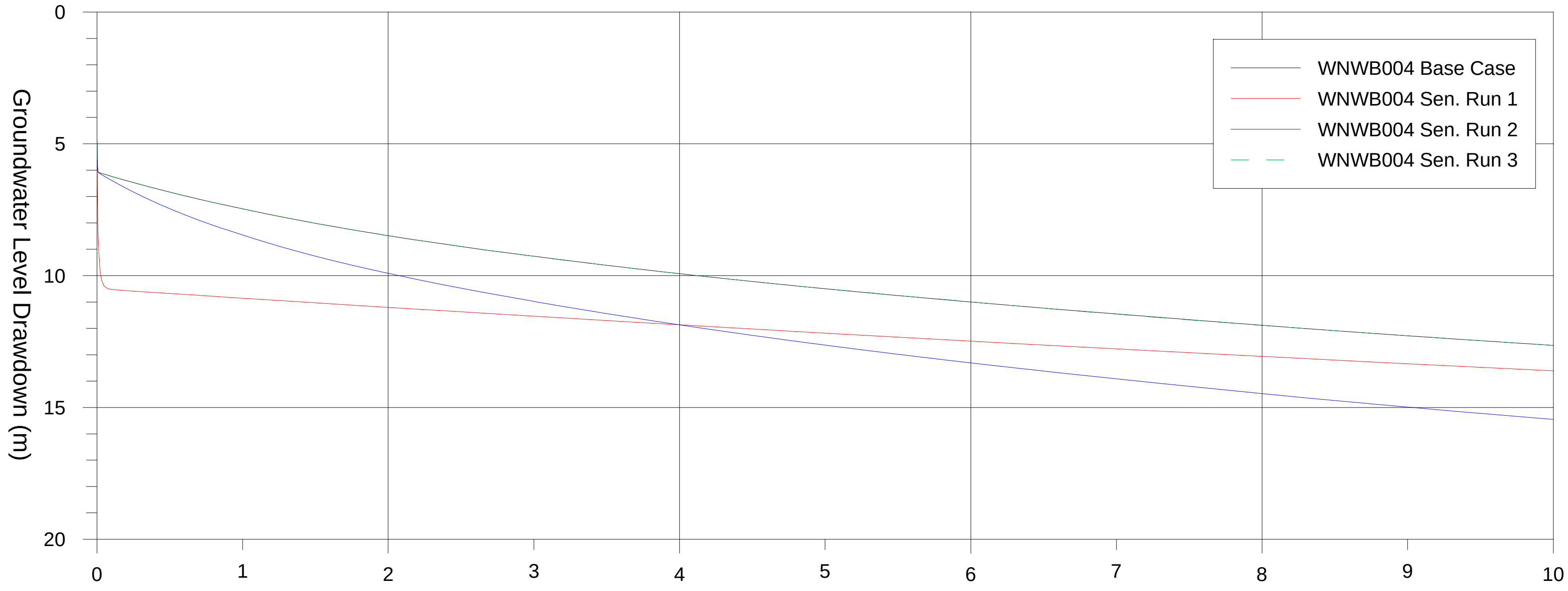


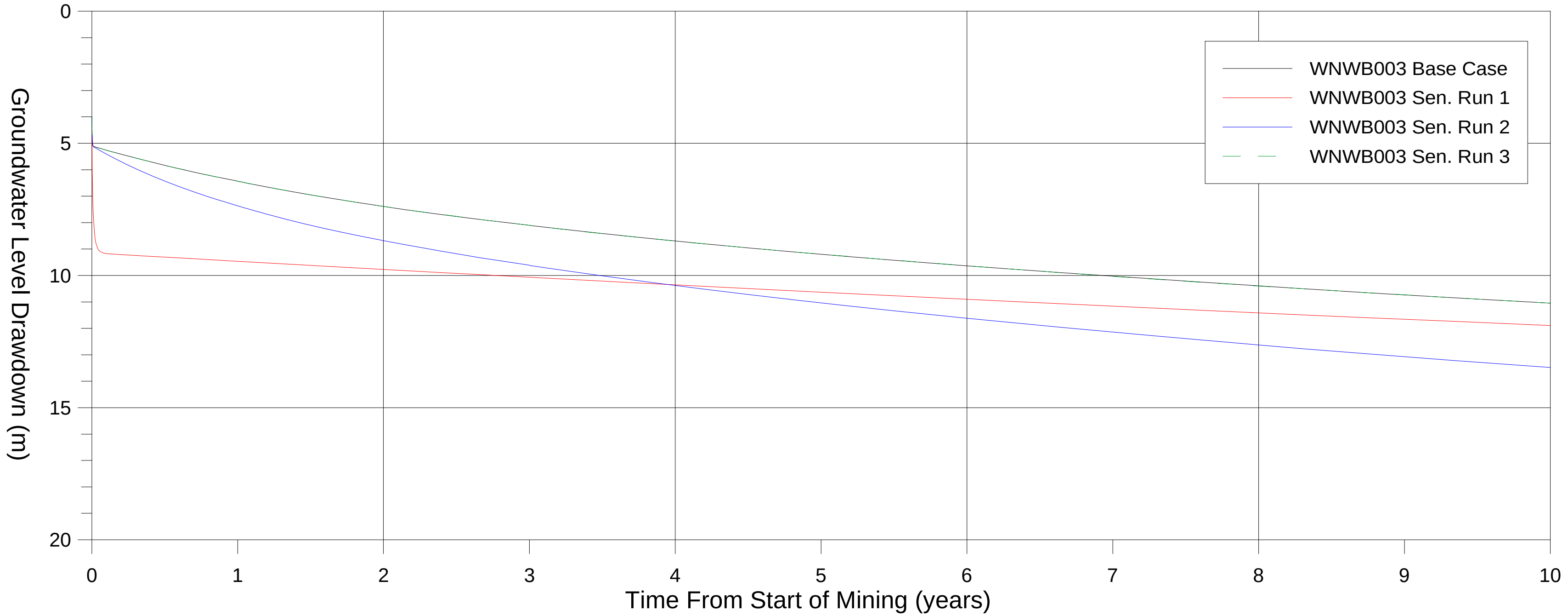
Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 22**

BASE CASE & SENSITIVITY RUN 3 DRAWDOWN COMPARISON AFTER 10 YEARS LAYER 2

GROUNDWATER RESOURCE MANAGEMENT

J080028/figures/surfer/J080028R01Surfer/SR3DrawdownL2Comparison.srf





Wonarah BFS (J090028R01)

Minemakers

RG

Sep 09

FIGURE 23

PREDICTED GROUNDWATER DRAWDOWNS BORES WNWB003 &004

GROUNDWATER
RESOURCE MANAGEMENT

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Wonarah BFS (J090028R01)

Minemakers

RG

Sep 09

FIGURE 24

PREDICTED GROUNDWATER DRAWDOWNS BORES WNWB005 &006

GROUNDWATER RESOURCE MANAGEMENT

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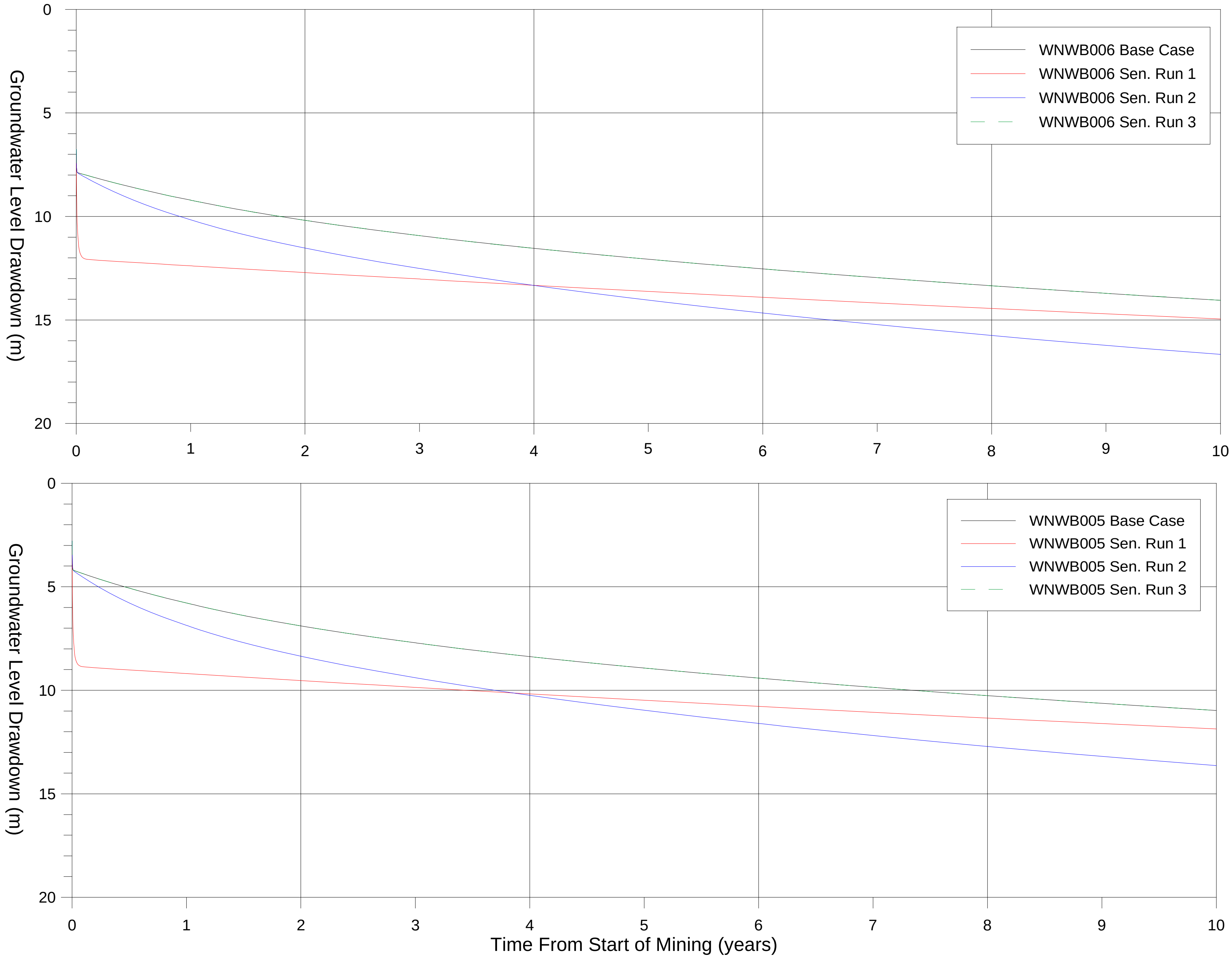
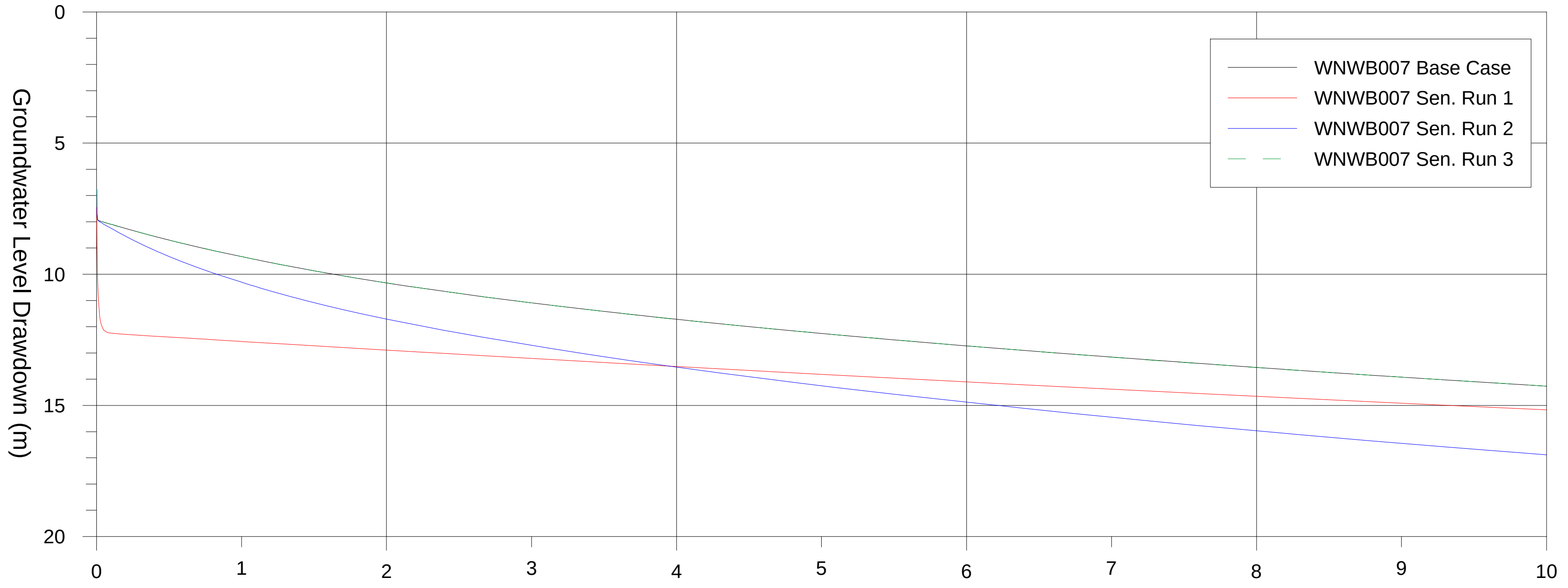




Wonarah BFS (J090028R01)

Minemakers

RG

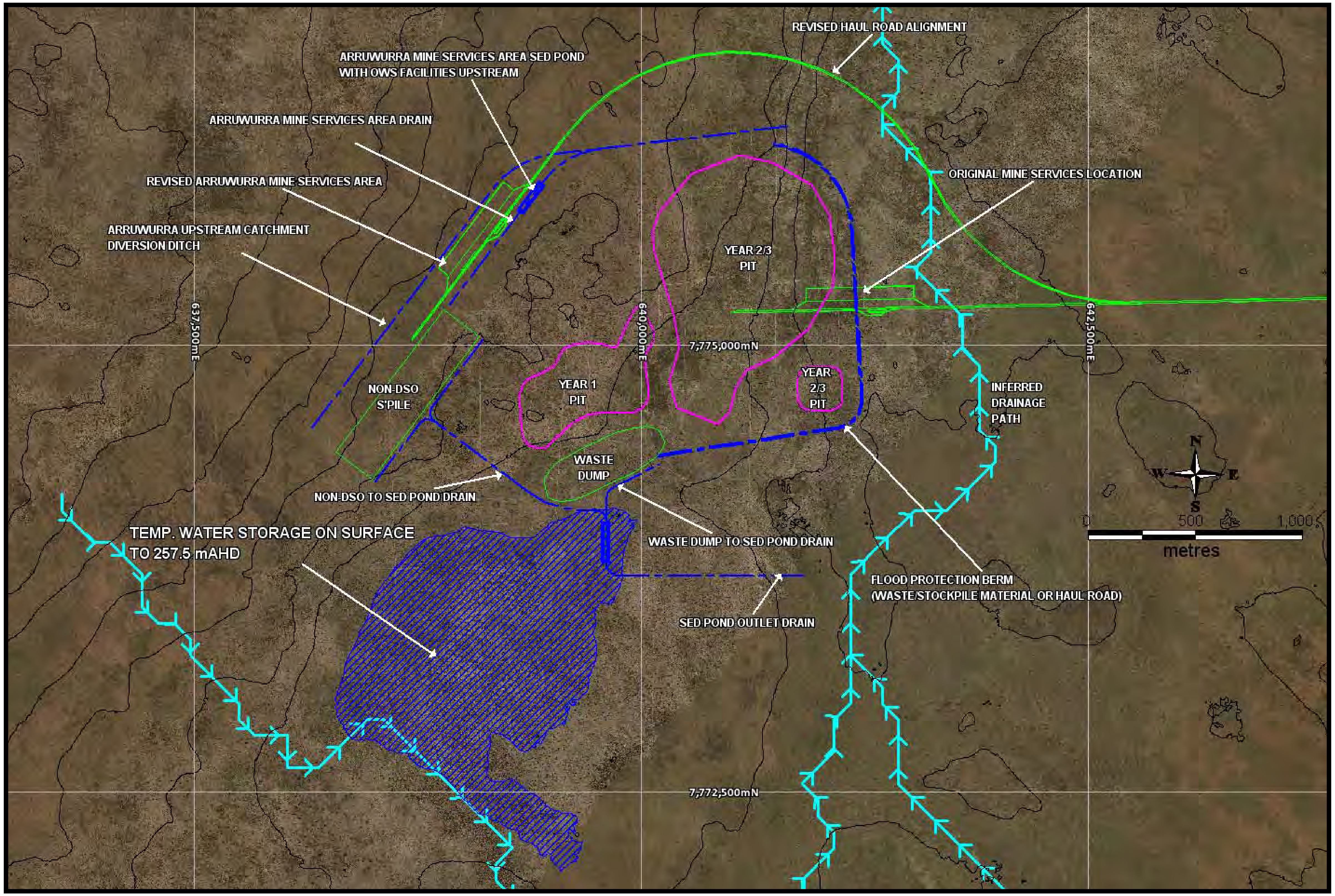
Sep 09

FIGURE 25

PREDICTED GROUNDWATER DRAWDOWNS BORE WNWB007

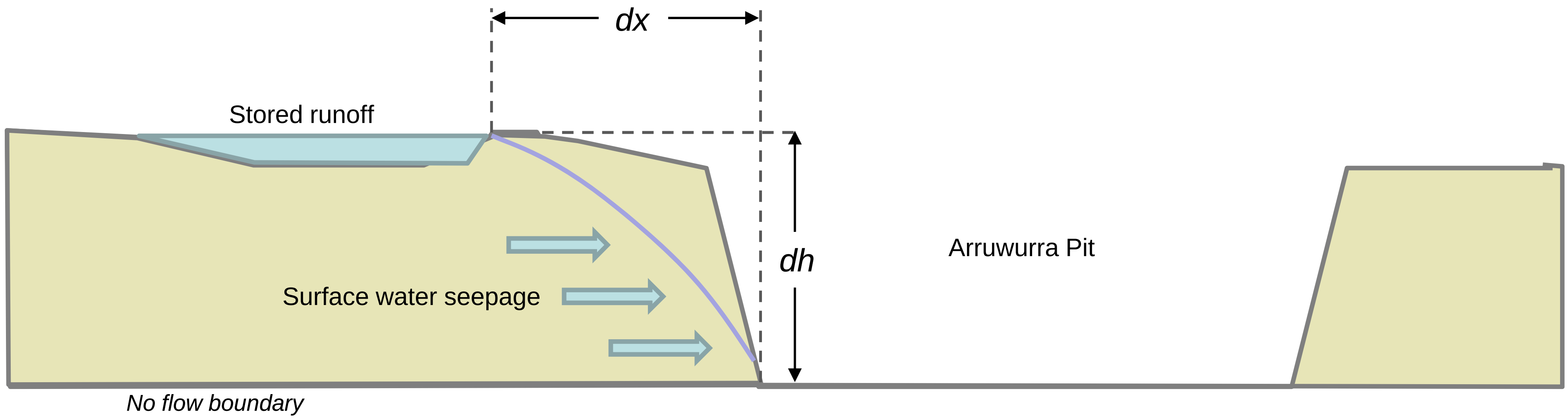
GROUNDWATER RESOURCE MANAGEMENT

\\Toaster\grm\Jobs2008\J080028_Wonarah\figures\grapher\ModelHydrograph3.grf



Notes:
1. Base Mapping provided by Minemakers Australia (GDA'94 Zone 53).
2. Drawing not to scale (2.5 km grid shown).
3. Contour interval is 2.5 m.

Wonarah BFS (J080028R01)			ARRUWURRA FLOOD PROTECTION AND IMPOUNDED AREA	GROUNDWATER RESOURCE MANAGEMENT
Minemakers				
ARL	Oct 09	**FIGURE 26**		



Wonarah BFS (J080028R01)		
Minemakers		
RG	Sep 09	**FIGURE 27**

CONCEPTUAL SEEPAGE MODEL ARRUWURRA PIT

GROUNDWATER RESOURCE MANAGEMENT

APPENDIX A

Ministerial Approval to Drill and Construct Production Bores

Our file ref ML
Your file ref 09.061

Minerals and Energy Titles Division
Postal address GPO Box 3000
Darwin NT 0801
Tel 08 8999 5322
Fax 08 8981 7106
titles.info@nt.gov.au

Minemakers Australia Pty Ltd
c/- McColl Exploration & Mining Title Services Pty Ltd
PO Box 2545
PALMERSTON NT 0831

Dear Sir/Madam

I refer to your application dated 9th July 2009 for the Minister's approval pursuant to section 182 of the *Mining Act,* to enter upon;

a) Mining tenement area; and
b) Crown land, for the purpose of sinking five (5) water bores.

I am pleased to advise that pursuant to the powers delegated to me, I authorise entry onto the land as specified in the enclosed Authorisation instrument under section 182(2) of the *Mining Act.*

The Authorisation is granted subject to the *Mining Act*, the Regulations thereunder, the *Mining Management Act* and all other laws of the Northern Territory as applicable.

In considering your application I have taken into account your advice you are consulting with the pastoral landholders in respect of proposed water usage and access.

I also considered an objection by FSL World Holdings Pty Ltd, the details of which you have previously been provided with. While I am satisfied "Minemakers" have made a reasonable attempt to find water of the quantities required within the application for Mineral Lease 27244, I am advised by the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) Water Resources Division that it would be beneficial to construct a number of test bores within the application area and to pump test these bores.

I request you seriously consider this advice.

It would be appreciated if the Department and NRETAS, Water Resources Division receive a copy of the results from the water exploration carried out both on the (5) five bores and within the mineral lease application area.

Yours sincerely

JP WHITFIELD
Principal Registrar
As Delegate of the Minister Primary Industry,
Fisheries and Resources

13 August 2009

NORTHERN TERRITORY OF AUSTRALIA

Mining Act

AUTHORISATION UNDER SECTION 182

I, JEREMY PAUL WHITFIELD, Principal Registrar, as Delegate of the Minister for Primary Industry, Fisheries and Resources pursuant to section 18(2) of the *Mining Act*, authorise Minemakers Australia Pty Ltd its servants and agents, to enter upon a mining tenement area, specifically Exploration Licences 26054 and 26055 in the Barkly Shire locality, held by FSL World Holdings Pty Ltd, and to enter upon Pastoral Lease Land, specifically NT Portion 773 in the Dalmore Downs locality, held by Baldy Bay Pty Ltd as Trustee for the Long Yard Trust and to enter upon Pastoral Lease Land, specifically NT Portion 2 in the Ranken locality, held by The North Australian Pastoral Company Pty Limited for the purpose of sinking five (5) water bores.

Dated 13 August 2009

....

Principal Registrar

APPENDIX B

Graphical Drill and Bore Logs
(Presented digitally on enclosed CD ROM)

APPENDIX C

Test Pumping Analyses
(Presented digitally on enclosed CD ROM)

APPENDIX D

Groundwater Risk Register

RISK REGISTER REV 1.0 (GROUNDWATER ASPECTS)

WONARAH PHOSPHATE FEASIBILITY STUDY REPORT													
PRIMARY RISK ANALYSIS										RESIDUAL RISK ANALYSIS			
Risk No.	**Initiator**	**Primary Risk Description**	**Likelihood**	**Consequence**	**Risk Rank**	**Causes**	**Impact of Risk (if it occurs)**	**Existing and/or Proposed Control Strategies**	**Responsible for Control Strategy**	**Control Effectiveness (Good/Fair/Weak)**	**Likelihood**	**Consequence**	**Residual Rank**
6.0		**Hydrology**											
6.1	RG	Groundwater supply failure	2	3	M	Acquifer not able to supply long term. Over-extraction of bores.	No dust suppression available	Borefield monitoring Install additional bores	MAK	Good	1	3	M
6.2	RG	Unacceptable reduction in groundwater supply quality	2	2	L	Lack of understanding of aquifer. Over-extraction of bores	Local leaseholders lose supply additional bores and pumping required	Borefield monitoring Install additional bores	MAK	Good	1	2	L
6.5	RG	Pit dewatering from groundwater	1	1	L	Water table rises due to flooding event	Production stops until pits pumped out	Install pumping system to cope with identified flood levels. Maintain adequate stockpiles	MAK/AMC	Good	1	2	L
6.6	RG	Pit dewatering infiltrating rainfall	3	1	L	Water flows into pit from ponded surface water outside pit	Production stops until pits pumped out	Install pumping system to cope with identified flood levels. Maintain adequate stockpiles	MAK/AMC	Good	1	2	L
6.7	RG	Unacceptable impacts upon the environment from groundwater production	1	3	M	Extraction of water or use of water causes environmental changes	Local leaseholders lose supply additional bores and pumping required	Borefield monitoring Install additional bores	MAK	Good	1	3	M
6.8	RG	Unacceptable impacts upon third parties from groundwater production	2	1	L	Lack of understanding of aquifer. Over-extraction of bores	Local leaseholders lose supply additional bores and pumping required	Borefield monitoring Install additional bores	MAK	Good	1	1	L

APPENDIX E

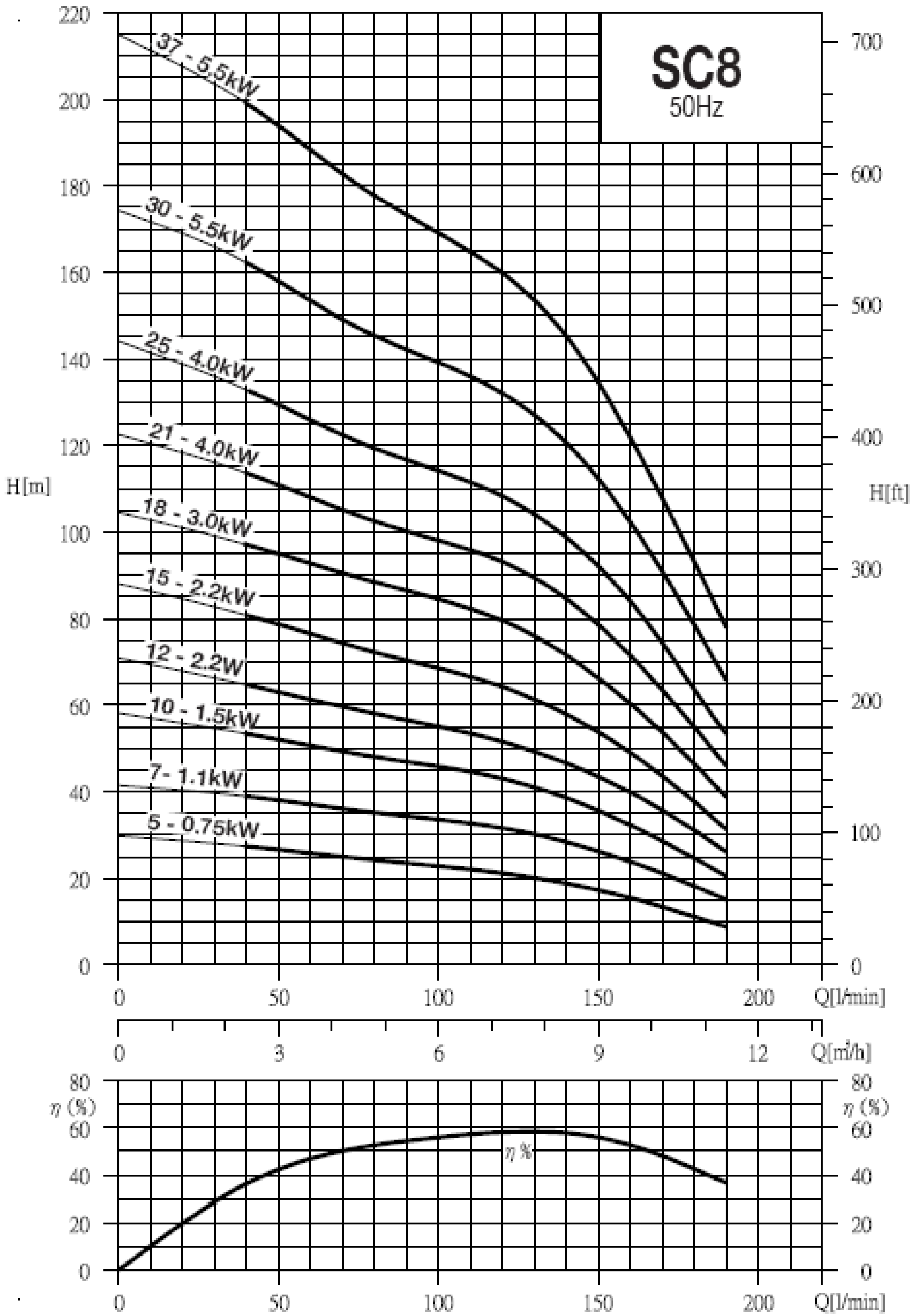
Bore Pump Performance Data

Southern Cross

"SC" Series
4 inch (100mm)
Submersible Borehole Pumps

MODEL
SC8

PERFORMANCE DATA



July 2006

MODEL
SC8

"SC" Series
4 inch (100mm)
Submersible Borehole Pumps

Southern Cross

TECHNICAL DATA

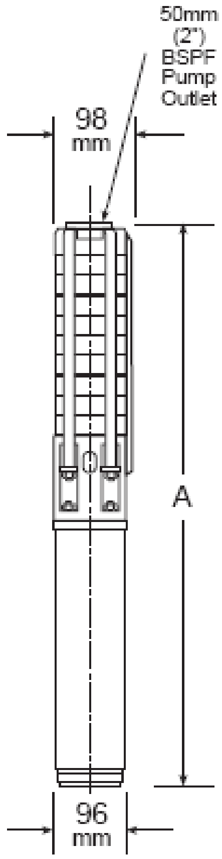
DIMENSIONS & WEIGHTS

Single Phase Units

MODEL	No. of Stages	Motor kW	2 Wire Single Phase Length A mm	2 Wire Single Phase Unit Weight kg	3 Wire Single Phase Length A mm	3 Wire Single Phase Unit Weight kg
With Single Phase *FRANKLIN* Motors						
SC8-05	5	0.75	710	15.2	710	15.2
SC0-07	7	1.10	000	19.4	041	21
SC8-10	10	1.50	–	–	1006	21.8
SC8-12	12	2.20	–	–	1190	26.4
SC8-15	15	2.20		–	1316	27.9
SC8-18	18	3.7	–	–	1674	42.6
With Single Phase *COVERCO* Motors						
SC8-05	5	0.75	–	–	862	15
SC8-07	7	1.10	–	–	986	17.7
SC8-10	10	1.50	–	–	1182	21.4
SC8-12	12	2.20	–	–	1306	26.2
SC8-15	15	2.20	–	–	1432	27.7
SC8-18	18	3.7	–	–	1703	35.8

Three Phase Units

MODEL	No. of Stages	Motor kW	3 Phase *FRANKLIN* Length A mm	3 Phase *FRANKLIN* Unit Weight kg	3 Phase *COVERCO* Length A mm	3 Phase *COVERCO* Unit Weight kg
SC8-05	5	0.75	710	15.2	832	13.7
SC8-07	7	1.10	794	16.2	946	16
SC8-10	10	1.50	967	19.5	1112	19.2
SC8-12	12	2.20	1113	23.7	1266	22.4
SC8-15	15	2.20	1239	25.2	1392	23.9
SC8-18	18	3.0	1522	35.8	1518	26.9
SC8-21	21	4	1711	40	1744	33.7
SC8-25	25	4	1879	42	1912	35.7
SC8-30	30	5.5	2178	48.6	2207	41.8
SC8-37	37	5.5	2468	62.1	2498	45.3



ELECTRICAL DATA

Motor kW	(1Ph) Single Phase Motor Type	(1Ph) Single Phase Full Load Amps	(1Ph) Single Phase Lock Rotor Amps	(1Ph) Single Phase Control Box	(3Ph) Three Phase Full Load Amps	(3Ph) Three Phase Lock Rotor Amps
			FRANKLIN Motors			
0.37	2 wire	4.1	26	Not reqd.	1.1	4.3
0.55	2 wire	6.5	37	Not reqd.	1.5	6.2
0.75	2 wire	7.6	44	Not reqd.	2	8.5
1.1	2 wire	10.8	53	Not reqd.	3	14
0.75	3 wire	7.0	27	Franklin	–	–
1.1	3 wire	8.9	37	Franklin	–	–
1.5	3 wire PSC	10.7	51	Franklin	4	21
2.2	3 wire	15.9	82	Franklin	6	27
3	—	—	—	—	7.3	42
3.7	3 wire	23.4	109	Franklin	9	46
4	–	–	–	–	10.4	59
5.5	–	–	–	–	13	70
7.5	–	–	–	–	18.7	99

ELECTRICAL DATA

Motor kW	(1Ph) Single Phase Motor Type	(1Ph) Single Phase Full Load Amps	(1Ph) Single Phase Lock Rotor Amps	(1Ph) Single Phase Control Box	(3Ph) Three Phase Full Load Amps	(3Ph) Three Phase Lock Rotor Amps
			COVERCO Motors			
0.37	3 wire	3.4	11.2	Coverco	1.2	5.6
0.55	3 wire	4.4	14	Coverco	1.8	8
0.75	3 wire	5.6	19	Coverco	2.1	11
1.1	3 wire	8.1	26	Coverco	3	16
1.5	3 wire	10.1	34	Coverco	4.5	24
2.2	3 wire	14.1	44	Coverco	6	32
3.0	—	—	—	—	7.7	37
3.7	3 wire	23.4	77	Coverco	—	—
4	—	—	—	—	10.3	48
5.5	—	—	—	—	13.1	64
7.5	—	—	—	—	18.7	99

July 2006

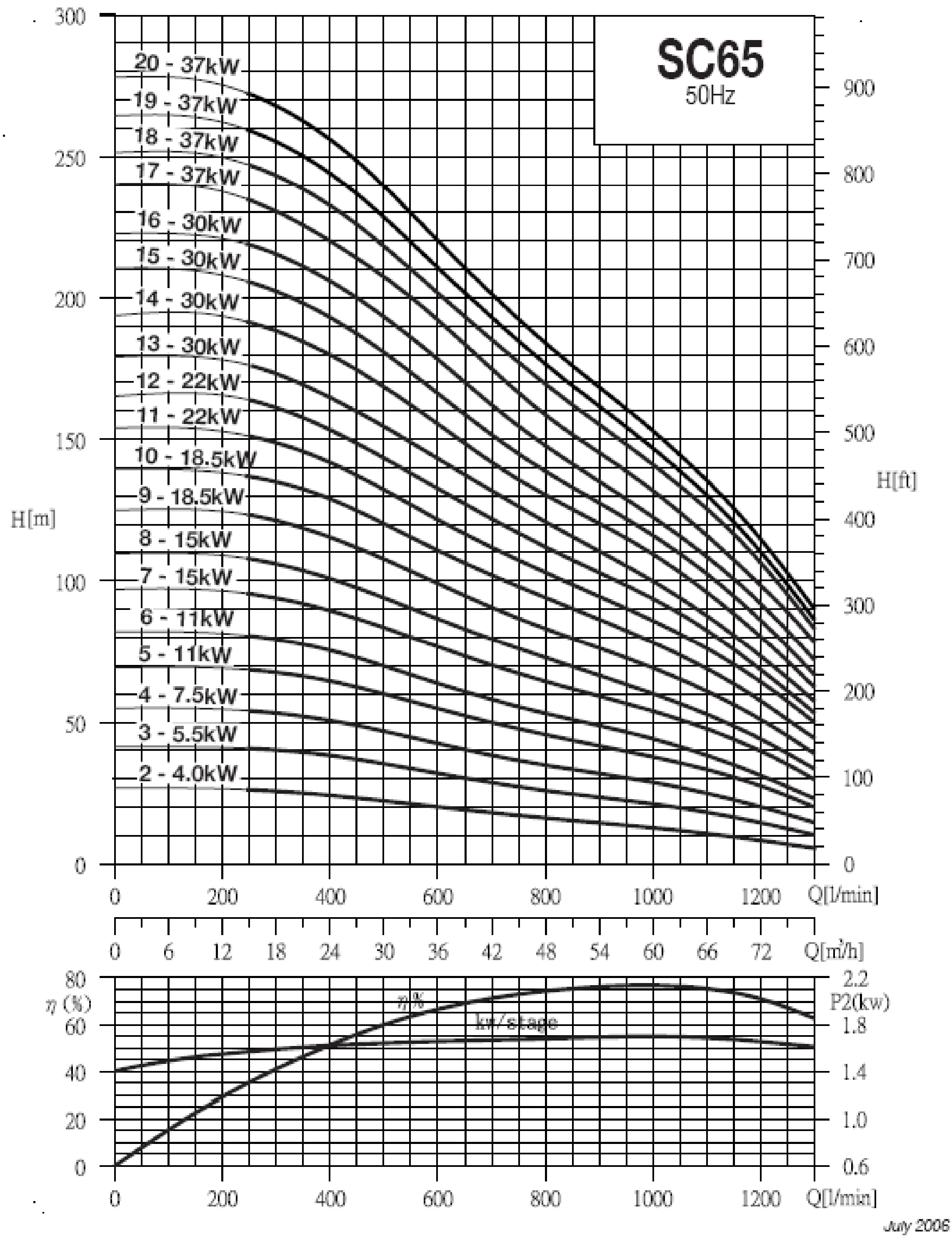
A division of tyco Flow Control Pacific Pty Ltd A.B.N. 83 000 922 690

Southern Cross

"SC" Series
6 inch (150mm)
Submersible Borehole Pumps

MODEL
SC65

PERFORMANCE DATA



July 2006

A division of tyco Flow Control Pacific Pty Ltd A.B.N. 83 000 922 690

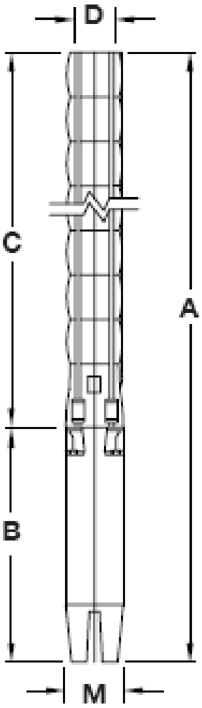
MODEL
SC65

"SC" Series

6 inch (150mm)
Submersible Borehole Pumps

Southern Cross

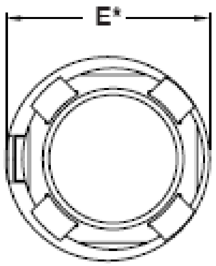
TECHNICAL DATA



SC65 DIMENSIONS & WEIGHTS

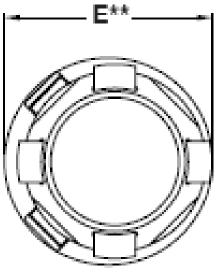
MODEL	NO. OF STAGES	MOTOR kW	MOTOR DIAM	DIMENSIONS (mm) A	B	C	D	E*	E**	M	MASS (kg) PUMP	MOTOR
SC65-02	2	4.0	4"	1059	563	496		146		96	9.2	25
SC65-03	3	5.5	4"	1324	715	609		146		96	11.5	48
SC65-04	4	7.5	6"	1368	646	722		149	152	138	13.7	52
SC65-05	5	11	6"	1546	711	835		149	152	138	16	58
SC65-06	6	11	6"	1659	711	948		149	152	138	18.3	58
SC65-07	7	15	6"	1837	776	1061		149	152	138	20.6	64
SC65-08	8	15	6"	1950	776	1174		149	152	138	22.9	64
SC65-09	9	18.5	6"	2128	841	1287		149	152	138	25.1	70
SC65-10	10	18.5	6"	2241	841	1400	4" BSPF	149	152	138	27.4	70
SC65-11	11	22	6"	2419	906	1513		149	152	138	29.7	76
SC65-12	12	22	6"	2532	906	1626		149	152	138	32	76
SC65-13	13	30	6"	2775	1036	1739		149	152	138	34.3	92
SC65-14	14	30	6"	2888	1036	1852		149	152	138	36.5	92
SC65-15	15	30	6"	3001	1036	1965		149	152	138	38.8	92
SC65-16	16	30	6"	3114	1036	2078		149	152	138	41.1	92
SC65-17	17	37	6"	3596	1405	2191		149	152	138	43.4	136
SC65-18	18	37	6"	3709	1405	2304		149	152	138	45.7	136
SC65-19	19	37	6"	3822	1405	2417		149	152	138	48	136
SC65-20	20	37	6"	3935	1405	2530		149	152	138	50.2	136

E: Maximum diameter of pump with single motor cable.*
*E**: Maximum diameter of pump with two motor cables.*
Motor dimensions are for standard Franklin Motors.



ELECTRICAL DATA 4 & 6 INCH MOTORS
415V 50 Hz 3 PHASE

MOTOR kW	THRUST kg	FULL LOAD AMPS	NOMINAL RPM	LOCK ROTOR AMPS
		4 INCH **FRANKLIN** MOTORS		
4.0	680	10.4	2875	59
5.5	680	13.0	2875	70
		6 INCH **FRANKLIN** MOTORS		
7.5	1600	16.2	2875	91
11	1600	24.1	2875	133
15	1600	31.0	2875	174
18.5	1600	38.5	2875	215
22	1600	45.5	2875	278
30	1600	64.6	2875	397
37	2800	77.9	2875	434



July 2006

A division of tyco Flow Control Pacific Pty Ltd A.B.N. 83 000 922 690

APPENDIX D GEOCHEMISTRY CHARACTERISATION OF WASTE ROCK AND ORE

Prepared by:

ENVIRONMENTAL GEOCHEMISTRY INTERNATIONAL PTY LTD

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For:

COFFEY NATURAL SYSTEMS PTY LTD

Level 1, 203 Greenhill Road
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Ph (08) 7221 3574

October 2009

Document No. 1751/874

Wonarah Phosphate Project

ACID FORMING CHARACTERISTICS OF WASTE ROCK COMPOSITE SAMPLES FROM THE ARRUWURRA PROSPECT AND MAIN ZONE AND LOW GRADE ORE
FINAL

Contents

List of Tables (after text)

List of Figures

List of Appendices (after tables)

1.0 Introduction

Environmental Geochemistry International Pty Ltd (EGi) were commissioned by Coffey Natural Systems Pty Ltd on behalf of Minemakers Australia Pty Ltd to carry out geochemical characterisation of composite waste rock samples from the Wonarah Phosphate Project in the Northern Territory. The project consists of two deposits, Main Zone and Arruwurra, with mining likely to begin with the Arruwurra Prospect. Testing of samples from the Wonarah Phosphate Project was undertaken in two separate stages. The first consisting of samples from the Arruwurra Prospect and the second consisting of samples from the Main Zone together with low-grade ore (from both deposits).

The objectives of the testing program were to:

- Determine the acid-forming characteristics of the samples;
- Evaluate the acid rock drainage (ARD) potential of the materials;
- Assess the availability of acid neutralising capacity (ANC) within the materials; and.
- Determine the elemental composition and enrichment of elements of environmental concern.

This report presents the results and findings of the geochemical test work conducted on all the samples.

2.0 Sample Description and Test Programme

The samples were provided in two batches with the first consisting of 47 composite waste rock samples from the Arruwurra Prospect (received by EGi on the 19th March 2009). The second batch comprised of 51 composite waste rock samples from the Main Zone and 20 low-grade ore samples (from both deposits), which was received by EGi on the 28th July 2009.

The composite waste rock samples were prepared on site using the following criteria:

- Sample holes selected to cover spatial and depth variation in geological units within the mining area.
- All lithological units within the mining area to be represented in the composite samples.
- Individual samples included in each composite should not transcend across different lithological boundaries or across different holes.
- Where possible for each hole, 4 composites should be made from overburden and 1 composite made from basement material. Composites should comprise no greater than 5 m intervals combined together.

- Composite samples should be about 1.5 to 2 kg each.

Upon receipt of samples, a 200 g split was sent to Sydney Environmental and Soil Laboratory (SESL) to pulverise to -75µm.

The testing program was as follows:

- Total sulphur analysis (all samples);
- Acid neutralising capacity (ANC) determination (all samples);
- $pH_{1:2}$ and $EC_{1:2}$ on water extracts (all Arruwurra Prospect samples, selected samples from the Main Zone and selected low grade ore samples);
- Single addition net acid generation (NAG) testing (all Arruwurra Prospect samples, selected samples from the Main Zone and selected low grade ore samples);
- Acid buffering characteristic curve (ABCC) testing (selected samples from the Arruwurra Prospect);
- Multi-element scans on liquors (selected samples from both batches); and
- Multi-element scans on solids (selected samples from both batches).

Samples from the second batch were selected for $pH_{1:2}$ and $EC_{1:2}$ and single addition NAG testing as results from testing of the Arruwurra Prospect samples indicated that waste rock would not be problematic with respect to ARD and metal leaching and it was expected that samples from the second batch would have similar characteristics.

Water extracts for pH, EC and multi-element scans on liquors were carried out on the as received samples. All other test work was carried out on pulverised samples.

Leco total sulphur assays were carried out by SESL, multi-element scans on solids were conducted by Australian Laboratory Services (ALS) in Brisbane and multi-element scans on water extracts was conducted by ALS in Sydney. All other analyses were carried out by EGi.

A general description of the pH/EC, total S, ANC and NAG test methods is included in Appendix A.

3.0 Results

3.1 Arruwurra Prospect

The geochemical test results of the Arruwurra Prospect composites are presented in Table 1 and comprise pH and EC of water extracts, total S, MPA, ANC, NAPP, ANC/MPA ratio and single addition NAG.

3.1.1 pH and EC

The $pH_{1:2}$ and $EC_{1:2}$ tests were carried out by equilibrating as received solid sample in deionised water for approximately 16 hours at a solid to water ratio of 1:2 (w/w). This gives an indication of the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area.

All samples tested had a circum-neutral $pH_{1:2}$ ranging from 6.7 to 8.5 and correspondingly low electrical conductivities ($EC_{1:2}$) of 0.1 to 0.7 dS/m, indicating that the samples were non-saline to slightly saline.

3.1.2 Acid-Base Account and Net Acid Generation (NAG)

The acid-base and net acid generation (NAG) test results for the samples are presented in Table 1.

The results show that all samples had a low total S content ranging from <0.01 to 0.1%S, with the majority of the samples having a value <0.05%S. The acid neutralising capacities (ANC's) of the samples were variable, ranging from 3 to 848 kg H_2SO_4/t. About 40% of the samples had moderate to high ANC values greater than 20 kg H_2SO_4/t.

All the samples have a negative net acid producing potential (NAPP[1]) varying from -3 to -848 kg H_2SO_4/t.

The NAPP value is used in conjunction with single addition net acid generation (NAG) test results to geochemically classify samples in relation to their ARD potential. Samples are classified as barren, non-acid forming (NAF), potentially acid forming (PAF) and uncertain (UC) according to the following characteristics:

- Barren: Total S $\leq$ 0.05%S and ANC $\leq$ 5 kg H_2SO_4/t.
- NAF: Non-Acid Forming. NAPP negative and NAGpH greater than or equal to 4.5.
- PAF: Potentially Acid Forming. NAPP positive and NAGpH less than 4.5.
- UC: Uncertain. Conflicting NAPP and NAG results (i.e., NAPP positive and NAGpH greater than 4.5 or NAPP negative and NAGpH less than 4.5).

[1] The net acid producing potential (NAPP) is a theoretical calculation that represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP is expressed in units of kg H_2SO_4/t and is calculated as follows:

$$NAPP = MPA – ANC$$

Where MPA = Maximum potential acidity (total %S x 30.6 = MPA in units of kg H_2SO_4/t)
ANC = Acid Neutralising Capacity

The single addition NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals present. Both acid generation and acid neutralisation occur simultaneously during the NAG test, hence the end result represents a direct measurement of the net amount of acid generated.

Figure 1a is an ARD classification plot showing the pH after reaction with hydrogen peroxide (NAGpH) and the NAPP of the samples and Figure 1b is the same as Figure 1a, except with an expanded NAPP scale. Potentially acid forming (PAF), non-acid forming (NAF) and uncertain (UC) classification domains are indicated.

The results show that the samples have a negative NAPP and NAGpH greater than 4.5 and plot in the top left hand quadrant. These samples are classified as non-acid forming (NAF). About 30% of the samples are further classified as barren as they have a total S content < 0.1%S and ANC ≤ 5 kg H_2SO_4/t and are thus barren with respect to acid generation and neutralisation.

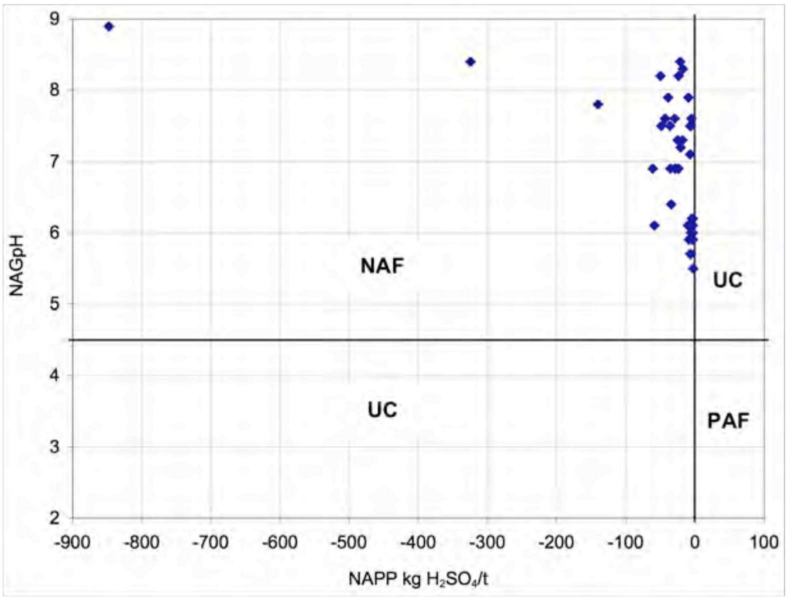

Figure 1a: ARD classification plot of composite samples – Arruwurra Prospect.

Three samples have a NAPP value less than -100 kg H_2SO_4/t. These include composite 4, with a NAPP of -848 kg H_2SO_4/t, composite 5 with a NAPP of -325 kg H_2SO_4/t and composite 6 with a NAPP of -140 kg H_2SO_4/t. These three samples are carbonates and described as dolomite, calcrete and phosphatic carbonate, respectively. They have high ANC values and negligible total S contents ranging from 0.01 to 0.04%S.

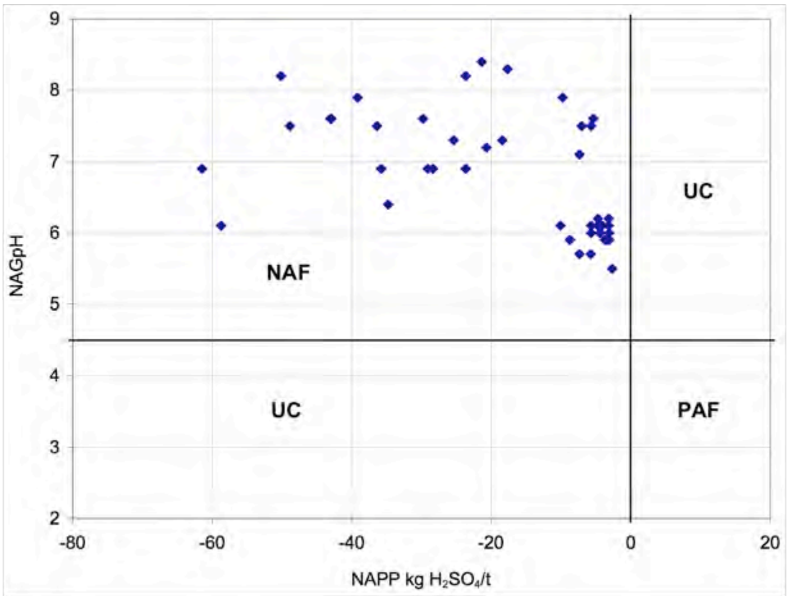

Figure 1b: Same as for Figure 1a, but with expanded NAPP scale.

3.1.3 ABCC Results

An acid buffering characteristic curve (ABCC) is produced by slow titration of a sample with acid, and provides an indication of the relative reactivity of the measured ANC. The acid buffering of a sample to pH 4 can be used as an estimate of the proportion of readily available ANC. Calcite, dolomite, ferroan dolomite and siderite standard curves are also plotted for reference. Calcite and dolomite readily dissolve in acid and exhibit strongly buffered pH curves in the ABCC test, rapidly dropping once the ANC value is reached. The siderite standard provides very poor acid buffering, exhibiting a very steep pH curve in the ABCC test. Ferroan dolomite is between siderite and dolomite in acid buffering availability.

Three samples (Composite 5, 30 and 42) were selected to undergo ABCC testing and had ANC values of 326, 26 and 52 kg H_2SO_4/t, respectively. The samples were selected to encompass the range in ANC values that were observed in the results. The results are presented in Figures 2 to 4.

Figure 2 presents the curve for Composite 5, which plots between the dolomite and ferroan dolomite standard curves. The sample has a strong initial pH plateau above pH 6 and has a readily available ANC, which is about 60% of the measured ANC of the sample. The results indicate that the ANC of this sample is dominated by dolomitic and ferroan dolomitic minerals with about 50% fast reacting.

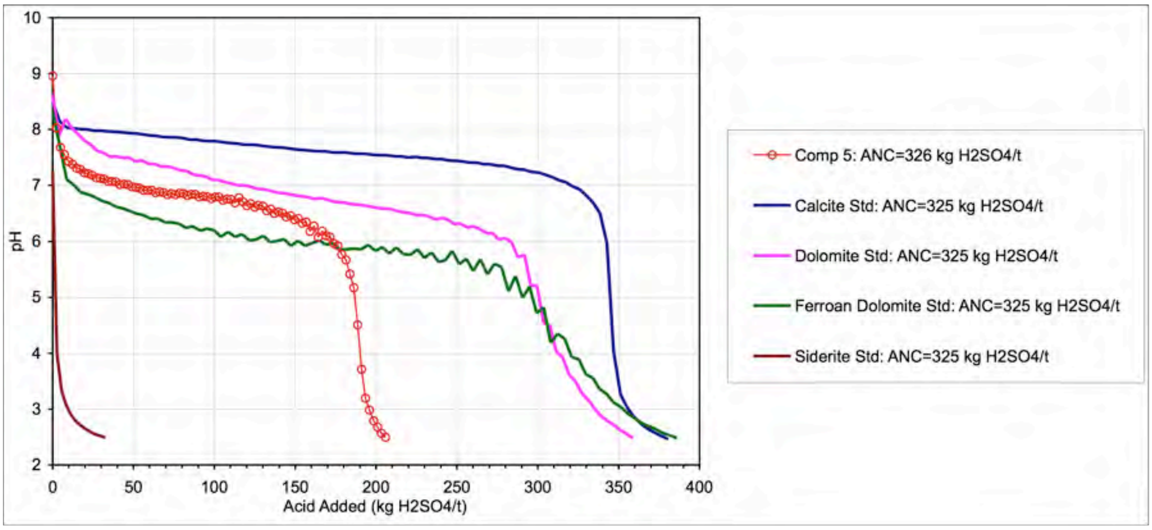

Figure 2: Acid buffering characteristic curve of composite 5, with ANC close to 325 kg H_2SO_4/t. Carbonate standard curves are included for reference.

Figures 3 and 4 present the ABCC plots for Composite 30 and 42, respectively. Both curves decrease rapidly from the beginning of the test and plot close to the siderite standard curve. The results indicate that the ANC of these two samples was ineffective and only about 10% of the measured ANC was readily available. The shapes of the curves suggest that the ANC of the samples is dominated by siderite. Siderite is known to cause interference with the standard ANC test (caused by incomplete oxidation of ferrous iron released during the ANC digest), resulting in overestimation of effective acid buffering.

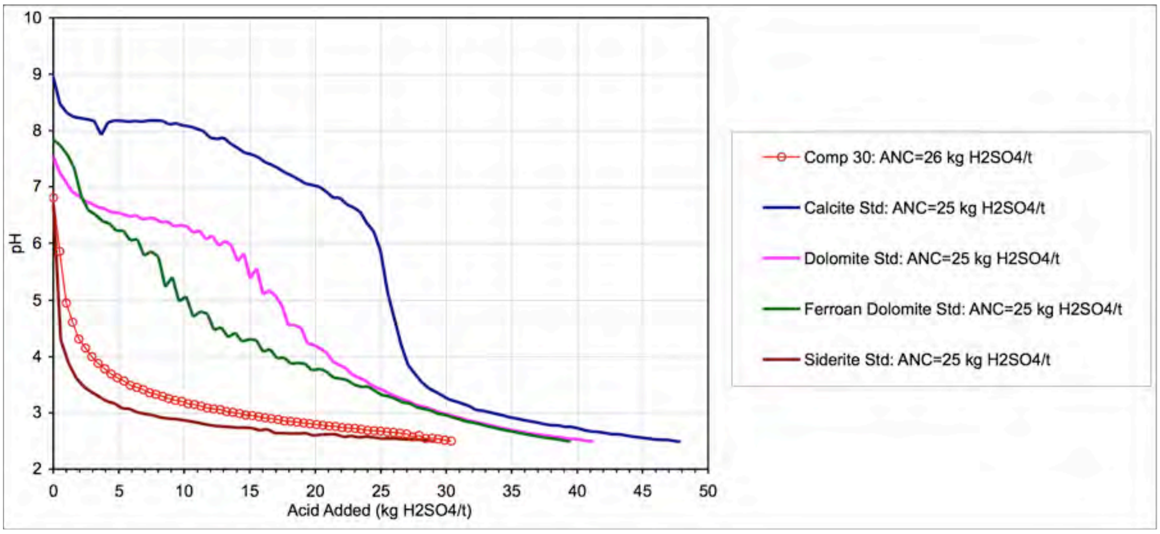

Figure 3: Acid buffering characteristic curve of composite 30, with ANC close to 25 kg H_2SO_4/t. Carbonate standard curves are included for reference.

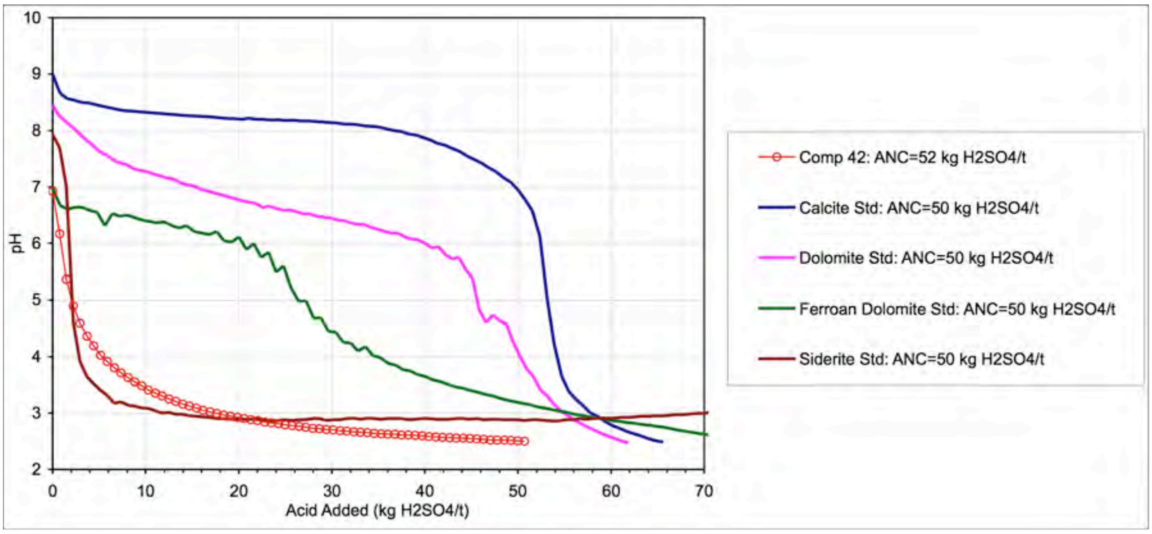

Figure 4: Acid buffering characteristic curve of composite 42, with ANC close to 50 kg H_2SO_4/t. Carbonate standard curves are included for reference.

Overall, ABCC testing indicates that in materials represented by Composite 5, 30 and 42, a large proportion of the ANC would not be available to neutralise pyrite generated acidity and hence the NAPP value can not be relied on to indicate the ARD risk. However, due to the low total S content and high NAGpH, all samples are classified as NAF and the lack of effective ANC would only be a concern if higher sulphide material were encountered.

3.1.4 Element Enrichment and Solubility

Multi-element scans were conducted on 8 samples and the elements included in the multi-element testing program were:

> Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sc, Se, Sn, Sr, Th, Ti, Tl, U, V, W and Zn.

Geochemical Abundance Indices (GAIs) were also calculated for each element. The GAI compares the actual concentration of an element in a sample with the median abundance in the selected reference material (world soil[2] concentrations used in this report) for that element. The main purpose of the GAI is to provide an indication of any elemental enrichment that may be of environmental importance. The GAI for an element is calculated as follows:

$$GAI = \log_2 [\, C / (1.5*S) \,]$$

where C is the concentration of the element in the sample and S is the median soil content for that element. The GAI are truncated to integer increments (0 through to 6,

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2 References for median soil data were: (1) Bowen, H.J.M. (1997) Environmental Chemistry of the Elements. Academic Press, London. (2) Berkman, D.A. (1976) Field Geologists' Manual, The Australian Institute of Mining and Metallurgy, Parkville, Victoria, Australia

respectively) where a GAI of 0 indicates the element is present at a concentration similar to, or less than, median soil abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above median soil abundance. The enrichment ranges for the GAI are as follows:

Little or No Enrichment

GAI=0	< 3 times median soil

Slightly Enrichment

GAI=1	3 to <6 times median soil
GAI=2	6 to <12 times median soil

Significant Enrichment

GAI=3	12 to <24 times median soil
GAI=4	24 to <48 times median soil
GAI=5	48 to <96 times median soil
GAI=6	≥ 96 times median soil

The multi-element results and geochemical abundance indices are presented in Tables 2 and 3, respectively. The results show that phosphorous (P) is significantly enriched in many samples with concentrations exceeding 5% P. Beryllium (Be) is significantly enriched in 7 of the 8 samples and Ca, Cu, Ce, Tl and U are significantly enriched in 1 or 2 of the samples. Although the GAI for Be exceeds 3 relative to median soil concentrations, the actual concentrations are not enriched compared to mean crustal abundance (2.6 mg/kg) and is unlikely to be a concern. The enrichment of P is to be expected given the mineralogy of the deposit.

The potential for dissolution and leaching of enriched elements is the main environmental concern during mining operations. To evaluate element solubility, the same samples that underwent multi-element scans on solids also underwent multi-element analyses of water extracts to provide an indication of the immediate solubility of these enriched elements as well as other environmentally important elements.

The results are presented in Table 4 and show only low concentrations of dissolved constituents. Phosphorous shows very low solubility with concentrations less than the detection limit of 1 mg/l in all samples. Na, Cl and SO_4 are the main ions in solution and there is some solubility of F. Fluorine (F) is typically associated with phosphate and leaching of F would be expected. The results indicate that routine water quality monitoring programmes should include F.

3.2 Main Zone

The acid forming characteristics of the Main Zone composite waste rock samples are presented in Table 5. A total of 51 samples were included in the program. All samples were assayed for total S and ANC and selected samples assayed for pH, EC, single addition NAG and multi-element scans on solids and water extracts.

3.2.1 pH & EC

Twelve (12) samples were selected for $pH_{1:2}$ and $EC_{1:2}$ testing. The samples were selected to encompass a range in total S and ANC values observed in the samples.

The samples had a circum-neutral $pH_{1:2}$ ranging from 7.1 to 7.7. The corresponding electrical conductivities ranged from 0.09 to 0.15 dS/m, indicating that the samples were non-saline.

3.2.2 Acid-Base Accounting and Net Acid Generation (NAG)

The total S contents of the composite waste rock samples was low, ranging from <0.01 to 0.13%S. More than two thirds of the samples had a value that was less than or equal to 0.05%S.

The acid neutralising capacity (ANC) of the composites ranged from 0 to 19 kg H_2SO_4/t, with about three quarters of the samples having a value less than or equal to 5 kg H_2SO_4/t. The samples had a net acid producing potential (NAPP) ranging from -19 to 2 kg H_2SO_4/t, with the majority of the samples having a value close to zero.

Twelve (12) samples, which had total S contents ≥ 0.04%S, were selected for single addition NAG testing. The results show that all samples had a NAGpH > 4.5. Eight of the samples have a positive NAPP value close to zero and are classified as uncertain (UC). However, it is unlikely that these samples will be acid generating, therefore the samples are further classified as UC (NAF), i.e., uncertain but likely to be non-acid forming. The remaining four samples that were NAG tested have a negative NAPP value and are classified as NAF.

Table 5 shows that overall about 50% of the samples (29 of 51) are classified as barren with respect to acid generation and have total S of less than or equal to 0.05%S and ANC less than 5 kg H_2SO_4/t. Of the remaining 22 samples, 18 are classified UC (NAF) and 4 are classified NAF. No samples were classified as PAF.

Based on the samples provided, these results indicate that ARD will not be an issue for the Main Zone waste rock.

3.2.3 Element Enrichment and Solubility

Multi-element composition and geochemical abundance indices (GAI) of selected solids samples from the Main Zone are presented in Tables 6 and 7, respectively. A description of the GAI was presented in Section 3.1.4.

The results show that phosphorus (P) is significantly enriched in 3 of the 12 samples tested, however, concentrations are not as high as in the Arruwurra Prospect. Beryllium (Be) is significantly enriched in 5 of the samples when compared with the median soil concentrations. However, similar to the Arruwurra Prospect samples, the actual concentrations are not enriched compared to mean crustal abundance (2.6 mg/kg) and are unlikely to be a concern. Ag, Cd, Mg, Mn, Pb, U and Zn were significantly enriched in 1 or 2 of the samples as identified on Table 7

Water extractions were performed to determine the solubility of these elements and other environmentally important constituents. The results are presented in Table 8 and show that the majority of the elements are at low concentrations or below the detection limit.

Phosphorous shows low solubility with concentrations at or less than the detection limit of 1 mg/l, except for sample 31 with a concentration of 4 mg/l. There is some solubility of F, which is expected as fluorine is typically associated with phosphate, with concentrations ranging from 0.2 to 2.0 mg/l. Ten (10) of the samples had F concentrations in the range of 1 to 2 mg/l.

One sample, composite 16, also had a high concentration of Mn (1.26 mg/l). This sample was significantly enriched in Mn having a GAI of 4. Fe (0.36 mg/l) and Zn (0.17 mg/l) are also slightly soluble in this sample.

As for the Arruwurra Prospect, it is recommended that F is included in routine water quality monitoring programmes.

3.3 Low Grade Ore

Twenty low-grade ore samples were provided for geochemical testing and the acid forming characteristics of the samples is presented in Table 9. The samples are labelled as Comp No. 52 to 71. All the samples underwent total S and ANC testing and selected samples were assayed for pH, EC, single addition NAG and multi-element scans on solids and water extracts.

3.3.1 pH & EC

$pH_{1:2}$ and $EC_{1:2}$ was conducted on eight selected samples (4 from the Arruwurra Prospect and 4 from the Main Zone), which covered a range in total S and ANC values. The results show that the low grade ore samples had a circum-neutral to alkaline pH ranging from 7.2 to 7.9.

The electrical conductivities of the selected samples were low, ranging from 0.09 to 0.15 dS/m, indicating that the samples were non-saline.

3.3.2 Acid-Base Accounting and Net Acid Generation (NAG)

The low grade ore samples had low total S contents, which varied from 0.03 to 0.19%S, with the majority of the samples having a value less than 0.1%S. The acid neutralising capacity (ANC) of the samples was moderate, ranging from 14 to 28 kg H_2SO_4/t.

All the samples had a negative NAPP value and high ANC/MPA ratios indicating a high factor of safety for prevention of acid generation.

Eight (8) samples were selected for single addition NAG testing. The results show that the samples had a NAGpH greater than 4.5 confirming the non-acid forming (NAF) nature of the low grade ore samples.

Table 9 shows that all low grade ore samples from the Arruwurra Prospect and Main Zone are classified as NAF.

3.3.3 Element Enrichment and Solubility

The multi-element composition and geochemical abundance indices (GAI) of selected solids samples is presented in Tables 10 and 11, respectively. The results show that Be and P are highly enriched in all the samples with Ca and U significantly enriched in half of the samples. Phosphorous (P) enrichment is to be expected given the mineralogy of the deposit. In addition, Ag, Co, Pb and Sr are enriched in 1 of he Main Zone samples.

The enrichment of P, Ca, Be and U is typical of phosphate ores. As expected, P is highly enriched in the low grade ore and although Be is also significantly enriched, the actual concentrations only slightly exceed the typical range in soils (0.1 to 15 mg/kg[3]) in 1 of 8 samples.

The enrichment of uranium is also typical of phosphate deposits. The average content of U in rock phosphate is 120 mg/kg[3], which is greater than the maximum concentration of 63 mg/kg determined in the Main Zone and Arruwurra low grade ore samples.

As for the waste rock samples, water extractions were conducted to determine the solubility of environmentally important elements and the results are presented in Table 12. The results show only low concentrations of dissolved constituents with Ca and Na the main cations and Cl and SO_4 the main anions. Phosphorous has low solubility with concentrations being less than or equal to 2 mg/l. There is some solubility of F in the low-grade ore samples with concentrations ranging from 0.4 to 2.5 mg/l.

Ba was slightly soluble in sample 53 from the Arruwurra Prospect, having a concentration of 0.6 mg/l. The remaining elements were at low concentrations or below the detection limit.

4.0 Summary and Recommendations

Geochemical characterisation of composite waste rock samples from the Arruwurra Prospect and Main Zone, and low-grade ore from both deposits has shown that materials

[3] István Pais and J. Benton Jones, Jr. (1997), *The Handbook of Trace Elements.* St Lucie Press, Boca Raton Fl, USA.

represented by the samples will not be problematic with respect to ARD. All samples tested were classified as non-acid forming (NAF) and about 40% of the waste rock composites were also barren with respect to S and ANC contents, having a total S less than or equal to 0.05%S and ANC less than or equal to 5 kg H_2SO_4/t.

The average total S and ANC of samples are presented in Table 13. The average total S contents of waste rock composites from the Arruwurra Prospect and Main Zone were the same, while the average ANC of the waste rock from the Arruwurra Prospect was almost an order of magnitude higher than in the Main Zone samples.

Table 13 shows that the Arruwurra Prospect and Main Zone low-grade ore samples had similar average total S contents that were slightly higher than waste rock composites and similar ANC values.

Table 13: Average total S, ANC and NAPP of composite waste rock and low grade ore samples.

Sample Type	Deposit	Total S (%)	ANC (kg H_2SO_4/t)
Waste Rock	Arruwurra Prospect	0.03	46
	Main Zone	0.03	5
Low Grade Ore	Arruwurra Prospect	0.09	25
	Main Zone	0.07	19

Elemental analysis of selected waste rock composites indicated that P and Be were significantly enriched (i.e. GAI ≥3) in most samples from the Arruwurra Prospect and Main Zone. Phosphorous (P) enrichment is to be expected given the mineralogy of the deposit and although Be was enriched when compared against median soil concentrations (0.3 mg/kg), the actual concentrations were not enriched compared to mean crustal abundance (2.6 mg/kg). Other elements showing significant enrichment in 1 or 2 of the samples were Ag, Ca, Cd, Cu, Mg, Pb, Tl, U and Zn.

Testing showed that all the low grade ore samples were significantly enriched in Be and P and half of the samples were also significantly enriched in Ca and U. The actual concentration of U in the low grade ore is lower than typically observed in rock phosphate ore.

Water extractions carried out on waste rock and low grade ore samples indicated only low solubility of dissolved constituents and that the majority of the environmentally significant elements were either at low concentrations or below the detection limit. Phosphorous showed very low solubility with the concentrations being close to or less than the detection limit of 1 mg/l. There was some solubility of F in the samples. Fluorine (F) is typically associated with phosphate and leaching of F would be expected in these samples.

Overall, the results of the current investigation indicated that ARD will not be a concern for the Wonarah Phosphate Project. However, there are some elements that occur at elevated concentrations in waste rock and low grade ore. Although their solubilities are expected to be low, it is recommended that PO_4, F and Be, be included in site water quality monitoring programmes.

Table 1: Acid forming characteristics of composite waste rock samples from the Arruwurra Prospect.

Composite Number	Hole No.	Lithology	Depth (m)		Interval (m)	$pH_{1:2}$	$EC_{1:2}$	ACID-BASE ANALYSIS					NAG TEST			ARD Classification
			From	To				Total %S	MPA	ANC	NAPP	ANC/MPA Ratio	NAGpH	$NAG_{(pH4.5)}$	$NAG_{(pH7.0)}$	
1	WNRC009	mudstone	5	9	4.0	7.6	0.112	0.02	1	5	-4	8	6.0	0	8	NAF (Barren)
2	WNRC009	silty mudstone	9	12	3.0	8.3	0.216	0.01	0	5	-5	16	6.1	0	9	NAF (Barren)
3	WNRC009	silty mudstone	12	17	5.0	7.5	0.146	0.01	0	6	-6	20	6.0	0	8	NAF
4	WNRC009	dolomite	26	32	6.0	8.3	0.104	0.01	0	848	-848	2771	8.9	0	0	NAF
5	WNRC013	calcrete	1	4	3.0	8.2	0.156	0.04	1	326	-325	266	8.4	0	0	NAF
6	WNRC013	phosphatic carbonate	4	9	5.0	7.8	0.152	0.03	1	141	-140	154	7.8	0	0	NAF
7	WNRC089	muddy siltstone	3	6	3.0	7.7	0.232	0.04	1	11	-10	9	7.9	0	0	NAF
8	WNRC089	phosphatic muddy siltstone	6	11	5.0	8.1	0.214	0.07	2	51	-49	24	7.5	0	0	NAF
9	WNRC089	basaltic sediments	14	16	2.0	8.0	0.211	0.06	2	41	-39	22	7.9	0	0	NAF
10	WNRC089	basalt	16	20	4.0	7.8	0.176	0.01	0	18	-18	59	8.3	0	0	NAF
11	WNRC090	ferricrete	1	3	2.0	7.6	0.189	0.02	1	6	-5	10	7.6	0	0	NAF
12	WNRC090	siltstone	3	8	5.0	7.5	0.259	<0.01	0	6	-6	20	6.1	0	9	NAF
13	WNRC091	siltstone/mudstone	4	8	4.0	6.8	0.166	<0.01	0	9	-9	29	5.9	0	9	NAF
14	WNRC091	mudstone/siltstone	8	12	4.0	7.6	0.179	0.02	1	4	-3	7	5.9	0	9	NAF (Barren)
15	WNRC091	mudstone	20	24	4.0	8.3	0.181	<0.01	0	24	-24	78	6.9	0	0	NAF
16	WNRC091	basalt	24	27	3.0	7.8	0.192	0.01	0	21	-21	69	7.2	0	0	NAF
17	WNRC094	aeolian sand	0	4	4.0	6.7	0.215	0.01	0	3	-3	10	5.5	0	9	NAF (Barren)
18	WNRC094	siltstone	5	10	5.0	7.9	0.176	0.02	1	5	-4	8	6.0	0	9	NAF (Barren)
19	WNRC094	siltstone	10	14	4.0	8.2	0.236	0.03	1	4	-3	4	6.0	0	9	NAF (Barren)
20	WNRC094	phosphatic siltstone	15	20	5.0	8.4	0.213	0.03	1	44	-43	48	7.6	0	0	NAF
21	WNRC094	basalt	25	28	3.0	7.6	0.248	0.02	1	22	-21	36	8.4	0	0	NAF
22	WNRC197	pisolitic	2	4	2.0	8.3	0.376	0.01	0	6	-6	20	7.5	0	0	NAF
23	WNRC197	mudstone-siltstone	4	8	4.0	8.2	0.276	0.01	0	5	-5	16	6.1	0	9	NAF (Barren)
24	WNRC197	mudstone c chert	8	12	4.0	8.1	0.311	0.03	1	4	-3	4	5.9	0	10	NAF (Barren)
25	WNRC197	cherty sandstone	12	14	2.0	7.8	0.198	0.03	1	11	-10	12	6.1	0	6	NAF
26	WNRC197	basalt	21	25	4.0	8.4	0.416	0.02	1	19	-18	31	7.3	0	0	NAF
27	WNRC203	mudstone c chert	3	7	4.0	7.7	0.321	0.03	1	5	-4	5	6.1	0	7	NAF (Barren)
28	WNRC203	mudstone c chert	7	11	4.0	8.2	0.412	0.06	2	5	-3	3	6.2	0	7	NAF
29	WNRC203	chert sandstone	11	14	3.0	7.5	0.329	0.06	2	5	-3	3	6.1	0	6	NAF
30	WNRC203	phosphatic mudstone	14	17	3.0	8.4	0.407	0.02	1	26	-25	42	7.3	0	0	NAF
31	WNRC203	weathered basalt	19	24	5.0	7.7	0.311	<0.01	0	24	-24	78	8.2	0	0	NAF

Table 1: Acid forming characteristics of composite waste rock samples from the Arruwurra Prospect.

Composite Number	Hole No.	Lithology	Depth (m)		Interval (m)	$pH_{1:2}$	$EC_{1:2}$	ACID-BASE ANALYSIS					NAG TEST			ARD Classification
			From	To				Total %S	MPA	ANC	NAPP	ANC/MPA Ratio	NAGpH	$NAG_{(pH4.5)}$	$NAG_{(pH7.0)}$	
32	WNRC210	mudstone	3	8	5.0	6.8	0.276	<0.01	0	5	-5	16	6.2	0	7	NAF (Barren)
33	WNRC210	mudstone	8	12	4.0	7.8	0.356	<0.01	0	4	-4	13	5.9	0	10	NAF (Barren)
34	WNRC210	cherty sandstone and mudstone	12	16	4.0	8.5	0.281	0.04	1	37	-36	30	6.9	0	0	NAF
35	WNRC210	mudstone c chert	16	19	3.0	7.9	0.198	0.04	1	36	-35	29	6.4	0	6	NAF
36	WNRC210	weathered basalt	22	25	3.0	7.8	0.235	0.02	1	29	-28	47	6.9	0	0	NAF
37	WNRC212	mudstone	1	4	3.0	7.7	0.324	0.02	1	37	-36	60	7.5	0	0	NAF
38	WNRC212	mudstone-siltstone	4	8	4.0	8.2	0.276	0.02	1	8	-7	13	7.1	0	0	NAF
39	WNRC212	mudstone-siltstone	8	12	4.0	6.9	0.319	0.03	1	30	-29	33	6.9	0	0	NAF
40	WNRC212	cherty sandstone and mudstone	12	15	3.0	7.5	0.415	0.10	3	46	-43	15	7.6	0	0	NAF
41	WNRC217	ferricrete	1	3	2.0	6.9	0.266	0.03	1	8	-7	9	7.5	0	0	NAF
42	WNRC217	mudstone	3	8	5.0	7.8	0.346	0.06	2	52	-50	28	8.2	0	0	NAF
43	WNRC217	mudstone c chert	8	11	3.0	7.9	0.309	0.04	1	60	-59	49	6.1	0	10	NAF
44	WNRC252	mudstone	4	9	5.0	8.3	0.235	0.04	1	31	-30	25	7.6	0	0	NAF
45	WNRC252	mudstone>siltstone	9	14	5.0	6.7	0.616	0.05	2	63	-61	41	6.9	0	0	NAF
46	WNRC252	mudstone-siltstone	14	19	5.0	6.8	0.529	0.04	1	7	-6	6	5.7	0	11	NAF
47	WNRC252	palaeoregolith/weathered basalt	30	34	4.0	6.9	0.721	0.02	1	8	-7	13	5.7	0	8	NAF

KEY

$pH_{1:2}$ = pH of 1:2 extract
$EC_{1:2}$ = Electrical Conductivity of 1:2 extract (dS/m)
MPA = Maximum Potential Acidity (kgH_2SO_4/t)
ANC = Acid Neutralising Capacity (kgH_2SO_4/t)
NAPP = Net Acid Producing Potential (kgH_2SO_4/t)

NAGpH = pH of NAG liquor
$NAG_{(pH4.5)}$ = Net Acid Generation capacity to pH 4.5 (kgH_2SO_4/t)
$NAG_{(pH7.0)}$ = Net Acid Generation capacity to pH 7.0 (kgH_2SO_4/t)

NAF = Non-Acid Forming
PAF = Potentially Acid Forming
PAF-LC = PAF - lower capacity
UC = Uncertain Classification
(expected classification in brackets)

Table 2: Multi-element composition of selected solids samples (mg/kg except where shown) - Arruwurra Prospect.

Element	Detection Limit	Composite Number / Hole ID / Lithology							
		5	8	13	21	25	40	42	45
		WNRC013	WNRC089	WNRC091	WNRC094	WNRC197	WNRC212	WNRC217	WNRC252
		calcrete	phosphatic muddy siltstone	siltstone/ mudstone	basalt	cherty sandstone	cherty sandstone and mudstone	mudstone	mudstone> siltstone
Ag	0.02	0.18	0.36	0.19	0.12	0.55	0.33	0.38	0.42
Al	0.01%	2.73%	5.61%	5.55%	6.78%	3.70%	3.82%	6.47%	2.12%
As	0.2	2	1.2	2	6.5	2.3	3.5	3.7	4
Ba	10	730	1550	520	230	500	210	780	160
Be	0.05	1.44	4.21	3.04	6.91	3.44	6.71	9.52	4.54
Bi	0.01	0.15	0.3	0.2	0.07	0.12	0.16	0.23	0.1
Ca	0.01%	9.18%	6.39%	0.12%	0.99%	0.20%	16.25%	3.83%	13.30%
Cd	0.02	0.12	0.31	<0.02	0.29	<0.02	0.42	0.12	0.63
Co	0.1	5	5.1	1.6	51.4	1.3	15.2	31.5	6.1
Cr	1	28	43	48	49	65	61	113	27
Cu	0.2	26.4	51.4	11.7	309	29	72.1	83.8	22.3
Fe	0.01%	0.73%	0.40%	0.47%	9.03%	0.45%	0.65%	0.51%	0.84%
Ga	10	10	10	10	10	10	10	10	<10
Hg	0.01	0.011	0.024	0.007	0.031	0.01	0.052	0.027	0.013
K	0.002%	0.54%	0.82%	1.24%	2.54%	0.34%	0.21%	0.18%	0.44%
La	10	30	30	40	20	30	40	40	10
Mg	0.002%	0.36%	0.52%	0.36%	0.73%	0.16%	0.22%	0.41%	0.14%
Mn	1.0	315	334	40	1330	20	472	1220	148
Mo	0.1	0.84	0.31	0.17	0.66	3.39	1.39	2.06	0.9
Na	0.002%	0.03%	0.09%	0.04%	0.05%	0.05%	0.11%	0.10%	0.04%
Ni	1.0	15.1	10.6	7.7	89.9	8.6	21.3	15.8	21.5
P	20	9390	29000	850	3530	1710	>50000	24500	>50000
Pb	2.0	44.4	135.5	35.2	22.7	70.7	57.8	123.5	18.1
S	0.001%	0.05%	0.07%	0.02%	0.02%	0.04%	0.12%	0.06%	0.05%
Sb	0.05	1.08	0.57	0.61	0.49	0.29	0.61	0.47	0.37
Sc	1	9	13	10	35	19	10	28	11
Se	0.01	2.2	2.3	1.3	1.9	2.5	2.6	4.3	1.4
Sn	0.1	1.5	2.5	3	1.3	1.2	1	2.3	1.1
Sr	0.05	79	112	190	55	328	150	735	66
Th	0.2	7	10.7	12	5.7	7.4	6.8	9.7	6.3
Ti	0.01%	0.14%	0.26%	0.26%	0.55%	0.12%	0.07%	0.23%	0.04%
Tl	0.02	0.18	0.41	0.33	1.08	0.13	0.2	1.93	0.2
U	0.01	2.6	11.6	3.3	2.6	4.7	12.1	13.1	24.1
V	2.0	43	68	80	292	53	64	62	56
W	0.1	1.3	2	2	1.2	2.4	1	2.2	0.9
Zn	1.0	66	38	19	205	39	52	22	99

< element at or below analytical detection limit.

Table 3: Geochemical abundance indices (GAI) of selected solids samples - Arruwurra Prospect.

Element	Median Soil Abundance*	Sample Number							
		5	8	13	21	25	40	42	45
		WNRC013	WNRC089	WNRC091	WNRC094	WNRC197	WNRC212	WNRC217	WNRC252
		calcrete	phosphatic muddy siltstone	siltstone/ mudstone	basalt	cherty sandstone	cherty sandstone and mudstone	mudstone	mudstone> siltstone
Ag	0.05	1	2	1	1	3	2	2	2
Al	7.1%	-	-	-	-	-	-	-	-
As	6	-	-	-	-	-	-	-	-
Ba	500	-	1	-	-	-	-	-	-
Be	0.3	2	3	3	4	3	4	4	3
Bi	0.2	-	-	-	-	-	-	-	-
Ca	1.5%	2	2	-	-	-	3	1	3
Cd	0.35	-	-	-	-	-	-	-	-
Co	8	-	-	-	2	-	-	1	-
Cr	70	-	-	-	-	-	-	-	-
Cu	30	-	-	-	3	-	1	1	-
Fe	4.0%	-	-	-	1	-	-	-	-
Ga	20	-	-	-	-	-	-	-	-
Hg	0.06	-	-	-	-	-	-	-	-
K	1.4%	-	-	-	-	-	-	-	-
La	40	-	-	-	-	-	-	-	-
Mg	0.5%	-	-	-	-	-	-	-	-
Mn	1000	-	-	-	-	-	-	-	-
Mo	1.2	-	-	-	-	1	-	-	-
Na	0.5%	-	-	-	-	-	-	-	-
Ni	50	-	-	-	-	-	-	-	-
P	800	3	5	-	2	1	>5	4	>5
Pb	35	-	1	-	-	-	-	1	-
S	0.07%	-	-	-	-	-	-	-	-
Sb	1	-	-	-	-	-	-	-	-
Sc	7	-	-	-	2	1	-	1	-
Se	0.4	2	2	1	2	2	2	3	1
Sn	4	-	-	-	-	-	-	-	-
Sr	250	-	-	-	-	-	-	1	-
Th	9	-	-	-	-	-	-	-	-
Ti	0.50%	-	-	-	-	-	-	-	-
Tl	0.2	-	-	-	2	-	-	3	-
U	2	-	2	-	-	1	2	2	3
V	90	-	-	-	1	-	-	-	-
W	1.5	-	-	-	-	-	-	-	-
Zn	90	-	-	-	1	-	-	-	-

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

Table 4: Chemical composition of water extracts of selected samples - Arruwurra Prospect.

Parameter		Detection Limit	Composite Number / Hole ID / Lithology							
			5	8	13	21	25	40	42	45
			WNRC013	WNRC089	WNRC091	WNRC094	WNRC197	WNRC212	WNRC217	WNRC252
			calcrete	phosphatic muddy siltstone	siltstone/ mudstone	basalt	cherty sandstone	cherty sandstone and mudstone	mudstone	mudstone> siltstone
pH		0.01	8.1	8.3	6.7	7.5	7.9	7.6	7.6	6.8
EC	dS/m	0.01	0.149	0.219	0.161	0.251	0.21	0.429	0.355	0.626
Ag	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/l	0.01	0.80	0.67	3.93	0.96	0.36	0.12	0.20	0.22
As	mg/l	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001
B	mg/l	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	mg/l	0.001	0.115	0.054	0.106	0.019	0.037	0.022	0.030	0.006
Be	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/l	1	19	6	3	6	3	12	8	2
Cd	mg/l	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/l	1	3	56	16	23	48	63	97	7
Co	mg/l	0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Cr	mg/l	0.001	0.001	<0.001	0.005	<0.001	<0.001	<0.001	0.001	<0.001
Cu	mg/l	0.001	0.003	0.002	0.004	0.013	0.004	0.002	0.002	0.002
F	mg/l	0.1	2.4	2.9	1.1	0.8	1.1	2.1	2.2	2.6
Fe	mg/l	0.05	0.23	0.17	0.52	0.48	0.36	0.09	<0.05	0.36
Hg	mg/l	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/l	1	8	5	7	6	6	6	4	5
Mg	mg/l	1	2	3	2	5	4	5	7	2
Mn	mg/l	0.001	0.010	0.004	0.031	0.075	0.008	0.001	0.004	0.004
Mo	mg/l	0.001	0.001	<0.001	<0.001	<0.001	0.004	0.003	0.003	0.001
Na	mg/l	1	2	57	16	19	26	35	59	9
Ni	mg/l	0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
P	mg/l	1	<1	<1	<1	<1	<1	<1	<1	<1
Pb	mg/l	0.001	0.001	<0.001	0.003	0.002	<0.001	<0.001	<0.001	<0.001
SO_4	mg/l	1	12	26	10	39	16	17	25	10
Sb	mg/l	0.001	0.006	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Si	mg/l	0.1	7.5	6.9	7.7	9.3	4.6	5.4	7.1	3.0
Sn	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	mg/l	0.001	0.044	0.041	0.046	0.054	0.079	0.116	0.092	0.017
Th	mg/l	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/l	0.005	<0.005	<0.005	0.050	0.013	0.006	<0.005	<0.005	<0.005

< element at or below analytical detection limit.

Table 5: Acid forming characteristics of waste rock composite samples from the Main Zone.

Comp. No.	Hole No.	Lithology	Depth (m)		Interval (m)	$pH_{1:2}$	$EC_{1:2}$ (dS/m)	ACID-BASE ANALYSIS					NAG TEST			ARD Classification
			From	To				Total %S	MPA	ANC	NAPP	ANC/MPA Ratio	NAGpH	$NAG_{(pH4.5)}$	$NAG_{(pH7.0)}$	
1	WNRC295	aeolian sand	0	3	3.0			<0.01	0	1	-1	3.3				NAF (Barren)
2	WNRC295	silty mudstone	5	10	5.0			0.03	1	1	0	1.1				NAF (Barren)
3	WNRC295	cherty sandstone	22	27	5.0	7.3	0.107	0.04	1	0	1	0.0	5.1	0	12	UC (NAF)
4	WNRC295	cherty sandstone/mudstone	30	35	5.0			0.02	1	1	0	1.6				NAF (Barren)
5	WNRC295	mudstone c chert	44	48	4.0			0.03	1	14	-13	15.3				UC (NAF)
6	WNRC313	mudstone/siltstone	4	9	5.0			0.01	0	1	-1	3.3				NAF (Barren)
7	WNRC313	mudstone/siltstone	12	17	5.0			<0.01	0	1	-1	3.3				NAF (Barren)
8	WNRC313	cherty sandstone and mudstone	25	30	5.0			0.02	1	0	1	0.0				NAF (Barren)
9	WNRC313	mudstone/siltstone c chert	36	40	4.0	7.4	0.114	0.02	1	3	-2	4.9				NAF (Barren)
10	WNRC313	weathered basalt	51	54	3.0			<0.01	0	18	-18	58.8				UC (NAF)
11	WNRC326	pisolitic regolith	0	3	3.0			<0.01	0	1	-1	3.3				NAF (Barren)
12	WNRC326	cherty/ferruginous silty mudstone	8	13	5.0			0.04	1	4	-3	3.3				NAF (Barren)
13	WNRC326	cherty mudstone	17	22	5.0			0.04	1	1	0	0.8				NAF (Barren)
14	WNRC326	weakly phosphatic mudstone	27	31	4.0	7.5	0.092	0.04	1	9	-8	7.4				UC (NAF)
15	WNRC326	weakly phosphatic c breccia	44	49	5.0			0.05	2	12	-10	7.8	5.6	0	10	NAF
16	WNRC326	cherty mudstone	49	53	4.0	7.6	0.121	0.13	4	12	-8	3.0	7.8	0	0	NAF
17	WNRC346	silcrete breccia	0	5	5.0			<0.01	0	1	-1	3.3				NAF (Barren)
18	WNRC346	siltstone-sandstone	7	12	5.0			0.01	0	1	-1	3.3				NAF (Barren)
19	WNRC346	mudstone-siltstone	13	18	5.0	7.7	0.146	0.07	2	0	2	0.0	5.2	0	12	UC (NAF)
20	WNRC346	mudstone-cherty sandstone	20	25	5.0			0.03	1	1	0	1.1				NAF (Barren)
21	WNRC346	phosphatic mudstone	41	46	5.0			0.02	1	14	-13	22.9				UC (NAF)
22	WNRC372	ferruginous silty mudstone	6	11	5.0			0.02	1	1	0	1.6				NAF (Barren)
23	WNRC372	mudstone	11	16	5.0	7.2	0.109	0.05	2	1	1	0.7	5.8	0	10	UC (NAF)
24	WNRC372	mudstone	16	21	5.0			0.03	1	1	0	1.1				NAF (Barren)
25	WNRC372	mudstone and cherty sandstone	26	31	5.0			<0.01	0	1	-1	3.3				NAF (Barren)
26	WNRC372	weakly phosphatic mudstone	42	46	4.0			0.02	1	16	-15	26.1				UC (NAF)
27	WNRC389	muddy siltstone	4	9	5.0			0.02	1	2	-1	3.3				NAF (Barren)
28	WNRC389	mudstone with chert sandstone	13	18	5.0			0.04	1	1	0	0.8				NAF (Barren)
29	WNRC389	mudstone with minor siltstone	19	24	5.0			0.03	1	1	0	1.1				NAF (Barren)
30	WNRC389	phosphatic cherty mudstone	25	27	2.0	7.4	0.111	0.10	3	6	-3	2.0	5.2	0	15	NAF

Table 5: Acid forming characteristics of waste rock composite samples from the Main Zone.

Comp. No.	Hole No.	Lithology	Depth (m)		Interval (m)	$pH_{1:2}$	$EC_{1:2}$ (dS/m)	ACID-BASE ANALYSIS					NAG TEST			ARD Classification
			From	To				Total %S	MPA	ANC	NAPP	ANC/MPA Ratio	NAGpH	$NAG_{(pH4.5)}$	$NAG_{(pH7.0)}$	
31	WNRC389	weakly phosphatic chert breccia	33	38	5.0	7.1	0.131	0.08	2	15	-13	6.1	5.6	0	11	NAF
32	WNRC389	phosphatic mudstone	38	41	3.0			0.05	2	18	-16	11.8				UC (NAF)
33	WNRC418	silcrete breccia	0	5	5.0			<0.01	0	1	-1	3.3				NAF (Barren)
34	WNRC418	mudstone with minor siltstone	10	15	5.0	7.3	0.124	0.07	2	1	1	0.5	4.9	0	14	UC (NAF)
35	WNRC418	mudstone with minor chert	17	22	5.0			0.05	2	1	1	0.7	5.0	0	15	UC (NAF)
36	WNRC418	mudstone-siltstone	22	28	6.0			0.02	1	1	0	1.6				NAF (Barren)
37	WNRC418	clay-rich phosphatic mudstone	42	45	3.0			0.04	1	14	-13	11.4				UC (NAF)
38	WNRC429	mudstone	9	14	5.0			0.04	1	1	0	0.8				NAF (Barren)
39	WNRC429	mudstone with minor chert	22	27	5.0	7.2	0.122	0.06	2	1	1	0.5	5.1	0	14	UC (NAF)
40	WNRC429	mudstone with minor chert	37	42	5.0			0.02	1	1	0	1.6				NAF (Barren)
41	WNRC429	weathered basalt	53	58	5.0			<0.01	0	19	-19	62.1				UC (NAF)
42	WNRC481	ferruginous silcrete	0	3	3.0	7.5	0.088	0.01	0	1	-1	3.3				NAF (Barren)
43	WNRC481	silty mudstone	7	12	5.0			0.03	1	1	0	1.1				NAF (Barren)
44	WNRC481	silty-mudstone c cherty sandstone	19	24	5.0			0.05	2	1	1	0.7	5.0	0	17	UC (NAF)
45	WNRC481	mudstone	30	35	5.0			0.03	1	1	0	1.1				NAF (Barren)
46	WNRC481	cherty phosphatic mudstone	48	51	3.0			0.02	1	15	-14	24.5				UC (NAF)
47	WNRC532	silcrete breccia	2	6	4.0			<0.01	0	2	-2	6.5				NAF (Barren)
48	WNRC532	mudstone c minor cherty sandstone	6	11	5.0			0.02	1	1	0	1.6				NAF (Barren)
49	WNRC532	silty mudstone	15	20	5.0			0.04	1	1	0	0.8				NAF (Barren)
50	WNRC532	cherty mudstone	25	30	5.0			0.05	2	1	1	0.7	5.4	0	11	UC (NAF)
51	WNRC532	weathered basalt	55	59	4.0	7.4	0.125	<0.01	0	13	-13	42.5				UC (NAF)

KEY

MPA = Maximum Potential Acidity (kgH_2SO_4/t)
ANC = Acid Neutralising Capacity (kgH_2SO_4/t)
NAPP = Net Acid Producing Potential (kgH_2SO_4/t)

NAGpH = pH of NAG liquor
$NAG_{(pH4.5)}$ = Net Acid Generation capacity to pH 4.5 (kgH_2SO_4/t)
$NAG_{(pH7.0)}$ = Net Acid Generation capacity to pH 7.0 (kgH_2SO_4/t)

NAF = Non-Acid Forming
PAF = Potentially Acid Forming
PAF-LC = PAF - lower capacity
UC = Uncertain Classification
(expected classification in brackets)

Table 6: Multi-element composition of selected solids samples (mg/kg except where shown) - Main Zone.

Element	Detection Limit	Composite Number/ Hole ID/ Lithology											
		3	9	14	16	19	23	30	31	34	39	42	51
		WNRC295	WNRC313	WNRC326	WNRC326	WNRC346	WNRC372	WNRC389	WNRC389	WNRC418	WNRC429	WNRC481	WNRC532
		cherty sandstone	mudstone/silt stone c chert	weakly phosphatic mudstone	cherty mudstone	mudstone-siltstone	mudstone	phosphatic cherty mudstone	weakly phosphatic chert breccia	mudstone with minor siltstone	mudstone with minor chert	ferruginous silcrete	weathered basalt
Ag	0.02	0.11	0.43	0.26	0.23	0.03	<0.01	1.69	0.38	0.03	0.05	0.23	0.04
Al	0.01%	4.10%	4.70%	2.50%	4.05%	5.52%	4.84%	5.77%	3.92%	3.54%	2.97%	3.74%	7.17%
As	0.2	1.1	0.9	1.9	12.6	0.6	3.5	3.7	2.2	0.3	0.8	7.7	0.3
Ba	10	280	420	360	880	580	330	940	280	660	330	450	150
Be	0.05	1.51	7.55	4.34	4.38	1.74	2.15	11.30	5.26	1.10	1.42	1.15	1.14
Bi	0.01	0.13	0.20	0.10	0.22	0.13	0.12	0.33	0.14	0.04	0.06	0.17	0.06
Ca	0.01%	0.10%	0.51%	1.17%	1.06%	0.11%	0.08%	1.82%	8.57%	0.09%	0.11%	0.03%	0.52%
Cd	0.02	0.04	0.05	0.13	4.45	<0.02	<0.02	0.07	1.17	<0.02	<0.02	<0.02	0.37
Co	0.1	2.2	18.5	17.8	26.6	0.5	0.9	0.8	5.9	0.4	1.0	2.9	48.5
Cr	1	35	37	21	55	23	30	42	41	21	18	127	31
Cu	0.2	17.5	37.7	29.4	85.0	2.1	3.2	44.2	44.5	6.1	9.8	12.3	142.5
Fe	0.01%	0.33%	0.38%	0.39%	2.83%	0.32%	0.36%	0.57%	0.94%	0.30%	0.27%	5.16%	5.94%
Ga	10	8.50	12.35	6.54	14.15	14.80	12.45	13.70	9.44	8.19	6.93	13.55	17.75
Hg	0.01	0.007	0.007	0.007	0.052	0.006	<0.005	0.097	0.014	<0.005	0.005	0.009	0.032
K	0.002%	0.37%	0.97%	0.46%	0.78%	0.55%	0.59%	0.73%	0.66%	0.34%	0.42%	0.13%	2.44%
La	10	46	58	27	26	79	58	104	28	55	32	20	16
Mg	0.002%	0.07%	0.17%	0.09%	0.41%	0.10%	0.11%	0.12%	0.18%	0.06%	0.08%	0.04%	5.21%
Mn	1.0	15	177	325	18100	18	43	26	185	8	28	73	905
Mo	0.1	0.91	0.49	1.03	2.81	0.40	0.21	1.15	1.94	0.13	0.53	0.99	0.27
Na	0.002%	0.03%	0.04%	0.03%	0.05%	0.03%	0.04%	0.04%	0.04%	0.03%	0.03%	0.02%	0.04%
Ni	1.0	11.1	7.1	14.6	135.5	3.3	5.1	4	13.9	3.8	5.4	13.1	88.5
P	20	1370	5520	7630	4470	1670	1110	23300	43400	1330	1370	150	830
Pb	2.0	30	51	44	455	17	9	482	243	8	8	32	7
S	0.001%	0.05%	0.02%	0.05%	0.02%	0.08%	0.06%	0.13%	0.09%	0.07%	0.05%	0.03%	0.01%
Sb	0.05	0.41	0.19	0.25	2.05	0.41	0.38	1.34	0.97	0.18	0.24	0.52	<0.05
Sc	1	5.7	22.0	7.1	12.1	7.1	7.0	31.3	13.1	6.5	15.1	6.8	38.3
Se	0.01	1	1	<1	1	1	1	3	1	1	1	1	1
Sn	0.1	2.3	1.9	1.4	2.4	4.6	4.2	3.5	1.8	2.1	2.2	2.1	1.3
Sr	0.05	326	506	450	43	534	323	1690	673	729	450	59	25
Th	0.2	15.1	10.3	4.4	9.7	20.4	17.2	13.9	10.4	17.2	8.7	8.0	5.0
Ti	0.01%	0.21%	0.14%	0.10%	0.26%	0.39%	0.35%	0.23%	0.15%	0.17%	0.19%	0.32%	0.58%
Tl	0.02	0.13	0.35	0.69	0.87	0.14	0.18	0.31	0.30	0.11	0.18	0.13	0.36
U	0.01	5.2	16.7	6.0	4.8	5.3	3.6	50.4	21.8	4.1	3.3	1.4	1.1
V	2.0	29	68	49	232	31	60	68	90	26	23	119	234
W	0.1	1.6	1.2	1.2	2.4	1.9	1.8	1.8	2.2	1.2	1.3	1.6	0.7
Zn	1.0	27	30	66	1120	7	8	76	112	8	12	11	472

< element at or below analytical detection limit.

Table 7: Geochemical abundance indices (GAI) of selected solids samples - Main Zone.

Element	Median Soil Abundance*	Composite Number/ Drill Hole/ Lithology											
		3	9	14	16	19	23	30	31	34	39	42	51
		WNRC295	WNRC313	WNRC326	WNRC326	WNRC346	WNRC372	WNRC389	WNRC389	WNRC418	WNRC429	WNRC481	WNRC532
		cherty sandstone	mudstone/silt stone c chert	weakly phosphatic mudstone	cherty mudstone	mudstone-siltstone	mudstone	phosphatic cherty mudstone	weakly phosphatic chert breccia	mudstone with minor siltstone	mudstone with minor chert	ferruginous silcrete	weathered basalt
Ag	0.05	1	**3**	2	2	-	-	**4**	2	-	-	2	-
Al	7.1%	-	-	-	-	-	-	-	-	-	-	-	-
As	6	-	-	-	-	-	-	-	-	-	-	-	-
Ba	500	-	-	-	-	-	-	-	-	-	-	-	-
Be	0.3	2	**4**	**3**	**3**	2	2	**5**	**4**	1	2	1	1
Bi	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Ca	1.5%	-	-	-	-	-	-	-	2	-	-	-	-
Cd	0.35	-	-	-	**3**	-	-	-	1	-	-	-	-
Co	8	-	1	1	1	-	-	-	-	-	-	-	2
Cr	70	-	-	-	-	-	-	-	-	-	-	-	-
Cu	30	-	-	-	1	-	-	-	-	-	-	-	2
Fe	4.0%	-	-	-	-	-	-	-	-	-	-	-	-
Ga	20	-	-	-	-	-	-	-	-	-	-	-	-
Hg	0.06	-	-	-	-	-	-	-	-	-	-	-	-
K	1.4%	-	-	-	-	-	-	-	-	-	-	-	-
La	40	-	-	-	-	-	-	1	-	-	-	-	-
Mg	0.5%	-	-	-	-	-	-	-	-	-	-	-	**3**
Mn	1000	-	-	-	**4**	-	-	-	-	-	-	-	-
Mo	1.2	-	-	-	1	-	-	-	-	-	-	-	-
Na	0.5%	-	-	-	-	-	-	-	-	-	-	-	-
Ni	50	-	-	-	1	-	-	-	-	-	-	-	-
P	800	-	2	**3**	2	-	-	**4**	**5**	-	-	-	-
Pb	35	-	-	-	**3**	-	-	**3**	2	-	-	-	-
S	0.07%	-	-	-	-	-	-	-	-	-	-	-	-
Sb	1	-	-	-	-	-	-	-	-	-	-	-	-
Sc	7	-	1	-	-	-	-	2	-	-	1	-	2
Se	0.4	1	1	1	1	1	1	2	1	1	1	1	1
Sn	4	-	-	-	-	-	-	-	-	-	-	-	-
Sr	250	-	-	-	-	1	-	2	1	1	-	-	-
Th	9	-	-	-	-	1	-	-	-	-	-	-	-
Ti	0.50%	-	-	-	-	-	-	-	-	-	-	-	-
Tl	0.2	-	-	1	2	-	-	-	-	-	-	-	-
U	2	1	2	1	1	1	-	**4**	**3**	-	-	-	-
V	90	-	-	-	1	-	-	-	-	-	-	-	1
W	1.5	-	-	-	-	-	-	-	-	-	-	-	-
Zn	90	-	-	-	**3**	-	-	-	-	-	-	-	2

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

Table 8: Chemical composition of water extracts of selected waste rock composite samples from the Main Zone.

Parameter		Detection Limit	Composite Numer/ Hole ID/ Lithology											
			3	9	14	16	19	23	30	31	34	39	42	51
			WNRC295	WNRC313	WNRC326	WNRC326	WNRC346	WNRC372	WNRC389	WNRC389	WNRC418	WNRC429	WNRC481	WNRC532
			cherty sandstone	mudstone/ siltstone c chert	weakly phosphatic mudstone	cherty mudstone	mudstone-siltstone	mudstone	phosphatic cherty mudstone	weakly phosphatic chert breccia	mudstone with minor siltstone	mudstone with minor chert	ferruginous silcrete	weathered basalt
pH		0.01	7.3	7.4	7.5	7.6	7.7	7.2	7.4	7.1	7.3	7.2	7.5	7.4
EC	dS/m	0.01	0.107	0.114	0.092	0.121	0.146	0.109	0.111	0.131	0.124	0.122	0.088	0.125
Ag	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/l	0.01	0.50	0.24	0.29	0.54	0.32	0.14	0.45	0.97	0.52	0.60	0.24	0.43
As	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B	mg/l	0.05	0.68	<0.05	<0.05	<0.05	<0.05	0.28	<0.05	<0.05	<0.05	<0.05	0.31	<0.05
Ba	mg/l	0.001	0.009	0.016	0.010	0.067	0.006	0.035	0.008	0.016	0.010	0.008	0.046	0.010
Be	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/l	1	<1	6	2	5	<1	7	<1	9	<1	<1	<1	2
Cd	mg/l	0.0001	0.0001	<0.0001	<0.0001	0.0007	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/l	1	8	13	22	14	6	24	14	13	6	6	5	12
Co	mg/l	0.001	<0.001	<0.001	0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr	mg/l	0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001
Cu	mg/l	0.001	0.008	0.002	0.004	0.014	0.003	0.001	0.006	0.009	0.002	0.004	0.002	0.003
F	mg/l	0.1	0.6	2.0	1.0	1.0	1.1	2.0	1.3	1.6	1.0	1.4	0.2	1.0
Fe	mg/l	0.05	<0.05	<0.05	<0.05	0.36	<0.05	<0.05	<0.05	0.17	0.05	0.06	<0.05	<0.05
Hg	mg/l	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/l	1	3	2	5	6	2	3	5	5	2	2	2	4
Mg	mg/l	1	<1	2	2	4	<1	3	<1	1	<1	<1	<1	1
Mn	mg/l	0.001	0.005	0.007	0.032	1.26	0.012	0.003	0.002	0.01	0.002	0.003	0.006	0.011
Mo	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001
Na	mg/l	1	7	12	12	14	6	19	7	8	7	8	6	10
Ni	mg/l	0.001	<0.001	<0.001	<0.001	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P	mg/l	1	<1	1	<1	<1	<1	<1	<1	4	<1	<1	<1	<1
Pb	mg/l	0.001	<0.001	0.002	0.001	0.008	<0.001	<0.001	0.002	0.007	<0.001	<0.001	<0.001	<0.001
Sb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Si	mg/l	0.05	8.79	4.53	12.8	3.84	31.6	3.84	11.4	3.01	3.21	2.64	4.82	16.4
Sn	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO_4	mg/l	1	7	6	7	11	<1	14	9	11	3	2	3	5
Sr	mg/l	0.001	0.019	0.030	0.025	0.012	0.006	0.070	0.015	0.050	0.012	0.023	0.014	0.021
Th	mg/l	0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Zn	mg/l	0.005	0.02	<0.005	0.013	0.174	0.006	<0.005	0.008	0.018	0.005	0.006	0.007	0.005

< element at or below analytical detection limit.

Table 9: Acid forming characteristics of low-grade ore from the Arruwurrua Prospect and Main Zone.

Comp. No.	Hole No.	Deposit	Lithology	Depth (m)		Interval (m)	$pH_{1:2}$	$EC_{1:2}$ (dS/m)	ACID-BASE ANALYSIS					NAG TEST			ARD Classification
				From	To				Total %S	MPA	ANC	NAPP	ANC/MPA Ratio	NAGpH	$NAG_{(pH4.5)}$	$NAG_{(pH7.0)}$	
52	WNRC210	Arruwurra Prospect	non-DSO phosphorite	15	18	3.0			0.03	1	16	-15	17.4				UC (NAF)
53	WNRC211		non-DSO phosphorite	12	16	4.0	7.8	0.092	0.09	3	24	-21	8.7	6.1	0	7	NAF
54	WNRC217		non-DSO phosphorite	8	10	2.0			0.05	2	27	-25	17.6				UC (NAF)
55	WNRC218		non-DSO phosphorite	14	18	4.0			0.07	2	26	-24	12.1				UC (NAF)
56	WNRC219		non-DSO phosphorite	9	13	4.0	7.2	0.129	0.15	5	28	-23	6.1	7.2	0	0	NAF
57	WNRC226		non-DSO phosphorite	4	9	5.0			0.09	3	28	-25	10.2				UC (NAF)
58	WNRC227		non-DSO phosphorite	13	17	4.0	7.9	0.146	0.11	3	25	-22	7.4	7.4	0	0	NAF
59	WNRC726		non-DSO phosphorite	10	12	2.0			0.14	4	25	-21	5.8	5.9	0	12	NAF
60	WNRC752		non-DSO phosphorite	7	11	4.0			0.10	3	25	-22	8.2				UC (NAF)
61	WNRC756		non-DSO phosphorite	9	11	2.0	7.2	0.096	0.04	1	24	-23	19.6				UC (NAF)
62	WNRC290	Main Zone	non-DSO phosphorite	32	34	2.0			0.06	2	23	-21	12.5				UC (NAF)
63	WNRC313		non-DSO phosphorite	40	42	2.0	7.5	0.117	0.07	2	23	-21	10.7	5.7	0	10	NAF
64	WNRC326		non-DSO phosphorite	31	35	4.0	7.6	0.124	0.03	1	22	-21	24.0				UC (NAF)
65	WNRC330		non-DSO phosphorite	38	41	3.0			0.04	1	28	-27	22.9				UC (NAF)
66	WNRC337		non-DSO phosphorite	30	32	2.0			0.09	3	15	-12	5.4	5.6	0	10	NAF
67	WNRC345		non-DSO phosphorite	37	39	2.0			0.06	2	14	-12	7.6				UC (NAF)
68	WNRC346		non-DSO phosphorite	29	31	2.0	7.6	0.099	0.19	6	14	-8	2.4	5.3	0	12	NAF
69	WNRC408		non-DSO phosphorite	30	38	8.0			0.06	2	15	-13	8.2				UC (NAF)
70	WNRC477		non-DSO phosphorite	44	47	3.0			0.07	2	23	-21	10.7				UC (NAF)
71	WNRC533		non-DSO phosphorite	41	43	2.0	7.7	0.087	0.05	2	16	-14	10.5	7.2	0	0	NAF

KEY

MPA = Maximum Potential Acidity (kgH_2SO_4/t)

ANC = Acid Neutralising Capacity (kgH_2SO_4/t)

NAPP = Net Acid Producing Potential (kgH_2SO_4/t)

NAGpH = pH of NAG liquor

$NAG_{(pH4.5)}$ = Net Acid Generation capacity to pH 4.5 (kgH_2SO_4/t)

$NAG_{(pH7.0)}$ = Net Acid Generation capacity to pH 7.0 (kgH_2SO_4/t)

NAF = Non-Acid Forming

UC = Uncertain Classification
(expected classification in brackets)

Table 10: Multi-element composition of selected low grade ore samples (mg/kg except where shown).

Element	Detection Limit	Composite Number/ Hole ID/ Lithology							
		Arruwurra Prospect				**Main Zone**			
		53	56	58	61	63	64	68	71
		WNRC211	WNRC219	WNRC227	WNRC756	WNRC313	WNRC326	WNRC346	WNRC533
		non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite
Ag	0.02	0.26	0.33	0.28	0.30	0.79	0.17	0.36	0.33
Al	0.01%	1.61%	1.97%	1.07%	3.19%	2.70%	2.32%	7.91%	2.77%
As	0.2	5.0	5.0	5.0	5.0	9.0	5	0.9	7.0
Ba	10	170	280	240	120	140	210	1060	910
Be	0.05	4.06	6.15	4.40	4.58	9.87	6.24	27.70	12.50
Bi	0.01	0.06	0.07	0.04	0.13	0.17	0.13	0.16	0.10
Ca	0.01%	11.15%	19.30%	18.05%	17.90%	14.05%	16.70%	6.84%	18.85%
Cd	0.02	0.49	0.34	0.59	0.86	1.84	1.58	0.63	2.51
Co	0.1	20.1	15.0	14.8	2.6	2.6	5.7	1.8	87.8
Cr	1	23	30	16	35	27	71	81	55
Cu	0.2	31.4	18.4	33.9	19.9	53.5	18.5	26.8	47.4
Fe	0.01%	0.16%	0.31%	0.28%	0.19%	0.29%	0.27%	0.42%	0.64%
Ga	10	3.53	5.33	2.63	6.84	7.90	6.1	13.15	8.29
Hg	0.01	0.016	0.024	0.034	0.014	0.017	0.02	0.034	0.031
K	0.002%	0.22%	0.20%	0.15%	0.31%	0.55%	0.32%	0.62%	0.29%
La	10	20	46	20	25	55	47.3	81	39
Mg	0.002%	0.10%	0.15%	0.08%	0.22%	0.11%	0.06%	0.08%	0.11%
Mn	1.0	268	599	1040	98	101	191	84	2510
Mo	0.1	0.42	0.73	1.47	0.24	0.30	1.65	0.84	0.92
Na	0.002%	0.07%	0.14%	0.09%	0.05%	0.06%	0.03%	0.05%	0.06%
Ni	1.0	5.5	7.9	5.7	7	4.6	24	3.6	61.1
P	20	>50000	>50000	>50000	>50000	>50000	>50000	>50000	>50000
Pb	2.0	78	126	44	100	345	82.3	93	106
S	0.001%	0.08%	0.16%	0.09%	0.03%	0.06%	0.03%	0.14%	0.05%
Sb	0.05	0.17	0.15	0.09	0.25	0.24	0.4	0.54	0.51
Sc	1	3.8	8.0	5.5	10.0	10.4	13	50.5	41.2
Se	0.01	<1	1	1	1	1	1	3	2
Sn	0.1	0.5	0.8	0.5	1.1	1.3	1.2	2.5	1.5
Sr	0.05	81	244	125	47	162	332	2200	1670
Th	0.2	2.8	3.5	2.4	6.0	6.7	6.5	16.7	6.5
Ti	0.01%	0.02%	0.02%	0.02%	0.04%	0.05%	0.02%	0.14%	0.06%
Tl	0.02	0.12	0.26	0.19	0.17	0.20	0.29	0.36	0.97
U	0.01	8.7	9.9	8.7	18.8	21.5	15.9	62.7	54.1
V	2.0	26	30	33	34	43	37	45	109
W	0.1	0.6	0.7	0.5	0.9	0.9	1.2	1.6	1.6
Zn	1.0	20	30	66	23	76	153	124	275

< element at or below analytical detection limit.

Table 11: Geochemical abundance indices (GAI) of selected low grade ore samples.

Element	Median Soil Abundance*	Composite Number/ Hole ID/ Lithology							
		Arruwurra Prospect				**Main Zone**			
		53	56	58	61	63	64	68	71
		WNRC211	WNRC219	WNRC227	WNRC756	WNRC313	WNRC326	WNRC346	WNRC533
		non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite
Ag	0.05	2	2	2	2	**3**	1	2	2
Al	7.1%	-	-	-	-	-	-	-	-
As	**6**	-	-	-	-	-	-	-	-
Ba	**500**	-	-	-	-	-	-	-	-
Be	0.3	**3**	**4**	**3**	**3**	**4**	**4**	**6**	**5**
Bi	0.2	-	-	-	-	-	-	-	-
Ca	1.5%	2	**3**	**3**	**3**	**3**	**3**	2	**3**
Cd	0.35	-	-	-	1	2	2	-	2
Co	**8**	1	-	-	-	-	-	-	**3**
Cr	**70**	-	-	-	-	-	-	-	-
Cu	**30**	-	-	-	-	-	-	-	-
Fe	4.0%	-	-	-	-	-	-	-	-
Ga	**20**	-	-	-	-	-	-	-	-
Hg	0.06	-	-	-	-	-	-	-	-
K	1.4%	-	-	-	-	-	-	-	-
La	**40**	-	-	-	-	-	-	-	-
Mg	0.5%	-	-	-	-	-	-	-	-
Mn	**1000**	-	-	-	-	-	-	-	1
Mo	1.2	-	-	-	-	-	-	-	-
Na	0.5%	-	-	-	-	-	-	-	-
Ni	**50**	-	-	-	-	-	-	-	-
P	**800**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Pb	**35**	1	1	-	1	**3**	1	1	1
S	0.07%	-	1	-	-	-	-	-	-
Sb	1	-	-	-	-	-	-	-	-
Sc	**7**	-	-	-	-	-	-	2	2
Se	0.4	1	1	1	1	1	1	2	2
Sn	**4**	-	-	-	-	-	-	-	-
Sr	**250**	-	-	-	-	-	-	**3**	2
Th	**9**	-	-	-	-	-	-	-	-
Ti	0.50%	-	-	-	-	-	-	-	-
Tl	0.2	-	-	-	-	-	-	-	2
U	2	2	2	2	**3**	**3**	2	**4**	**4**
V	**90**	-	-	-	-	-	-	-	-
W	1.5	-	-	-	-	-	-	-	-
Zn	**90**	-	-	-	-	-	-	-	1

*Bowen H.J.M.(1979) Environmental Chemistry of the Elements.

Table 12: Chemical composition of water extracts of selected low-grade ore samples.

Parameter		Detection Limit	Composite Numer/ Hole ID/ Lithology							
			Aruwurra Prospect				**Main Zone**			
			53	56	58	61	63	64	68	71
			WNRC211	WNRC219	WNRC227	WNRC756	WNRC313	WNRC326	WNRC346	WNRC533
			non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite	non-DSO phosphorite
pH		0.01	7.8	7.2	7.9	7.2	7.5	7.6	7.6	7.7
EC	dS/m	0.01	0.092	0.129	0.146	0.096	0.117	0.124	0.099	0.087
Ag	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/l	0.01	0.01	0.16	0.09	0.05	0.28	0.27	0.26	0.32
As	mg/l	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B	mg/l	0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	mg/l	0.001	0.565	0.030	0.056	0.027	0.011	0.004	0.002	0.052
Be	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/l	1	11	8	7	7	7	5	2	<1
Cd	mg/l	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/l	1	94	35	20	15	19	7	5	7
Co	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr	mg/l	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/l	0.001	0.002	0.001	0.001	0.001	0.002	0.009	0.004	0.002
F	mg/l	0.1	1.9	1.4	2.5	2.1	2.5	1.2	1.2	0.4
Fe	mg/l	0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.1
Hg	mg/l	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/l	1	7	3	4	2	<1	5	3	2
Mg	mg/l	1	8	4	3	2	2	1	<1	<1
Mn	mg/l	0.001	<0.001	0.002	0.002	0.009	0.001	0.003	0.003	0.006
Mo	mg/l	0.001	0.003	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Na	mg/l	1	70	24	17	13	18	8	6	6
Ni	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P	mg/l	1	<1	<1	<1	<1	2	2	<1	<1
Pb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.006	0.001	<0.001
Sb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Si	mg/l	0.05	7.87	4.59	4.03	3.36	6.53	7.46	8.38	4.65
Sn	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO_4	mg/l	1	60	23	8	8	4	7	<1	4
Sr	mg/l	0.001	0.185	0.103	0.065	0.041	0.03	0.006	0.005	0.013
Th	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/l	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/l	0.005	0.013	<0.005	<0.005	<0.005	<0.005	0.005	0.006	0.006

< element at or below analytical detection limit.

APPENDIX A

Assessment of Acid Forming Characteristics

Assessment of Acid Forming Characteristics

Introduction

Acid rock drainage (ARD) is produced by the exposure of sulphide minerals such as pyrite to atmospheric oxygen and water. The ability to identify in advance any mine materials that could potentially produce ARD is essential for timely implementation of mine waste management strategies.

A number of procedures have been developed to assess the acid forming characteristics of mine waste materials. The most widely used methods are the Acid-Base Account (ABA) and the Net Acid Generation (NAG) test. These methods are referred to as static procedures because each involves a single measurement in time.

Acid-Base Account

The acid-base account involves static laboratory procedures that evaluate the balance between acid generation processes (oxidation of sulphide minerals) and acid neutralising processes (dissolution of alkaline carbonates, displacement of exchangeable bases, and weathering of silicates).

The values arising from the acid-base account are referred to as the potential acidity and the acid neutralising capacity, respectively. The difference between the potential acidity and the acid neutralising capacity value is referred to as the net acid producing potential (NAPP).

The chemical and theoretical basis of the ABA are discussed below.

Potential Acidity

The potential acidity that can be generated by a sample is calculated from an estimate of the pyrite (FeS_2) content and assumes that the pyrite reacts under oxidising conditions to generate acid according to the following reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \Rightarrow Fe(OH)_3 + 2\ H_2SO_4$$

Based on the above reaction, the potential acidity of a sample containing 1 %S as pyrite would be 30.6 kilograms of H_2SO_4 per tonne of material (i.e. kg H_2SO_4/t). The pyrite content estimate can be based on total S and the potential acidity determined from total S is referred to as the maximum potential acidity (MPA), and is calculated as follows:

$$\text{MPA (kg } H_2SO_4/t) = (\text{Total \%S}) \times 30.6$$

The use of an MPA calculated from total sulphur is a conservative approach because some sulphur may occur in forms other than pyrite. Sulphate-sulphur, organic sulphur and native sulphur, for example, are non-acid generating sulphur forms. Also, some sulphur may occur as other metal sulphides (e.g. covellite, chalcocite, sphalerite, galena) which yield less acidity than pyrite when oxidised or, in some cases, may be non-acid generating. The total sulphur content is commonly used to assess potential acidity because of the difficulty, costs and uncertainty involved in routinely determining the speciation of sulphur forms within samples, and determining reactive sulphide-sulphur contents. However, if the sulphide mineral forms are known then allowance can be made for non- and lesser acid generating forms to provide a better estimate of the potential acidity.

Acid Neutralising Capacity (ANC)

The acid formed from pyrite oxidation will to some extent react with acid neutralising minerals contained within the sample. This inherent acid buffering is quantified in terms of the ANC.

The ANC is commonly determined by the Modified Sobek method. This method involves the addition of a known amount of standardised hydrochloric acid (HCl) to an accurately weighed sample, allowing the sample time to react (with heating), then back-titrating the mixture with standardised sodium hydroxide (NaOH) to determine the amount of unreacted HCl. The amount of acid consumed by reaction with the sample is then calculated and expressed in the same units as the MPA (kg H_2SO_4/t).

Net Acid Producing Potential (NAPP)

The NAPP is a theoretical calculation commonly used to indicate if a material has potential to produce acidic drainage. It represents the balance between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H_2SO_4/t and is calculated as follows:

$$\text{NAPP} = \text{MPA} - \text{ANC}$$

If the MPA is less than the ANC then the NAPP is negative, which indicates that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC then the NAPP is positive, which indicates that the material may be acid generating.

ANC/MPA Ratio

The ANC/MPA ratio is frequently used as a means of assessing the risk of acid generation from mine waste materials. The ANC/MPA ratio is another way of looking at the acid base account. A positive NAPP is equivalent to an ANC/MPA ratio less than 1, and a negative NAPP is equivalent to an ANC/MPA ratio greater than 1. A NAPP of zero is equivalent to an ANC/MPA ratio of 1.

The purpose of the ANC/MPA ratio is to provide an indication of the relative margin of safety (or lack thereof) within a material. Various ANC/MPA values are reported in the literature for indicating safe values for prevention of acid generation. These values typically range from 1 to 3. As a general rule, an ANC/MPA ratio of 2 or more signifies that there is a high probability that the material will remain circum-neutral in pH and thereby should not be problematic with respect to acid rock drainage.

Acid-Base Account Plot

Sulphur and ANC data are often presented graphically in a format similar to that shown in Figure A-1. This figure includes a line indicating the division between NAPP positive samples from NAPP negative samples. Also shown are lines corresponding to ANC/MPA ratios of 2 and 3.

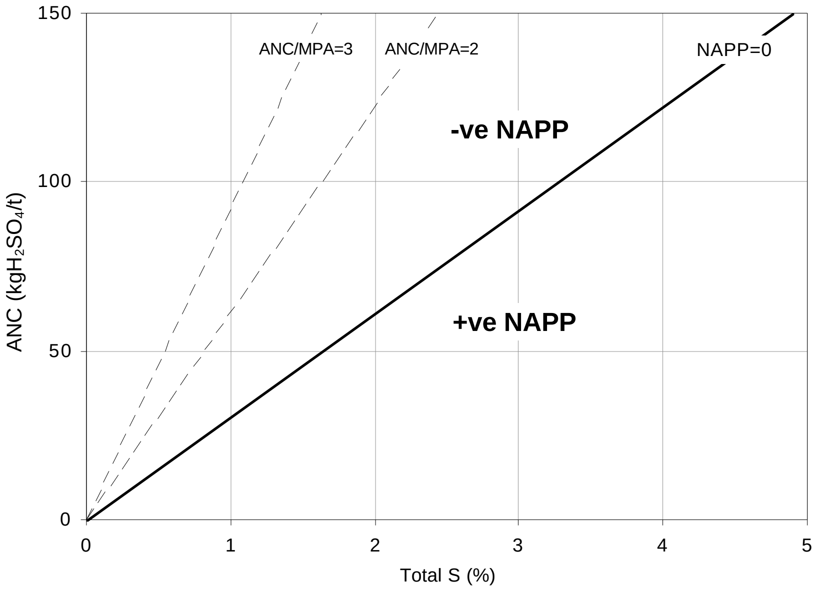

Figure A-1: Acid-base account (ABA) plot

Net Acid Generation (NAG) Test

The NAG test is used in association with the NAPP to classify the acid generating potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals contained within a sample. During the NAG test both acid generation and acid neutralisation reactions can occur simultaneously. The end result represents a direct measurement of the net amount of acid generated by the sample. The final pH is referred to as the NAGpH and the amount of acid produced is commonly referred to as the NAG capacity, and is expressed in the same units as the NAPP (kg H_2SO_4/t).

Several variations of the NAG test have been developed to accommodate the wide geochemical variability of mine waste materials. The four main NAG test procedures currently used by EGi are the single addition NAG test, the sequential NAG test, the kinetic NAG test, and the extended boil and calculated NAG test.

Single Addition NAG Test

The single addition NAG test involves the addition of 250 ml of 15% hydrogen peroxide to 2.5 g of sample. The peroxide is allowed to react with the sample overnight and the following day the sample is gently heated to accelerate the oxidation of any remaining sulphides, then vigorously boiled for several minutes to decompose residual peroxide. When cool, the NAGpH and NAG capacity are measured.

An indication of the form of the acidity is provided by initially titrating the NAG liquor to pH 4.5, then continuing the titration up to pH 7. The titration value at pH 4.5 includes acidity due to free acid (i.e. H_2SO_4) as well as soluble iron and aluminium. The titration value at pH 7 also includes metallic ions that precipitate as hydroxides at between pH 4.5 and 7.

Sequential NAG Test

When testing samples with high sulphide contents it is not uncommon for oxidation to be incomplete in the single addition NAG test. This can sometimes occur when there is catalytic breakdown of the hydrogen peroxide before it has had a chance to oxidise all of the sulphides in a sample. To overcome this limitation, a sequential NAG test is often carried out. This test may also be used to assess the relative geochemical lag of PAF samples with high ANC.

The sequential NAG test is a multi-stage procedure involving a series of single addition NAG tests on the one sample (i.e. 2.5 g of sample is reacted two or more times with 250 ml aliquots of 15% hydrogen peroxide). At the end of each stage, the sample is filtered and the solution is used for measurement of NAGpH and NAG capacity. The NAG test is then repeated on the solid residue. The cycle is repeated until such time that there is no further catalytic decomposition of the peroxide, or when the NAGpH is greater than pH 4.5. The overall NAG capacity of the sample is then determined by summing the individual acid capacities from each stage.

Kinetic NAG Test

The kinetic NAG test is the same as the single addition NAG test except that the temperature and pH of the liquor are recorded. Variations in these parameters during the test provide an indication of the kinetics of sulphide oxidation and acid generation. This, in turn, can provide an insight into the behaviour of the material under field conditions. For example, the pH trend gives an estimate of relative reactivity and may be related to prediction of lag times and oxidation rates similar to those measured in leach columns. Also, sulphidic samples commonly produce a temperature excursion during the NAG test due to the decomposition of the peroxide solution, catalysed by sulphide surfaces and/or oxidation products.

Extended Boil and Calculated NAG Test

Organic acids may be generated in NAG tests due to partial oxidation of carbonaceous materials[1] such as coal washery wastes. This can lead to low NAGpH values and high acidities in standard single addition NAG tests unrelated to acid generation from sulphides. Organic acid effects can therefore result in misleading NAG values and misclassification of the acid forming potential of a sample.

The extended boil and calculated NAG tests can be used to account for the relative proportions of pyrite derived acidity and organic acidity in a given NAG solution, thus providing a more reliable measure of the acid forming potential of a sample. The procedure involves two steps to differentiating pyritic acid from organic derived acid:

Extended Boil NAG	decompose the organic acids and hence remove the influence of non-pyritic acidity on the NAG solution.
Calculated NAG	calculate the net acid potential based on the balance of cations and anions in the NAG solution, which will not be affected by organic acid.

The extended boiling test is carried out on the filtered liquor of a standard NAG test, and involves vigorous boiling of the solution on a hot plate for 3-4 hours. After the boiling step the solution is cooled and the pH measured. An extended boil NAGpH less than 4.5 confirms the sample is potentially acid forming (PAF), but a pH value greater than 4.5 does not necessarily mean that the sample is non acid forming (NAF), due to some loss of free acid during the extended boiling procedure. To address this issue, a split of the same filtered NAG solution is assayed for concentrations of S, Ca, Mg, Na, K and Cl, from which a calculated NAG value is determined[2].

The concentration of dissolved S is used to calculate the amount of acid (as H_2SO_4) generated by the sample and the concentrations of Ca, Mg, Na and K are used to estimate the amount of acid neutralised (as H_2SO_4). The concentration of Cl is used to correct for soluble cations associated with Cl salts, which may be present in the sample and unrelated to acid generating and acid neutralising reactions.

The calculated NAG value is the amount of acid neutralised subtracted from the amount of acid generated. A positive value indicates that the sample has excess acid generation and is likely to be PAF, and a zero or negative value indicates that the sample has excess neutralising capacity and is likely to be NAF.

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[1] Stewart, W., Miller, S., Thomas, J.E., and Smart R. (2003), 'Evaluation of the Effects of Organic Matter on the Net Acid Generation (NAG) Test', in *Proceedings of the Sixth International Conference on Acid Rock drainage (ICARD), Cairns, 12-18th July 2003*, 211-222.

[2] Environmental Geochemistry International, Levay and Co. and ACeSSS, 2008. *ACARP Project C15034: Development of ARD Assessment for Coal Process Wastes*, EGi Document No. 3207/817, July 2008.

Sample Classification

The acid forming potential of a sample is classified on the basis of the acid-base and NAG test results into one of the following categories:

- Barren;
- Non-acid forming (NAF);
- Potentially acid forming (PAF); and
- Uncertain (UC).

Barren

A sample classified as barren essentially has no acid generating capacity and no acid buffering capacity. This category is most likely to apply to highly weathered materials. In essence, it represents an ‘inert’ material with respect to acid generation. The criteria used to classify a sample as barren may vary between sites, but for hard rock mines it generally applies to materials with a total sulphur content ≤ 0.1 %S and an ANC ≤ 5 kg H_2SO_4/t.

Non-acid forming (NAF)

A sample classified as NAF may, or may not, have a significant sulphur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. A sample is usually defined as NAF when it has a negative NAPP and the final NAG pH ≥ 4.5.

Potentially acid forming (PAF)

A sample classified as PAF always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a high risk that such a material, even if pH circum-neutral when freshly mined or processed, could oxidise and generate acidic drainage if exposed to atmospheric conditions. A sample is usually defined as PAF when it has a positive NAPP and a final NAGpH < 4.5.

Uncertain (UC)

An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (i.e. when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤ 4.5). Uncertain samples are generally given a tentative classification that is shown in brackets e.g. UC(NAF).

Figure A-2 shows the format of the classification plot that is typically used for presentation of NAPP and NAG data. Marked on this plot are the quadrats representing the NAF, PAF and UC classifications.

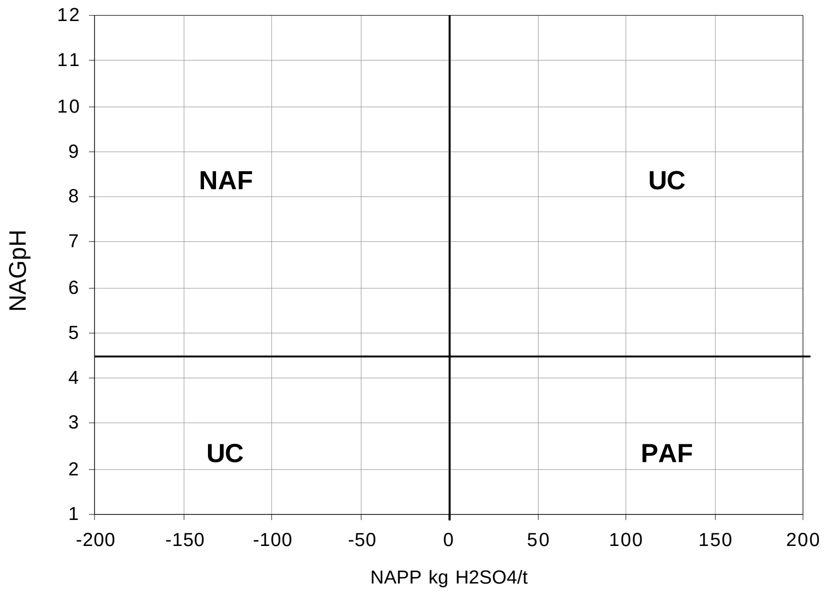


Figure A-2 ARD classification plot

Other Methods

Other test procedures may be used to define the acid forming characteristics of a sample.

pH and Electrical Conductivity

The pH and electrical conductivity (EC) of a sample is determined by equilibrating the sample in deionised water for a minimum of 12 hours (or overnight), typically at a solid to water ratio of 1:2 (w/w). This gives an indication of the inherent acidity and salinity of the waste material when initially exposed in a waste emplacement area.

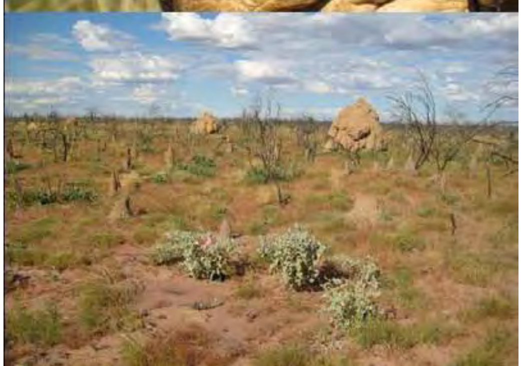
Acid Buffering Characteristic Curve (ABCC) Test

The ABCC test involves slow titration of a sample with acid while continuously monitoring pH. These data provides an indication of the portion of ANC within a sample that is readily available for acid neutralisation.

APPENDIX E BASELINE FLORA AND FAUNA REPORT

Minemakers Wonarah Phosphate Project

Baseline Flora and Fauna Report



Prepared for
Coffey Natural Systems

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April 2009

Executive Summary

Overview

Minemakers Australia Pty Ltd is currently in the pre-feasibility stage of their Wonarah Phosphate Project. Low Ecological Services P/L (LES) was commissioned to broadly characterise the ecology of the area, to identify threatened species of flora and fauna present, or likely to be present in the project area, and determine if there is a potential for the project to have significant impacts on these species.

The biodiversity of the area has generally been documented at a regional scale with only occasional incursion to adjacent areas for on-the-ground flora and fauna survey (Wakaya Desert survey - Gibson and Wurst, 1994). Existing data sets were used for a rapid landscape analysis to determine, in a regional context, landforms, geology, drainage systems, vegetation communities or habitats, and compile flora and fauna species lists for the project area. Two landscape, flora and fauna surveys of the project area were conducted by Low Ecological Services between the 18^{th} and 22^{nd} June 2008 (Dry Season 2008) and 20^{th} and 25^{th} March 2009 (Wet Season 2009). A more detailed soil survey was included in the 2009 survey.

Regional Context

The project area lies within the Davenport and Murchison Ranges Bioregion. The project area overlies the phosphate rich Wonarah beds site, which is classified as significant on a bioregional scale as determined by the NT Parks and Conservation Masterplan (Baker *et al.*, 2005). This was likely due to the variety of habitats resulting from the relative mix of shallow sand covered rocky sub-crop and deeper aeolian sandy and alluvial silty drainage depressions. The project area is dominated by the Yelvertoft land system (Stewart *et al*. 1954) with minor occurrences of the Wonarah land system (Perry *et al.* 1962, Stewart *et al*. 1954).

The project area occurs within vegetation community 42 (Wilson et al., 1990) which is described as *Corymbia opaca* (Bloodwood) low open-woodland with *Triodia pungens* (Soft Spinifex) hummock grassland understorey. Vegetation community 42 occupies 28095.3 km^2 within the Northern Territory of which the Wonarah Phosphate Project area constitutes ~100 km^2 and the proposed disturbance (i.e. mine area) equates to 27 km^2 (0.1% of vegetation community).

Existing Data

A search of the NT Parks and Wildlife Flora Atlas (2007) for the project area and surrounding region did not identify any flora species of conservation significance under the EPBC Act. However, fourteen species were listed under the TPWC Act or by White *et al*. (2000) as significant at the NT or National level. Four of these species occur within the project area, two of which are listed as significant at a national level (*Sporobolus latzii* and *Bonamia alatisemina*) by White *et al.*, (2000). Many of these species are essentially data deficient due to lack of surveys in appropriate habitat in the region. No flora species of conservation significance were identified by a protected matters report generated by the Department of Environment Water Heritage and the Arts (DEWHA) web site for the project area and surrounding region.

A search of the NT Parks and Wildlife Fauna Atlas (2007) for the project area and surrounding region identified three species of conservation significance under the EPBC Act and TPWC Act, and eight species listed solely under the TPWC Act. Three of these species have been recorded within the project area (Australian bustard, *Ardeotis australis*, woma, *Aspidites ramsayi*, and long-haired rat, *Rattus villosissimus*). Two threatened (vulnerable) fauna species (mulgara, *Dasycercus cristicauda* or *D. blythi*, and Australian painted snipe, *Rostratula australis*); and eight migratory fauna species were identified by a protected matters report (DEWHA) as potentially present in the project area and surrounding region. No endangered or critically endangered species were listed.

Field Surveys

While the vegetation classification developed by Wilson *et al.* 1990 is broadly appropriate to the project area, LES desk top and field surveys defined five fine scale vegetation communities within the broader vegetation communities. The fine scale vegetation communities were found to be correlated with land units described by LES, which were verified in the field. Fine scale vegetation communities were mapped by LES for the project area to allow assessment of disturbance at a local scale.

The sand plain land units (Alluvial Sand Plains, Shallow Sand Plains and Deep Sand Plains) supported a continuous but variable vegetation community with differing proportions of flora species determined by landscape variables (vegetation community 1 = Eucalypt (coolabah, mallee & bloodwood) and Acacia (dogwood) low open-woodland with Senna sp. low shrublands over hummock grassland). The

Black Soil and Clay Plain land units were grouped, and supported vegetation community 2 = Coolabah low-open woodland with silky browntop (*Eulalia aurea*) and Mitchell grass grassland understorey. Calcareous Plains supported vegetation community 3 = Supplejack low open woodland with open-grassland understorey. Ephemeral Lakes supported vegetation community 4 = *E. victrix* (coolabah) low open-woodland with open-grassland understorey. There were limited floristic data for the Rocky rise land units (Limestone Outcrop and Mud Stone Outcrop) due to inaccessibility, but they were grouped with the surveyed rocky rise land units (Silcrete and Ironstone Rocky Rises) which were found to support the same vegetation community with varying proportions of species present. This was defined as vegetation community 5 = Acacia & mallee shrubland over hummock grassland.

Fine scale vegetation communities (as classified by LES) 1, 3 & 5 will be the only areas disturbed by the proposed works and the other two communities 2 and 4 are remote and not accessible to the mining operation. No habitats of ecological significance were detected within the project area; however the main ephemeral lake, which is located 5 km north of the Arruwurra Prospect and 13 km south-west of the Main Zone (Wonarah Prospect), is likely to provide important seasonal refuges for fauna and for both annual and perennial plant species adapted to seasonal inundations. This area is outside of the proposed disturbance area.

Up to 60% of the project area was burnt prior to the Dry Season 2008 survey, as reflected in the vegetation transects, which, on average, had 48 % bare ground and 23 % litter. Good vegetation growth was recorded during the Wet Season 2009 survey following favourable summer rains, with bare ground along vegetation transects reduced to an average of 19 %. Data from the Wet Season 2009 survey revealed an additional 102 flora species relative to the 42 species identified during the Dry Season 2008 survey, emphasising the importance of a follow-up survey to capture seasonal changes in species composition including those in response to fire. A total of 144 flora species was recorded in the Dry (2008) and Wet (2009) season surveys.

No plant species identified during LES field surveys are listed under the EPBC Act; however, two species are listed as Near Threatened (*Bergia barklyana* and *Hibiscus brachychlaenus*) and one as Data Deficient (*Heliotropium pulvinum*) under the TPWC Act. Two environmental weed species were recorded during the Wet Season 2009 survey along road verges and in drainage lines, buffel grass (*Cenchrus ciliaris*) and kapok bush (*Aerva javanica*). Neither species is declared under the *NT Weeds*

Management Act (2001), and Buffel Grass is a useful pasture species. Five declared weeds have been recorded in other studies within the surrounding region (50 km buffer); (Bellyache Bush (*Jatropha gossypifolia*), Mesquite (*Prosopis limensis*), Noogoora Burr (*Xanthium strumarium*), Paddy's Lucerne (*Sida rhombifolia*) and Parkinsonia (*Parkinsonia aculeata*)).

LES field surveys recorded a total of 15 mammal, 14 reptile and 33 bird species. One species listed as Vulnerable under the TPWC Act (2000), the Australian bustard, (*Ardeotis australis*), and the northern nailtail wallaby (*Onychogalea unguifera*), listed as Near Threatened under the TPWC Act, were recorded. A further nine species of conservation significance have been recorded within the project area and the surrounding region (50 km buffer) in other studies. LES conducted targeted surveys for species of conservation significance, especially bilby (*Macrotis lagotis*) and mulgara (*Dasycercus cristicauda* or *D. blythi*) where suitable habitat was identified during the Dry Season 2008 survey, but no evidence was found. Traditional owners assisted with tracking surveys and were consulted regarding their knowledge of significant fauna species occurring in the local region, but none were identified.

Within the surrounding region over 90 bird species have been recorded and many of these species are likely to occur within the project area. Sand plain habitats are likely to support the greatest bird diversity owing to the micro-topographic diversity and density of habitat, as well as the range of food resources due to the variable phenology of plant species that occur from ridge to flood out. Ephemeral wetland areas are also likely to be important habitats during wet seasons for many migratory species. None of the species listed are especially uncommon or rare in a regional sense. Most species present and potentially present, are wide-ranging.

Five species of introduced fauna were recorded. Three herbivore species, camel (*Camelus dromedarius*), cow (*Bos taurus*) and donkey (*Equus asinus*), were evidenced by old (> 1 month old) tracks at low densities around depressions, suggesting the animals were attracted to the water. Source populations for cattle include pastoral stations particularly to the north, but also possibly feral populations. Feral donkeys and especially camels are dispersed throughout the NT but congregate around water sources, which include natural waterholes and artificial sources such as dams, bores, and those at communities. Three carnivorous species were recorded: cat (*Felis catus*), fox (*Vulpes vulpes*) and dingo (*Canis lupis*). Fresh tracks (< 1 week old) were observed, mostly along exploration tracks, although some cat tracks were scattered within survey quadrats. Low incidence of tracks suggests low populations, with fresh tracks suggesting that the project area is currently utilised for intermittent hunting.

Bushfires within the project area are known to have a frequency of 1 – 2 events per 10 years. Beneficial fire conditions to assist persistence of significant species include low intensity, mosaic burns; however, there is limited information available for these species.

Plant and animal species of indigenous cultural value were identified and shown to be mainly of utilitarian value (i.e. food and medicine). All species are widespread and many are managed by indigenous peoples with fire. However, culturally significant trees are defined by the Central Land Council (CLC) as having trunk diameters equal to or greater than 12.5 cm and being at least 1.5 m tall and CLC approval is required prior to the removal and/or modification of such trees in these desert areas.

Low Ecological Services identified four soil types within the project area - Kandosols, Vertosols, Calcarosols and Rudosols (Australian Soil Classification: Isbell, 1996). Kandosols and Rudosols dominate the sand plains within the project area, Vertosols are restricted to areas subject to inundation (e.g. ephemeral lakes) and Calcarosols are restricted to two localities in the southern end of the Wonarah Phosphate Project area.

Minimising Impacts of the Operation

The proposed operations will not have a significant impact on flora and fauna at a national or bioregional scale as the habitat is common and widespread and most species recorded during on-site investigations are wide-ranging. Of the restricted or uncommon flora species recorded within the Wonarah Phosphate Project area, the Southern Sites of Botanical Significance (SSOBS) conservation codes, as defined by White *et al.* (2000), suggests that only *Sporobolus latzii* may be reliant on the project area for its continued persistence. The known record of this species is within a cultural exclusion zone associated with the ephemeral lake land unit which will not be disturbed by mining operations. Targeted fauna surveys, consultation with Traditional Owners and reference to the literature indicate that significant or major populations of fauna of conservation significance are unlikely to occur within the project area. It is therefore determined that the status of flora and fauna species of conservation significance that occur or could occur within the project area will not be affected by the proposed operations.

There will be loss of flora and fauna on a local scale and a variety of management strategies are described herein to minimise these impacts.

The most important of these are:

- On-going monitoring throughout the operation and rehabilitation phase of the project. In particular, track surveys for fauna species of conservation significance should be conducted immediately before mining operations commence, so identified threatened species can be translocated or harassed to move them out of the open cut pit or infrastructure sites;
- Important habitats, such as the ephemeral lakes land unit and areas subject to inundation, should be preserved where possible;
- Induction of all staff should include information on significant flora and fauna, how to identify them and how to minimise impact;
- Careful management of top soil, striped for mining activities, to aid rehabilitation success. Use of top soils (managed to maintain viable seed stocks) allows rehabilitated areas to regenerate utilising the existing seed bank.
    - Top soil stripping should be done after the soils have dried out to allow plants and seed to go into dormancy;
    - Top soil should be re-used as soon as possible after stripping, preferably within 3 to 6 months and before the wet season to enable maximum germination of seeds of appropriate maturity;
    - Early in the mine development, plant revegetation trials (based on stripped topsoil) should be established to determine if natural revegetation will be adequate for rehabilitation purposes. In the unlikely event that trials show inadequate revegetation, a seed collection program may be required based on local provenance material. A plant species list is provided herein showing suitable species for rehabilitation specific to land units within the project area;
    - Rehabilitation of soils and flora should be in accordance to the specific land unit which minimises impacts to biodiversity and species of conservation significance, and
- Best practice environmental principles should be adhered to at all times.

Table of Contents

Tables

Figures

1. Introduction

Minemakers Australia Pty Ltd (Minemakers) is currently in the pre-feasibility stage of their Wonarah Phosphate Project, located in the Barkly Tableland region of the Northern Territory (NT) (Appendix 1). Two main prospects have been identified within the project area, the Main Zone (Wonarah Prospect) and Arruwurra Prospect, (Appendix 2). Low Ecological Services P/L (LES) was commissioned to: broadly characterise the ecology of the area (habitats and faunal communities present); to characterise soils within the area and provide mitigating measures for potential soil degradation under mining; to identify threatened species of flora and fauna present or likely to be present in the project area; to highlight the potential for the project to have significant impacts on these species as well as assess potential impacts on these species of other disturbances such as bushfire and pest species which may be influenced by mining activities. LES conducted two field surveys, one in the dry and one in the wet seasons (June 2008 and March 2009). This report combines results from both surveys to address the requirements of Coffey Natural Systems in Briefs 1 and 2 (provided June 2008 and March 2009).

2. Scope of Works

The following scope of works was provided to LES and has been divided into Survey 1 and 2.

2.1. Study Objectives Survey 1 (Dry Season 2008)

- To broadly characterise the ecology of the area (habitats and faunal communities present);
- To determine whether threatened flora and fauna species listed under the *Environment Protection and Biodiversity Act* 1999 (EPBC Act) or *Territory Parks and Wildlife Conservation Act* 2000 (TPWC Act) are present, or likely to be present, in the two project areas;
- To determine the significance of the habitat in these areas for listed threatened flora and fauna species;
- To determine the potential for significant impacts on threatened flora and fauna species as a result of the project; and
- To recommend management and mitigation measures specific to any threatened species at risk from the project.

2.2. Study Objectives Survey 2 (Wet Season 2009)

- To characterise the vegetation and habitat types during the wet season, identifying any flora and fauna listed under the EPBC Act or TPWC Act present or likely to be present in the project area;
- To prepare maps identifying areas with conservation values and habitat known to support, or with potential to support, listed species including the mulgara, bilby, yellow chat and migratory birds.
- To prepare vegetation maps of the project area and the surrounding area at a sufficient scale to put vegetation disturbance as a result of the project into a regional context.
- To identify any introduced fauna and flora, assess their abundance in and around the project area and identify any potential source populations which may have an impact on the area;
- To assess the impact of attracting introduced grazing species (i.e. rabbits and camels) to the project area and outline mitigating measures;
- To identify flora and fauna in the project area of Indigenous value (e.g. mythical, cultural or utilitarian);
- To assess the potential for any significant impacts on threatened flora and fauna as a result of the project, and specifically the likelihood and consequence of these impacts. Potential impacts must be considered at the local, regional, territory and national scale;
- To recommend management and mitigation measures specific to any species at risk from the project as well as significant species (i.e. EPBC listed and TPWC listed species, species of indigenous values) at a local, regional, territory and national scale;
- To outline the impacts of bushfires on flora and fauna in the region, and identify threatened species potentially at risk from bushfire;
- To specify local plant species suitable for ongoing and final revegetation and rehabilitation works in the project area;
- To identify opportunities to rehabilitate and improve habitat availability and quality in the project area for EPBC and TPWC listed species;
- To characterise and describe the soils within the project area;
- To prepare maps detailing the soils of the study area, and
- To outline management and mitigation recommendations for soils likely to be disturbed during the construction and operation of the project.

2.3. Study Tasks Survey 1 (Dry Season 2008)

2.3.1. Desktop Survey

The initial desktop survey will include:

- A land system description; and,
- Identification of flora and fauna species expected to be present in the project areas based on data from LES and Northern Territory and Commonwealth government databases.

2.3.2. Field Surveys

Flora and fauna surveys within the project areas will:

- Identify fauna collected, directly observed or indirectly observed;
- Identify the major vegetation structural types, plant species and, particularly, vulnerable bushland resources for threatened fauna species, or local stakeholders, that will be affected by the project;
- Enable the preparation of a database for vegetation structure and/or floristic composition in the project areas; and,
- Record the locations of any observations of threatened flora or fauna species using a GPS.

2.4. Study Tasks Survey 2 (Wet Season 2009)

2.4.1. Desktop Survey

- Review existing data sources (e.g. aerial photography, satellite imagery and existing soils mapping) and describe the topography, geology and soils. Existing level of soil erosion and other disturbances within the study area will be identified.

2.4.2. Field Surveys

Flora and fauna surveys within the project areas will:

- Identify fauna collected, directly or indirectly observed;
- Identify and record the location of all survey quadrats, transects and traps with global positioning system (GPS) coordinates;
- Identify and record the distribution and abundance of introduced flora and fauna;
- Provide seasonal information regarding the distribution and abundance of flora and fauna;

- Provide information regarding the distribution of ephemeral water bodies in the project area and the fauna seasonally using this habitat;
- Enable preparation of habitat and vegetation maps for the project area with particular reference to potential habitat for significant species;
- Establish survey control sites (within the flora and fauna survey boundary but outside the project area and phosphorite deposits) and impact sites (within project area) for future monitoring programs. Sites should be representative of the various habitat types within and around the project area;
- Use appropriate methods to determine the extent and significance of the potential impacts of the project on flora and fauna. The Biodiversity Conservation Unit of the Department of Natural Resources, Environment, the Arts and Sport (NRETAS) must be consulted on the survey methods prior to commencing field work. It is expected that staff from Coffey Natural Systems will participate in any meetings;
- A soil survey will be conducted, with areas to be disturbed by the project being mapped more intensively than non-disturbed areas. The survey should follow *Australian Soil and Land Survey Field Handbook* (McDonald *et al*., 1990) guidelines; however if survey parameters deviate from acceptable survey standards, evidence must be provided to demonstrate why such a deviation is acceptable (for example soil profiles must be consistent across the survey area). Soil profiles should be mapped at a suitable scale and described according to the *Australian Soil and Land Survey Field Handbook* (McDonald *et al*., 1990) and *Australian Soil Classification* (Isbell, 1996), and
- An appraisal of the depth and quality of topsoil will be undertaken. Any limiting properties of the soils will be discussed and any implications or special management requirements for the construction, operation and rehabilitation will be identified.

2.5. Reporting Survey 1 & 2 (Dry Season 2008 and Wet Season 2009)

A report collating all work to date (suitable as a stand alone document for inclusion as an appendix to a Public Environmental Report / Environmental Impact Statement) will be prepared. This report will include:

- A detailed description of the survey method and why this method provides confidence in results presented;

- A description of the ecology of the area (habitats and faunal communities present), including a list of species identified during the field visits;
- A list of all threatened species of flora and fauna present and likely to be present in the project area and the surrounds, including GPS coordinates of recorded locations for these species;
- Classification of these species in terms of their conservation significance at a local, regional, territory and national level;
- A habitat and vegetation map of the project area, including identification of any critical habitat types;
- Broad scale vegetation mapping for the project area, flora and fauna survey area and surrounding region;
- A summary of the potential for impacts on listed threatened species of flora and fauna, and habitats, as a result of the project;
- A summary of recommended management and mitigation measures to minimise the potential for impacts to species (including EPBC and TPWC listed species and species of Indigenous values) identified as present or potentially present;
- A list of local plant species suitable for use in regeneration and rehabilitation works;
- Opportunities and measures to rehabilitate and/or improve habitat for significant species (i.e. EPBC and TPWC listed species, species of indigenous significance);
- A detailed description of the soil survey method, detailing any deviations from Australian standards;
- A description of the geology and topography of the project area, and
- The soils and land units of the study area will be described and mapped, with particular reference to the physical and chemical properties of the soils that will influence erosion potential, acid generation and any other properties which require special management.

3. Methods

3.1. Summary of Terminology

For the purposes of this report we have focused on SEL 26452 (refered to as project area hereafter) south of the Barkly Highway, within the greater Wonarah Phosphate Project area (Appendix Two). The proposed disturbance area occupies a 27 km^2 area around the Main Zone (Wonarah) and Arruwurra Prospects and our surveys concentrated in these areas and within adjacent non impact areas. The two main prospects refer to the Main Zone and Arruwurra prospects and proposed mineral lease applications will cover these areas. The NT Flora and Fauna Atlases (2007) were searched for records occurring within a 50 km buffer from the centre of the project area. This search area is referred to as the surrounding region.

3.2. Existing data

Existing data formed the basis of a landscape analysis to determine, at a regional scale, landforms, geology, drainage systems, vegetation communities or habitats, and associated flora and fauna. Existing fauna and herbarium flora data were used to compile species lists for the project area and surrounding region. In order to account for changes in declared species of conservation significance listed under the EPBC Act and TPWC Act, a protected matters report was generated from the Department of Environment Water Heritage and the Arts (DEWHA) web site for the project area and surrounding region. Existing fire scar data was collected from the NT Bushfire Council website to determine fire frequency within the project area and surrounding region. Indigenous values of flora and fauna species were determined through consultations with Traditional Owners during field surveys and through utilising existing reference material. Detailed geological data for the project area, provided by Rio Tinto, was utilised in conjunction with on-site surveys to produce land unit, vegetation and soil maps of the project area.

3.3. Field Surveys

Two landscape, flora and fauna surveys of the project area were undertaken by LES between the 18th and 22nd June 2008 (Dry Season 2008) and 20th and 25th March 2009 (Wet Season 2009).

Fauna surveys were based on biodiversity sampling methods established by the Department of Natural Resources Environment and The Arts (NRETA) for Central Australia (Neave *et al.* 2006). Site descriptions and flora surveys were based on *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst *et al,* 2007; pp 85-87) and were adapted to suit the scope of works and landscape characteristics, and to take advantage of the expertise within LES. Two-hundred metre vegetation transects were introduced to the surveying methodology to provide a quantitative method to monitor temporal variability in floristics at sites.

The Dry Season 2008 survey consisted of:

- Establishing familiarity with the site and landscape to determine appropriate sites for flora and fauna surveys;
- Elliott and pitfall trapping for three nights at four selected sites;
- Intensive tracking surveys at eight selected sites;
- General flora surveys of the entire project area;
- Intensive flora surveys, including vegetation transects, at eight selected sites;
- Site descriptions (including landscape variables) at eight selected sites;
- Rapid landscape assessment and site description of the entire project area; and
- Searches for habitats of ecological significance.

The Wet Season 2009 survey consisted of:

- Establishment of eight survey quadrats within six land units representative of the project area, with six sites in proposed impact zones and two replicate sites in corresponding land units in non-impact zones, suitable for establishing an ongoing monitoring program. GPS coordinates were recorded for all survey quadrats, vegetation transects and traps.
- Elliott, pitfall, cage and funnel trapping for three nights at eight sample quadrats;
- ANABAT sonar microchiropteran bat detector at four sample quadrats for one night each.
- Bird survey at eight survey quadrats each day.
- Intensive tracking surveys at eight sample quadrats, including identification of introduced fauna. All incidental observations of fauna on the lease site were recorded with GPS and land unit data;
- Intensive flora surveys, including vegetation transects, at eight sample quadrats, including identification of introduced flora;
- Site descriptions (including landscape variables) at eight sample quadrats;

- Ground truthing of land unit map based on Rio Tinto geological map at an appropriate fine scale by traversing portions of the project area;
- Searches for habitats/flora/fauna of ecological significance, including brief survey of dried ephemeral lakes within mine lease; and
- Soil survey, including soil classification suitable for producing a soil map, of traversed areas including an appraisal of the depth and quality of topsoil and potential management issues.

3.3.1 Establishing Familiarity with the Site and Landscape (Dry Season 2008)

Following discussions about the site with supervisory geological exploration staff, a drive over the project area was undertaken to determine appropriate sites for flora and fauna surveys and to develop familiarity with the landscape. The aim of the process was to maximise exposure to different habitat zones and land units within the two main prospects and the project area. In 2008, five sites were selected in the two main prospects and three additional sites were selected throughout the project area. In 2009, six sites were selected within the two prospects and two sites were selected in non-impact areas. A description of survey methods used at each site is provided below.

3.3.2 Survey Methodologies

Site Selection

Eight survey quadrats were selected during the Dry Season 2008 survey to represent different land units within the project area, as well as replicate burnt and unburnt sites due to extensive fire within the region prior to the survey. Eight survey quadrats were selected during the Wet Season 2009 survey within six land units representative of the project area, with six sites in proposed impact zones and two replicate sites in corresponding land units in proposed non-impact zones. In the Wet Season 2009 survey, quadrats selected were suitable for recommended future monitoring to assess impacts of mining activities on local biodiversity and, specifically, on listed threatened species. Survey quadrats utilised in the Dry Season 2008 survey were re-used in the Wet Season 2009 survey when they met the above criteria.

Access to sites was by current roads, thus preventing access into some land units, which are therefore not represented in these surveys. As per the brief, the Dry Season 2008 survey focused quadrats within proposed impact areas within both prospects. The second brief (Wet Season 2009) required survey quadrats to be within replicate land units within proposed impact and non-impact areas, again spread between both prospects. However, our choice of land units in non impact areas was limited to those that occur on the single exploration track that links the two main zones. It may therefore be useful to install new access tracks for future monitoring if there is a desire to have exact land unit replicates within proposed impact and non-impact areas. Locations of survey quadrats are provided in Appendix Three and coordinates are provided in Table 1. An overview of the stratification of survey quadrats is provided in Appendix Four and Table 2.

Site Description

Site description summaries were completed for all quadrats surveyed in 2008 and 2009. Photographs were taken of each site, as well as more broadly, to provide examples of the habitat types in the area and features of note.

Fauna Trapping

During the Dry Season 2008 survey, vegetation description, fauna tracking and fauna trapping were undertaken at sites one to five (TS1-5 – Appendix Three), and vegetation description and fauna tracking were undertaken at an additional three sites (S6-S8 – Appendix Three) within the project area to maximise exposure to different habitat zones and land units (Appendix Four). Elliott trapping (one line with 25 traps placed 10 - 15 m apart) was conducted over three nights and represented a total of 225 trap nights (one Elliott trap open for one night = one trap night) for the survey. During the Wet Season 2009 survey, vegetation description, fauna tracking and fauna trapping were undertaken at eight sites (Appendix Three and Four). Elliott trapping was conducted over three nights and represented a total of 600 trap nights for the survey. Traps were baited with a mixture of oats and peanut butter. Two pit fall traps, consisting of a 25 L bucket with a 10 m drift fence, were placed 100 m apart along each of the Elliott trap lines. All traps were placed in potentially shady locations when available, or had shade shelters constructed using on-site vegetation; traps were checked each morning.

Vegetation Survey

The vegetation sampling consisted of recording all plant species within an approximate 200 m x 200 m area at each site. A 200 m transect was also established to provide abundance estimates, structural complexity and to provide a quantitative method to monitor temporal variability in floristics at each site. To enable future monitoring, permanent stakes were erected at each site, marking the start and finish of vegetation transects; GPS coordinates are provided in Table 1. All plant species were recorded at 1 m intervals along the 200 m transect. Plant structure was recorded by classifying all individuals occurring at a point into height classes of 1=1-10 cm, 2=10-25 cm, 3=25-50 cm, 4=50-100 cm, 5=100-200cm, and 6=200+ cm. Bare ground was categorised as bare soil/clay/sand and/or crusting. Litter was categorised as dead or loose plant material, and rocks were categorised as rock cover. Voucher specimens were collected when identification was uncertain, and were identified by Des Nelson (local botanist) with reference to the NT Herbarium. Vegetation characteristics were recorded to indicate species composition and cover, dominance and vegetation structure at each site. Percentage cover of dominant species was also estimated at each site. Dominant vegetation was categorised into four structural layers: (1) Emergent tree layer; (2) Upper shrub layer; (3) Lower shrub layer; and (4) Ground layer.

Vegetation communities were classified based on Wilson *et al.* (1990) but were modified, using more detail where required, to be more representative of the community, due to the broad classes provided by Wilson *et al.* (1990) who mapped at a 1:1 000 000 scale.

Fauna Tracking

Fauna tracking was undertaken at all survey quadrats, although high winds during the Dry Season 2008 survey period cleared tracks in sandy soils and the results are likely to be an underestimate of species occurrence and frequency. Weather conditions were ideal for tracking during the Wet Season 2009 survey. The fauna tracking consisted of a walk-over survey for 25 mins at each site within a 200 m x 200 m area. The 200 m vegetation transect was also utilised for fauna tracking and consisted of recording all tracks within each 1 m interval if present, allowing for occurance estimates to be derived. Again this methodology provides a quantitative survey method to detect change with future monitoring. Tracks and sign of fauna were also recorded opportunistically throughout the project area and have been added to the fauna species list for the Wonarah project area. Traditional Owners were involved in tracking and were consulted regarding unusual digs (e.g. Site 6 – Wet Season 2009 survey on a rocky rise where digs resembled bilby digs but were identified as echidna). Traditional owners were also consulted regarding any species of conservation significance known to occur in the region.

Bird Survey

Standardised bird surveys were undertaken at each site for 25 mins in the morning and/or afternoon, and all species seen or heard opportunistically throughout the project area were recorded.

Microchiropteran Bat Survey

Anabat II (Version 6) sonar detection devices were used to record the high frequency calls of microchiropteran bats. Recordings were made at four sites for a period of 12 consecutive hours (1800 to 0600). Call records are identified to species by Dennis Matthews (Consultant) using keys to calls developed by Parks and Wildlife and Matthews.

Despite conducting the microchiropteran bat survey during the Wet Season 2009 survey, no results were obtained, which was latter attributed to faulty equipment. It is recommended that microchiropteran bat surveys are incorporated into any future environmental surveys and the Anabat II detector may be sent to Minemakers staff on-site if data is required sooner.

Rapid Landscape Analysis

Rapid landscape analysis is a rapid assessment technique aimed at determining landforms, geology, drainage systems, vegetation communities or habitats, and associated fauna. Landscape patterns were determined from existing data and were refined using available aerial photographs, satellite imagery, and GIS layers (Digital Elevation Model, DEM, and Digital Terrain Model, DTM contours, and spot heights). These data were used to assess potential habitats of ecological significance, erosion potential and construction considerations for all sites.

Soil Survey

A soil survey was undertaken during the Wet Season 2009 survey and was based upon *Australian Soil and Land Survey Field Handbook* (McDonald *et al.*, 1990). Soils were classified according to *Australian Soil Classification* (Isbell, 1996). Soil surveying methodology deviated from McDonald *et al.*(1990) in the depth of soil profile surveyed (recommended 1.8 m), due to time constraints limiting use of an excavator and limited availability of pre-dug pits related to drilling operations. Forty centimetre pits were surveyed at survey quadrats and soil profiles of up to 1.2 m depth were opportunistically surveyed utilising pre-existing diamond drill sumps. The lack of horizons beyond 40 cm depth in the seven drill sumps analysed indicated that 40 cm pits were adequate for soil classification within the Wonarah Phosphate Project area. Horizon boundaries in soil trenches were measured and described using physical and chemical parameters according to criteria in Isbell (1996). Landform and soil data were documented at each site according to the criteria of McDonald *et al.* (1990). Soil classifications were corroborated by former NRETAS soil scientist, Rudy Lennartz utilising raw data including photographs of soil profiles, to ensure accurate classification of soils and confidence in data provided herein.

GPS Cataloguing and Mapping

Track and waypoint data were collected using a *Garmin GPS 76C Mapper* and were mapped in Arc Map (Version 9.2).

4. Regional Context – Background Data

4.1. Climate

The climate of the area is described by Slatyer and Christian (1954) as semi-arid and monsoonal with nearly all the rain being received between November and April. Climatic conditions are indicated by those described for Wonarah Weather Station which operated between 1946 and 1974 (Bureau of Meteorology (BOM), 2009). Mean annual rainfall is about 317 mm with a range of 300 mm to 460 mm. Temperatures are high throughout the year and average monthly maximum temperatures may reach 39^0C just before the onset of the wet season, minimum temperatures may reach 10^0C in the dry season. The strongly seasonal character of rainfall results in wet humid conditions for three to six months of the year and progressively drier conditions through to winter and spring when water stress can be quite severe. Potential evaporation rate is about 3000 mm/year.

Conditions in the region in June 2008 (Dry Season 2008 survey) were relatively warm, although at the time of this survey conditions an intense high pressure system created strong winds and cool temperatures. Furthermore, the Barkly region was experiencing a severe deficiency of rainfall verging on the lowest on record for the 12 months preceding the survey, and the majority of the project area had been burnt within the month prior to surveying (BOM, 2008).

Recent climatic conditions leading up to and during the Wet Season 2009 survey are described for the closest weather station recorded by BOM during the period, Brunette Downs 145.3 km NNW of Wonarah project area. Regional conditions in March 2009 (Wet Season 2009 survey) at Brunette Downs were warm, with average maximum temperatures of 36°C and average minimum temperatures of 20°C recorded at the closest weather station (Figure 1). Regional conditions at the time of the survey were relatively calm (wind speeds between (2 – 11 km/hr), warm (maximum temperatures between 36.4 – 38.2°C) and moderately humid (relative humidity between 18 – 29%) (BOM, 2009). A total of 600 mm rainfall fell during the summer months (Figure 1).

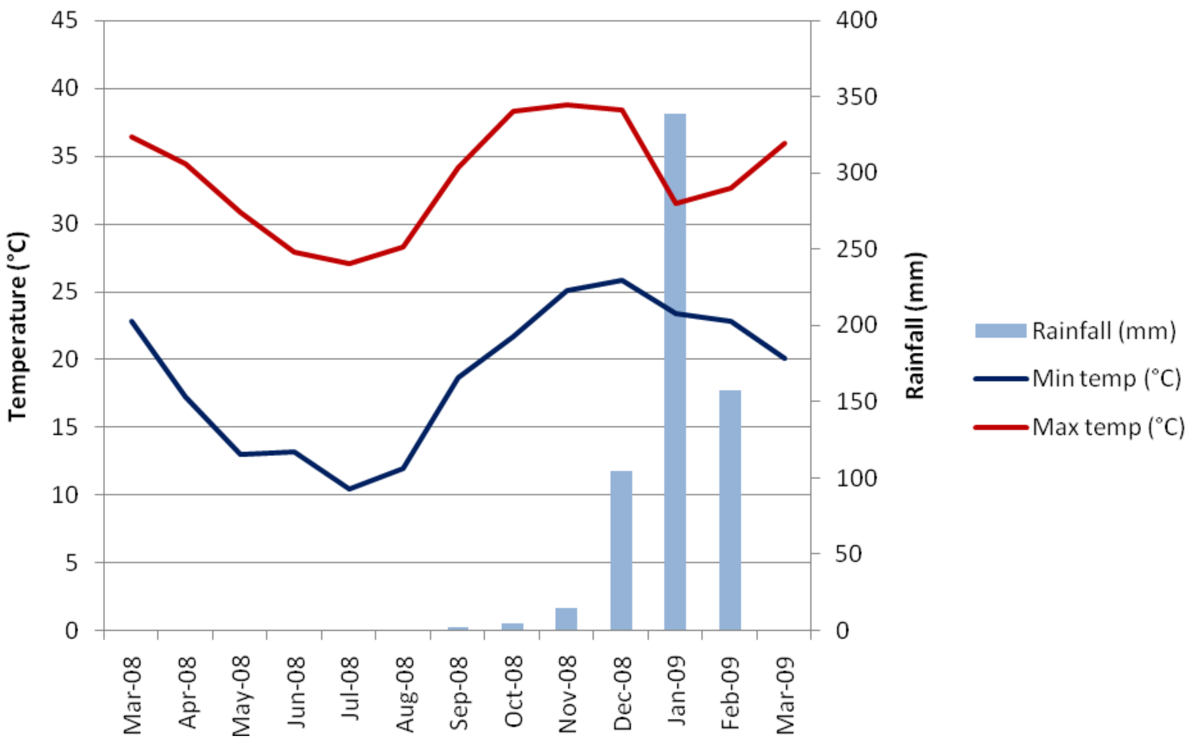

Figure 1: Maximum and minimum temperatures and rainfall between March 2008 and March 2009 at Brunette Downs (145.3 km NNW), the closest weather station to the Wonarah Phosphate Project area since Wonarah Weather Station ceased operations in 1974 (data adapted from BOM, 2009).

4.2. Bioregion

The project area lies within the Davenport and Murchison Ranges bioregion which is described by Purdie *et al.* (2008) as being "dominated by rugged rocky hills of folded volcanics, sandstone, siltstone and conglomerates. Soils are generally shallow lithosols, however deep fine-grained alluvial soils occur in the valleys and surrounding plains. Vegetation communities are dominated by spinifex (*Triodia* sp.), hummock grassland and low eucalypt and acacia open woodland". The project area overlies the Wonarah beds site, which is classified as significant on a bioregional scale as determined by the NRETA Parks and Conservation Masterplan (Appendix Five). White *et al.* (2000) describe the Wonarah beds as low rises of chert chalcedony, tertiary travertine, silicified coquinite and limestone, and outcrops of Cambrian dolomite framed in a sandplain. The beds occur over a very large area and values of this site may not be unique and may extend over a much larger region. The distinctive undulating feature is unique to the Wakaya desert and contains the only known collection site of *Sporobolus latzii* and is a type location for *Acacia drepanocarpa subsp. latifolia*. Another important feature of the bioregion is the relative diversity of aquatic and semi-aquatic plants associated with the large number of permanent or semi-permanent waterholes within the ranges. No ecosystems in this bioregion have been formally listed as threatened.

4.3. Landforms Physiography and Geology

The physiography of the project area has been described by Noakes and Traves (1954). The area is noted for general low relief of the landscape although small bevelled chert/silcrete rocky outcrops are locally common. Surface flow in the area is relatively disorganised, with no significant water courses present. More detailed geological information is available as a result of the considerable mineral exploration work in the region by Minemakers and its predecessors over the last 45 years.

4.4. Land Systems

Land systems of the surrounding region and project area have been mapped and described by Stewart *et al.* (1954) (Barkly Region) and Perry *et al.* (1962) (Southern NT). The project area falls on the edge of these two studies, and, for the purpose of this report, land systems boundaries have been modified slightly and combined where appropriate (Appendix Six). The Wonarah Phosphate Project area is dominated by Yelvertoft land system (Stewart *et al*. 1954) with minor Wonarah land system (Perry *et al.* 1962 and Stewart *et al*. 1954).

Stewart *et al.* (1954) describes the Yelvertoft land system as undulating, with mostly skeletal soils and truncated gravelley lateritic red earths; *Eucalyptus brevifolia* or *E. dichromophloia* woodlands. The Wonarah land system is described as gently undulating with lateritic red earths and *Eucalyptus brevifolia* woodland or *Eucalyptus. spp* (low mallees) – *Acacia* spp. shrubland. Perry *et al.* (1962) described the Wonarah land system as gently undulating plains with stonier higher parts and broad lowlands, relief mainly up to 30 ft; red clayey sands and red earths, partly lateritic; soft spinifex with sparse shrubs and low trees.

4.5. Soils

The soils in the Wonarah Phosphate Project area fall within soil classes By4 and My80 (Appendix Seven) (Bureau of Rural Sciences 1991). By4 dominates the project area, while My80 occurs in the north-east of the project area, outside of the proposed works. Soil classes are described as follows utilising Principal Profile Forms (PPF's) of Northcote (1979): By4 is composed of undulating ridge and slope terrain on lateritic sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts (> 60%) of mixed and variable gravels (K-Uc1.4) or ironstone gravels (KS-

Uc1.4), and also uniform coarse sands (Uc1.4) with some gravels on ridges and upper slopes generally. Associated are shallow to deep varieties of loose red siliceous sands (Uc1.23), and the previous incorporating large amounts (> 60%) of mixed and variable gravels (K-Uc1.23), neutral red earths (Gn2.12), and gravelly red neutral massive earths (K-Gn2.12) on mid and lower slopes. Small areas of other soils are likely. My80 contains gently undulating plains slightly elevated above the adjoining cracking clay plains; some narrow ridges and hills with rock outcrop and some shallow depressions. The dominant soils on the long gentle slopes and low rises are neutral red earths (Gn2.12) with a variable content and surface scatter of ironstone gravels. Associated are sands with coherent red and yellow earthy subsoils (Uc5.21 and Uc5.22) on slopes and in depressions; loamy massive earths (Gn2) incorporating neutral red earths (Gn2.12) and acid yellow earths (Gn2.21) marginal to the cracking clay plains; and some shallow gravelly and stony coarse sands (Uc) on ridges and hills. Small areas of soil units BA13, BY4, and My82 are included.

4.6. Flora

ARC/INFO coverage for the 1:1,000,000 NT vegetation map based on Wilson *et al.* (1990) indicates that the vegetation in the project area falls within Class 42 L1H3, which is described as encompassing *Corybia opaca*, (bloodwood), low open-woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey. L1 is a structural formula referring to lifeform and height of trees <10m tall with a density (projective foliage coverage) of 1-9%. H3 is a structural formula referring to lifeform and height of hummock grassland with a density (projective foliage coverage) of 30-69% (Appendix Eight). Vegetation associations in the area are likely to be strongly related to soil types with distribution limited mainly by water availability which is affected by the summer wet and winter dry periods.

Within the Wonarah beds site, White *et al.* (2000) identify three taxa of Australian significance (*Bonamia alatisemina, Rothia indica subsp australis* and *Sporobolus latzii*) seven taxa of NT significance (*Distichostemon barklyanus*, *Heliotropium ballii, Heliotropium pulvinum*, *Najas marina*, *Triumfetta centralis*, *Triumfetta deserticola*) one taxa of southern NT significance (*Grevillea dryandri subs. dryandri*) and four taxa of bioregional significance (*Eragrostis olida*, *Exocarpos sparteus*, *Isoetes muelleri*, and *Tephrosia stuartii*).

A protected matters report generated from the DEWHA web site within the project area and surrounding region identified no flora species of conservation significance (Appendix Nine). A search of the NT Parks and Wildlife Flora Atlas (2007) identified 746 records with 346 species within the surrounding region (Appendices Ten & Eleven). None of these species were listed under the EPBC Act for conservation significance, although 14 species were listed under the TPWC Act as data deficient and/or by Baker *et al*. (2005) as significant at a NT or National level (Appendices Fourteen and Fifteen). Four of these species occur within the project area, two of which are listed as significant at a national level (White *et al.* 2000) (*Sporobolus latzii*, 1K, and *Bonamia alatisemina* 3K) (Appendices Twelve & Thirteen).

Five introduced flora species were identified by the NT Parks and Wildlife Flora Atlas (2007) within the surrounding region and some of these could potentially occur in the project area (Appendix Fourteen). Baker *et al*. (2005) identify 10 introduced species that are of concern in the bioregion (Appendix Fourteen). Many other introduced species could potentially occur, particularly as the project area is in close proximity to a major highway where vehicles are a major vector for weeds.

A biological survey of the Wakaya Desert was undertaken by DNRETAS in the early 1990's. Important species data from this survey have been entered in the NT Flora and Fauna Atlases (2007) which have been included in this report.

4.7. Fauna

The Davenport Murchison Range bioregion is not renowned for its high diversity of mammalian and reptile fauna, although there have been very few extensive surveys undertaken. As with other central Australian bioregions, the mammalian fauna has suffered substantial losses. Of 36 mammal species previously recorded, 9 have become extinct, 3 have declined and 24 remain stable. Connors. *et. al.*, (1996) listed 394 vertebrate species from the Davenport and Murchison Ranges Bioregion combined with the far larger Tanami bioregion. Avian fauna (particularly water birds) can be rich where large areas of semi-permanent water exist. An unconfirmed sighting of a night parrot (*Pezoporus occidentalis*) was recorded in 1970 along the Barkly Highway (Low 1985). Bilby (*Macrotis lagotis*) have been collected west of the present Barkly Roadhouse on Dalmore Downs station, and habitat in the surrounding region is suitable for the spectacled hare wallaby (*Lagorchestes conspicillatus*) and northern nailtail wallabies (*Onychogalea unguifera*). Burrowing bettongs (*Bettongia lesueur*) were once widespread throughout the area, but are now extinct in the wild on the mainland. One of the distinctive features of the Davenport and Murchison Ranges Bioregion is that it may contain core range area for the central pebble-mound mouse (*Pseudomys johnsoni*). The regionally extinct species include the central rock-rat

(*Zyzomys pedunculatus*), which has persisted in rocky ranges south of the Wonarah Phosphate Project area near Alice Springs.

A search of the NT Parks and Wildlife Fauna Atlas (2007) identified 693 records of 163 species within the surrounding region (Appendices Fifteen & Sixteen). Three of these species were listed for conservation significance under the EPBC Act and TPWC Act, and eight species were listed solely under the TPWC Act (Appendices Seventeen & Eighteen). Three of these species were located within the project area; Australian bustard (*Ardeotis australis*), woma (*Apsidites ramsayi*) and long-haired rat, (*Rattus villosissimus*). Species listed under the EPBC Act that occur within the surrounding region include mulgara (*Dasycercus cristicauda* or *D. blythi*), bilby (*Macrotis lagotis*) and yellow chat *(Epthianura crocea*). The yellow chat is listed as vulnerable under the EPBC Act, and as endangered/lower concern under the TPWC Act, although it is the northern sub species (Alligator River, *Epthianura crocea tunneyi*) that is listed as endangered. The yellow chat (southern form) has been recorded 20 km north east of the project area.

A protected matters report (generated from the DEWHA web site) for the Wonarah Phosphate Project area and surrounding region identified two threatened (vulnerable) species (mulgara, *Dasycercus cristicauda*, and Australian painted snipe, *Rostratula australi*) eight migratory bird species (Appendix Nine). No endangered or critically endangered species were listed.

Note that mulgara was reclassified by Woolley (2005) into two species, the Crest-tailed Mulgara (*Dasycercus cristicauda*) and the Brush-tailed Mulgara (*D. blythi*), and both these mulgara species are now recognised. *D. cristicauda* is classified as endangered under the EPBC Act and vulnerable under the TPWC Act. *D. blythi* is classified as vulnerable under both the EPBC and TPWC Acts. Due to this reclassification, it is unclear in historical data which species was recorded.

5 Site Description and Existing Environment – LES Field Survey Data

5.1 Survey Overview and Limitations

An initial flora, fauna and landscape survey of the project area was undertaken by LES between the 18th and 22nd June 2008 (Dry Season 2008 survey). Weather during the survey period was relatively cool, and a high-pressure system created strong winds each day. Cool temperatures decreased reptile and mammal activity and strong winds severely limited fauna tracking on the sandy soil. Further, 60% of the project area had burnt within the previous month, decreasing overall species records and the ability to locate flora species of conservation significance. To account for this, survey sites were distributed throughout burnt and unburnt sites (where possible) to maximise exposure to undisturbed areas and this, in combination with a drive-over inspection of the project area, allowed identification of habitats of ecological significance. It was recommended by LES that prior to the commencement of any works, additional fauna surveys should be conducted, especially towards the end of the year when conditions are warmer, to ensure baseline data is collected during different seasons.

A second flora, fauna and landscape survey of the project area was undertaken by LES between the 21st and 25th March 2009 (Wet Season 2009 survey). Good weather conditions during the survey provided good trackability of sites and warm evenings were conducive to high overnight fauna activity, evidenced by high track numbers each morning. Despite this, capture rates remained low. Favourable summer climatic conditions had facilitated good vegetation growth since the June 2008 fires with many plants in seed (especially Spinifex species). It is therefore likely that abundant food sources reduced the effectiveness of baiting traps and/or that additional time may be required for ground dwelling species to respond to the recent favourable conditions. It is also likely that the previous year's drought and fire had reduced fauna numbers. Nevertheless, tracking and opportunistic sightings bolstered species lists improving confidence in detecting fauna species present. Good vegetative growth and presence of flowers and fruit in the majority of plants allowed accurate identification of species.

The range of land units surveyed, and consequently, vegetation communities, was restricted to those accessible via existing exploration tracks. Large distances, vegetation growth, the potential for flat tyres (especially by stakes from burnt acacias), logistical and time constraints were all factors that limited surveying away from existing exploration tracks. However, all land units to be directly affected by mining were surveyed, with control sites in the same land units, but away from impact areas. Further, a high number of sites were surveyed in both survey periods, providing detailed baseline data and improving the capacity to detect change with future surveys.

5.2. Site Selection

Coordinates of survey quadrats for the Dry Season 2008 and Wet Season 2009 surveys within the Wonarah project area are provided in Table 1 and displayed in Appendix Three. Stratification of survey quadrats against land units and proposed disturbance zones are provided in Table 2 and displayed in Appendix Four.

Table 1: Coordinates of survey quadrats for Dry Season 2008 and Wet Season 2009 surveys within the Wonarah project area.

Year	Site	Latitude	Longitude
2008	TS1	-20.11548	136.33603
	TS2	-20.11533	136.35056
	TS3	-20.11531	136.35996
	TS4	-20.00894	136.45436
	TS5	-19.97024	136.50182
	S6	-20.11591	136.31153
	S7	-20.0094	136.47036
	S8	-20.00864	136.50196
2009	1	-20.13156	136.32523
	2	-20.11534	136.33611
	3	-20.09689	136.36247
	4	-20.04958	136.4555
	5	-20.00932	136.47204
	6	-19.97021	136.50192
	7	-20.01935	136.4549
	8	-20.09292	136.45692
	9	-20.07607	136.34425

Table 2: Survey quadrats for Dry Season 2008 and Wet Season 2009 surveys stratified by land units and proposed disturbance zones.

Land Unit	Disturbance	2008 Survey	2009 Survey	Replicate Sites
Alluvial Low Lying Sand Plain	Impact	TS1, TS4, S6, S7.	2, 5	7 (2008) = 5 (2009). 1 (2008) = 2 (2009).
Calcareous Plain	Impact	TS3	3	
Deep Sand Plain	Impact	TS2	7	7, 8 (2009).
	Non-impact		8	
Ephemeral Lakes	Non-impact		9	
Ironstone Rocky Rise	Impact	TS5, S8	6	5 (2008) = 6 (2009).
Shallow Sand Plain	Impact	TS3	1	
Silcrete Rocky Rise	Non-impact		4	6, 4 (2009)

5.3 Site Description Summaries - Flora

Site description summaries, including dominant plant species identified at each site, are provided in Appendices Nineteen to Thirty-five. A full list of flora (including conservation status) identified during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys) is provided in Appendix Thirty-six. The project area is dominated by sand plains with *Acacia, Grevillea,* and *Hakea spp.* over *Aristida* and *Triodia*; open woodlands with *Acacia, Eucalyptus* and *Corymbia, Hakea* and *Melaleuca spp.* over *Acacia* shrubs and *Triodia* spp; and rocky rises with sparse *Acacia*, *Eucalyptus* and *Corymbia*, and *Triodia* spp.

A total of 144 plant species were recorded during the Dry Season (2008) and Wet Season (2009) surveys (Appendix Thirty-six).

Forty-two flora species were recorded during the Dry Season 2008 survey. Prior to the survey approximately 60% of the project area was burnt in the previous month; which was reflected in the vegetation transects which, on average, had 48% bare ground and 23% litter and the low number of species recorded. The vegetation was showing good signs of regeneration with many *Eucalyptus* and *Corymbia* and *Triodia* spp. re-sprouting from their bases.

Good vegetation growth was recorded during the Wet Season 2009 survey following favourable summer rains. During the Wet Season 2009 survey, a total of 132 flora species were recorded, providing an additional 102 flora species compared to the Dry Season 2008 survey. Although it was known that the Dry Season 2008 survey would have limited flora species due to the fire, this emphasises the importance of the follow-up survey to capture seasonal species, including species occurring in response to fire.

<u>Habitats of Ecological Significance</u>

No habitats of ecological significance were recorded during LES field surveys; however ephemeral areas are likely to provide important seasonal habitat or refuges for fauna and for both annual and perennial species which are adapted to seasonal inundations.

Significant Flora Species

LES surveys recorded no flora species listed under the EPBC Act; however, two species recorded are listed as Near Threatened (*Bergia barklyana* and *Hibiscus brachychlaenus*) and one as Data Deficient (*Heliotropium pulvinum*) under the TPWC Act, (Table 3 and Appendix Thirty-seven). A table compiling significant flora species recorded within the Wonarah project area in the NT Flora Atlas (2007) and LES surveys are presented in Appendix Thirty-seven and coordinates are provided Appendix Thirteen.

The Southern Sites of Botanical Significance (SSOBS) conservation codes, as defined by White *et al.* (2000) for each of these species are as follows: *Bergia barklyana* (SSOBS = 3R) – a rare species of national significance with a geographic range exceeding 100 km but not currently considered to be threatened; *Hibiscus brachychlaenus* (3r) – a rare species of significance in the Northern Territory with a geographic range exceeding 100 km but not currently considered to be threatened; and *Heliotropium pulvinum* (3k) a taxa with a geographic range exceeding 100 km with the potential to belong to a conservation category (Appendix Thirty-seven).

Table 3: Significant Flora Species identified during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys).

Species Name	TPWC	EPBC	SSOBS level	SSOBS code	Site No.	
					2008	2009
Bergia barklyana	nt		National	3R		9
Heliotropium pulvinum	dd		Northern Territory	3K		6
Hibiscus brachychlaenus	nt		Northern Territory	3r		6

Sporobolus latzii

Sporobolus latzii is listed as data deficient under the TPWC Act and is recorded from only one site in the Northern Territory (and world), which is within the Wonarah Phosphate Project area at coordinates (136.33454, -20.06521536), making it potentially one of the most restricted and rarest plant taxa in the NT (Appendix Thirteen). More survey work is required to determine its conservation status under the TPWC and EPBC Acts; however it is noted here to be of significance because of the single record. The record occurs within a cultural exclusion zone associated with the ephemeral lake land unit (Appendices Four and Twelve).

The Wet Season 2009 survey conducted a land unit verification survey into the ephemeral lake cultural exclusion zone (with prior permission from the CLC and accompanied by traditional owners) which targeted identification of *S. latzii*, but it was not recorded.

As per existing CLC requirements, no further survey work is planned within the cultural exclusion zone.

Weeds

Two introduced plant species were recorded during the Wet Season 2009 survey, the pastoral grass, buffel grass (*Cenchrus ciliaris*) and road side rehabilitation species, kapok bush (*Aerva javanica*). Neither species are declared under the *NT Weeds Management Act* (2001). Both are invasive species and are identified as environmental weeds. Introduced plant species known to occur in the region are shown in Appendix Fourteen.

Buffel grass was recorded in four isolated patches along the exploration track between the Main and Arruwurra zones and near the proposed bore fields (Sites 1 & 3), occurring on low lying areas within sand plains. One patch was located within a clayey-loam depression at coordinates (S20.09432 E136.35818). Buffel grass occurs extensively outside the project area, especially along the Barkly Highway, where vehicles will be major vectors spreading seed into the project area. Buffel grass is regarded as a significant pastoral grass, a dominant land use in the Barkly Tableland, and continues to be sown for pastoral use today. Buffel grass has dramatically changed the vegetation structure and species composition of drainage systems in central Australia. As well as displacing native understorey species, buffel grass increases the intensity of wildfires due to the high fuel loads it produces (Paltridge and McAlpin, 2002). The spread of buffel grass has increased dramatically in some areas throughout central Australia, especially along major highways (Purdie *et al.* 2008).

An individual kapok bush was recorded along the exploration track leading into the Arruwurra Zone, in a shallow sand plain. Kapok bush grows in red sandy and gravelly soils along roadsides, particularly where the soil has been disturbed (Purdie *et al.* 2008). The proximity of the plant to the exploration track suggests that vehicle access and/or soil disturbance is responsible for its presence. In recent times it has been used a fodder plant and for stabilisation of earthworks (Purdie *et al.* 2008).

5.4 Site Description Summaries - Fauna

Site description summaries, including species identified at each site are provided in Appendices Nineteen to Thirty-five. A full list of fauna identified during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys) are provided in Appendix Thirty-nine. In general, the area does not exhibit any special features for biodiversity although one species of conservation significance (Australian bustard, *Ardeotis australis*) was recorded at sites TS4, S7 & S8 during the Dry Season 2008 survey and Sites 2 & 3 during the Wet Season 2009 survey through tracks. One species listed as Near Threatened (northern nail-tailed wallaby, *Onychogalea unguifera*) (TPWC Act) was recorded at Site 1 during the Wet Season 2009 survey through scats. A table compiling significant fauna species recorded within the Wonarah project area in the NT Flora Atlas (2007) and LES surveys are presented in Appendix Thirty-eight and coordinates are provided in Appendix Eighteen.

Birds

A total of 33 bird species were recorded during LES field surveys (Appendix Thirty-nine) including one bird species of conservation significance, the Australian bustard (*Ardeotis australis*), listed as vulnerable under the TPWC Act 2000 (locations given above). No protected migratory species were recorded during LES field surveys. Within the surrounding region over 90 bird species have been recorded in habitats similar to those in the project area and many of these species are likely to occur within the project area. Sand plain habitats are likely to support the greatest bird diversity owing to the micro-topographic diversity and density of habitat, as well as the range of food resources due to the differing phenologies of plant species that occur from ridge to flood out. Ephemeral wetland areas are also likely to be important habitats during wet seasons for many migratory species, although no species specific to wetland areas were observed during LES field surveys. In general, species listed are not especially uncommon or rare in a regional sense. Most present and potential species are wide-ranging.

Mammals

A total of 15 mammals were recorded during LES field surveys (Appendix Thirty-nine). Trap captures during both surveys were relatively low over the three nights. Dring the Dry Season 2008 survey numbers ranged from 5 individuals (Trap Site 4 and 5) to 21 individuals (Trap Site 3). Highest trap captures were recorded in Trap Site 3, which had not been recently burnt. Unburnt areas are likely to act as refuges for some species, although there was an abundance of seeds available for small mammals to collect in some of the burnt sites. Weather during the survey was relatively cold and this may have reduced small mammal activity, although all sites had some trapping success. During the Wet Season 2009, only 3 individuals, all lesser-hairy footed dunnarts (*Sminthopsis youngsoni*), were captured. It is likely that good plant growth conditions following favourable summer rains and subsequently abundant seeds and fruit observed during the survey are responsible for the low effectiveness of trapping. However, nightly faunal activity was high, as evidenced by tracks each morning, and an additional nine species were recorded from tracks, scats and digs (Appendix Thirty-nine).

One species, the northern nailtail wallaby (*Onychogalea unguifera*), listed as near threatened under the TPWC Act (2000) was recorded at Site 1 during the Wet Season 2009 survey and has been recorded within a 50 km buffer of the project area in the NT Fauna Atlas (2007). No species listed under the EPBC Act (1999) were recorded during LES field surveys. However, habitats in the project area, particularly the acacia shrublands and hummock grasslands are suitable for bilby (*Macrotis lagotis*) and mulgara (*Dasycercus cristicauda* or *D. blythi*) and both of these species have been recorded within the surrounding region in the NT Fauna Atlas (2007) (Appendices Seventeen and Eighteen). Further, there is potential habitat in the open woodlands to the south-west of the project area for spectacled hare-wallaby *(Lagorchestes conspicillatus*).

Evidence of significant fauna species, in particular bilby and mulgara, were targeted in the Wet Season 2009 survey during which tracking conditions were excellent. Some survey quadrats during the Wet Season 2009 survey were established in habitats suitable for bilby and mulgara; Site 6 for bilby and hummock sand plains sites for both bilby and mulgara. An active search involving LES staff and Traditional Owners was conducted in the drainage channel containing large termite mounds built by *Nasutitermes triodiae,* proximal to Site 6, which are often shown to support bilby and mulgara in the Tanami desert (Moon and Low, 2006 & 2007); however no evidence was found. Furthermore, Traditional Owners were consulted regarding presence of these species but did not indicate knowledge of these species in the local region.

<u>Amphibian and Reptiles</u>

No amphibian species were recorded during LES field surveys (Appendix Thirty-nine).

A total of 14 reptile species were recorded during LES field surveys (Appendix Thirty-nine). Trapping yielded 12 species, while tracking added two species to this list during the Wet Season 2009 survey.

While tracking conditions were favourable during the survey, many tracks were unable to be identified to species level and have been categorised as legless lizard, snake, small lizard and goanna. Trapping success during the Wet Season survey ranged from 2 individuals at Site 3 (calcrete rise with surrounding sand plains) to 9 at Site 4 (silcrete rocky rise). Only one species (sand goanna, *Varanus gouldii*) was identified during the Dry Season 2008 survey and very few identifiable tracks were found due to strong winds and poor tracking conditions. Within the surrounding region, 50 reptile species have been recorded in the NT Fauna Atlas (2007), and LES field surveys observed suitable habitat within the project area for many of these species.

No species of conservation significance under the TPWC Act (2000) or EPBC Act (1999) were recorded during LES field surveys. One species (woma, *Apsidites ramsayi*) listed as near threatened under the TPWC Act was recorded within the project area in a previous survey (NT Fauna Atlas 2007). One species, *Varanus spenceri*, is listed as data deficient under the TPWC Act, and was recorded outside of the Wonarah project area within a 50 km buffer (NT Fauna Atlas 2007).

Significant Fauna Species

Locations of fauna species of conservation significance recorded during LES field surveys (Dry Season 2008 and Wet Season 2009 surveys) are listed in Table 4.

Table 4: Significant Fauna Species identified during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys).

Species Name	TPWC	EPBC	Site No		Evidence
			2008	2009	
Ardeotis australis (Australian Bustard)	vu		TS4, S7 & S8	2 & 3	Tracks/Feather
Onychogalea unguifera (Northern nailtail Wallaby)	nt			2	Scats

A table compiling the current distribution, preferred habitat, preferred fire regimes and threatening process for significant fauna species is provided in Appendix Forty. These species include species recorded during on-site investigations (both LES field surveys and NT Fauna Atlas (2007) records) and species identified in the DEWHA *Matters of Environmental Significance* report (Appendix Nine) as potentially occurring within a 50 km buffer of the project area.

The preferred habitat for significant fauna species listed encompasses a wide range of landforms and plant communities. It does not suggest that the species exclusively occur in this habitat, however, where this habitat does occur in the project area then the likelihood of occurrence may be increased. Threatening processes are also highly variable; however, common themes include predation, alteration to habitat (by clearing, competition and degradation by introduced competitors) and alterations to fire regimes. Preferred fire regime data for significant fauna species is limited although it is evident that regimes developing a variety of habitat age and structure are important for the maintenance of shelter, reproductive and dietary requirements.

Feral Animals

Five introduced species were recorded within the project area during LES field surveys, (Appendix Thirty-nine). Three herbivore species were recorded: camel (*Camelus dromedarius*), cow (*Bos taurus*) and donkey (*Equus asinus*). All the evidence of these species was old (> 1 month old) tracks around depressions (suggesting water access). Tracks were few and, in the case of cow and donkey (only recorded during the Wet Season 2009 survey) were confined to one drill sump (S20.12903 E136.32635) and reflected single individuals. There was no evidence of camels within the project area during the Wet Season 2009 survey. A lack of fresh evidence of introduced herbivores during the Wet Season 2009 survey suggests that individuals are not reliant on the project area and that just a few individuals may access the site infrequently while searching for water. Source populations for cattle include those on surrounding cattle stations. Feral donkeys and especially camels disperse throughout the Northern Territory but congregate around water sources which include natural waterholes and artificial sources such as dams, bores and those on communities.

Two carnivore species; cat (*Felis catus*) and fox (*Vulpes vulpes*), were recorded during both LES field surveys. Fresh tracks (< 1 week) were observed during the Wet Season 2009 survey mostly along exploration tracks although some cat tracks were recorded scattered within survey quadrats. The low incidence of tracks suggests low populations, with fresh tracks suggesting that the project area is currently utilised for hunting.

5.5 Site Description Summaries – Land Unit Map

A land unit map was developed by LES for the project area, Appendix Four. Land Systems and Land Units have long been used as classification units (Perry *et al.* 1962) and have been suggested by many authors as surrogates for diversity (Ferrier and Watson 1997, Oliver 1998, Smart *et al.* 2000). Land units were therefore considered the appropriate level at which to commence stratification of the landscape. Existing land system mapping for the project area and surrounding region is described by Perry *et al.* (1962) and Stewart *et al*. (1954) although not at a sufficient scale to distinguish between land units within the project area. An alternative system was regolith (defined as the mantle of material that overlies bedrock) mapping which describes 12 units within the project area (derived from Rio Tinto). Low *et al*. (2001) showed that regolith units could be re-interpreted in a systematic way to provide meaningful inferred land units. Following the procedure employed by Holmes and Low (2000), Low *et al.* (2003a, 2003b) and Moon and Low (2006, 2007) regoliths with similar geology, soils and landform were grouped into inferred land units resulting in the formation of 11 land units over the study area. This was extended spatially using standard GIS procedures.

Fifty-four points were verified in the field during the Wet Season 2009 survey against the land unit map derived in 2008. Minor differences were found between the original land unit map and ground verifications, especially between the Shallow Sand Plain and Deep Sand Plain land units, and minor calcrete outcrops and drainages within Shallow Sand Plains. However, these differences within land units only occur at a fine scale (i.e. within 50 m). When points were assessed at a broader scale, they were shown to be consistent within the larger land unit. On-site verification therefore determined that the boundaries on the existing land unit map and the scale of the map (1:210,000) are adequate to use for stratification of the landscape and vegetation communities, as well as providing a "baseline" for detecting change with future monitoring.

5.6 *Site Description Summaries – Flora Map*

The project area occurs within vegetation community 42 which is described as *Corymbia opaca* (Bloodwood) low open-woodland with *Triodia pungens* (Soft Spinifex) hummock grassland understorey (Wilson *et al.* 1990). Vegetation community 42 occupies 28095.3 km^2 within the Northern Territory covering the broad desert country south of the cracking clay plains of the Barkly Tablelands. While this vegetation classification is broadly appropriate to the project area, LES field surveys identified five variable plant communities within the project area. These are related to Wilson *et al*. (1990) fine vegetation units as used by the NT Parks and Conservation Masterplan (Baker *et al.*, 2005) to show proportion of vegetation communities which are protected within reserves (Table 5). These were mapped by LES for the project area to allow assessment of disturbance at a local scale.

Classifications of vegetation communities are described and mapped in Appendix Forty-one. Vegetation communities were classified utilising floristic data (species composition and structure) collected during the Wet Season 2009 survey (refer to Appendices Twenty-seven to Thirty-five) and species presence data from the NT Flora Atlas (2007). Floristic data was insufficient from the Dry Season 2008 survey to classify vegetation communities due to recent fires. Vegetation communities were found to reflect land units through field verifications which were conducted simultaneously with land unit verifications during the Wet Season 2009 survey. However, the sand plain land units (Alluvial Low-lying Sand Plains, Shallow Sand Plains and Deep Sand Plains) were found to support the same vegetation community; with variations in landscape determined by differing proportions of flora species as opposed to determining different assemblages. Similarly, the three rocky rise land units (Silcrete Rocky Rise, Silcrete and Ironstone Rocky Rises) were found to support the same vegetation communities but with varying proportions of species. Site 3 (2009 survey) contained a small patch of mature Supplejack (*Ventilago viminalis*) over grasses and herbs on a calcrete rise. This species is consistent with the sand plain vegetation classification but is a unique patch (mostly due to the maturity of Supplejacks) and noteworthy in showing the variability within vegetation communities. Spinifex (*Triodia* spp.) throughout the project area is in early stages of regeneration following the July 2008 fires and is expected to be in higher densities and in more locations in future studies. This has been accounted for where possible in vegetation classifications.

A plant species list has been developed for each land unit using data from LES field surveys and the NT Flora Atlas (2007) (Appendix Forty-two). Plant species lists for some land units are still unrepresentative due to inabilities to access these areas during LES field surveys (Black Soil Plain, Clay Plains, Limestone Outcrop and Mud Stone Outcrop); all with limited distribution outside the proposed mine area. However, some information is available for these land units from the NT Flora Atlas (2007) and Land System descriptions (Appendix Forty-two). These land units occupy only a small area within the project area and are not within the proposed impact areas. Comprehensive species lists have been provided for land units within impact zones and will likely be expanded with future monitoring, as the vegetation will continue to regenerate following the 2008 fires. It is important to note that a verification column has been added to plant species list per land unit (Appendix Forty-two) that denotes plant species recorded in each land unit during LES surveys. Indication of presence of all other species was determined from the NT Flora Atlas (2007) by extracting data spatially using land unit boundaries in Arc Map. There are some discrepancies in the true location of these species and possibly the land units they occur in due to the accuracy of recording location in historic studies as well as the accuracy in transferring between mapping datum's used in the NT Flora Atlas (2007) spatial database.

Classification of vegetation communities in the unaccessed and very limited land units with limited floristic data, was simplified by combining the Black Soil Plain and Clay Plains land units, due to similar landscape characteristics, and classified according to Wilson *et al's.* (1990) coarsely mapped indicative vegetation classification using landscape data. Similarly, the two rocky rise land units (Limestone Outcrop and Mud Stone Outcrop) that were unable to be surveyed have been grouped with the surveyed rocky rise land units (Silcrete and Ironstone Rocky Rises), due to similar landscape characteristics. As noted above, the sand plain land units (Alluvial Sand Plains, Shallow Sand Plains and Deep Sand Plains) were found to support the same vegetation community and were grouped for the purposes of mapping. Excluding the Black Soil Plain and Clay Pan land units, all vegetation communities assigned to land units were not taken from Wilson *et al.* (1990) classification system as these were too course (scale of 1:1 000 000) to be appropriate to vegetation communities surveyed within LES field surveys. Instead, vegetation communities were classified based on the field data collected. Vegetation communities classified at each survey quadrat during the Wet Season 2009 survey are presented in Table 5 with vegetation descriptions defined during the Wet Season 2009 survey presented. Vegetation classifications are described in and mapped in Appendix Forty-one. Mapping of vegetation communities were extended over land units (Appendix Four) for the Wonarah Phosphate Project area and close surrounds (Appendix Forty-one).

Table 5: Classification of vegetation communities at each survey quadrat based upon floristic data collected during the Wet Season 2009 survey and their relationship to fine vegetation classes of Wilson *et al* 1990 that occur widely in the middle latitudes of NT.

LES Survey quadrat	Land Unit	Vegetation Classification in this report	Fine Vegetation Classes of Wilson *et al* 1990 that contains this map unit	Vegetation description (as per the site description summaries, Appendices Twenty-seven to Thiry-five)
1	Shallow Sand Plain	1	42, 43	Eucalypt open woodland dominated by scattered Coolabah upperstorey, Senna sp. lower shrub layer and dense *Indigofera colutea* and *Aristida holathera* ground cover
2	Alluvial Low-lying Sand Plain	1	27, 43, 76	Acacia open woodland dominated by scattered Dogwood (*Acacia sericophylla*), occasional Bloodwood and Coolabah emergent trees and dense *Aristida holathera, Yakirra australiensis* and *Whiteochloa airoides* ground cover.

LES Survey quadrat	Land Unit	Vegetation Classification in this report	Fine Vegetation Classes of Wilson *et al* 1990 that contains this map unit	Vegetation description (as per the site description summaries, Appendices Twenty-seven to Thiry-five)
3	Calcareous Plain	3	51, 27	Eucalypt open woodland dominated by scattered Coolabah and Bloodwood on floodplain and scattered Supplejack on calcrete rises, over *Aristida holathera, Tribulus eichlerianus* and *Cleome viscosa* grassland ground cover.
4	Silcrete Rocky Rise	5	36, 43, 76	Acacia and Mallee shrubland with hummock grassland dominated by E*ucalyptus odontocarpa, E. pachyphylla* and *Acacia hilliana* over soft Spinifex.
5	Alluvial Low-lying Sand Plain	1	42	Open Eucalypt woodland with hummock grassland dominated by Coolabah and Bloodwood upper-storey over Spinifex ground-cover.
6	Ironstone Rocky Rise	5	36, 43, 76	Acacia and Mallee shrubland dominated by *A. stipuligera, A. hilliana* and *Eucalyptus odontocarpa* over sedges and perennial grasses.
7	Deep Sand Plain	1	42, 43	Open Eucalyptus woodland over hummock grassland dominated by *Eucalyptus victrix, E. pachyphylla* and *Acacia sericophylla* over soft Spinifex.
8	Deep Sand Plain	1	26, 36, 42	Eucalypt and Acacia low open woodland over hummock grassland with *Melaleuca lasiandra* in drainages, dominated by *Acacia sericophylla, A. stipuligera* and *Triodia schinzii* and *Aristida holathera* groundcover.
9	Ephemeral Lake	1	*26, 27*	*E. microtheca* (Coolabah) low-open woodland with low grassland and clay depressions with sedges.

5.7 Site Description Summaries – Soil Map

Four soil types were classified using the Australian Soil Classification system (Isbell, 1996) based upon the Wet Season 2009 survey - Kandosols, Vertosols, Calcarosols and Rudosols and are described in Table 6. Soil classifications were found to correlate with land units, although many land units contained similar soil types and were thus grouped for mapping purposes, as described in Table 6 and mapped in Appendix Forty-three. Kandosols and Rudosols dominate the sand plains and rocky rises within the project area; Vertosols are restricted to areas subject to inundation (e.g. ephemeral lakes) and Calcarosols are restricted to two localities in the southern end of the lease area. Mapping of soil types was extended over land units (Appendix Four) for the Wonarah Phosphate Project area and close surrounds (Appendix Forty-three).

Table 6: Classification and description of soils within the Wonarah Phosphate Project area against land units based on the Wet Season 2009 survey.

Land Unit	Soil Classification	Soil description (Isbell, 1996)
Sand plains (Alluvial Low-lying, Shallow & Deep sand plains)	Kandosols	These soils lack strong textural contrast, B horizons are massive or weakly structured and the profile is not calcareous throughout. The maximum clay content in some part of the B2 horizon exceeds 15%. These soils are a widespread group in Central Australia.
Rocky Rises (Silcrete & Ironstone Rocky Rises & Limestone & Mud Stone Outcrops)	Rudosols	Soils in this order have little if any (rudimentary) pedological organisation. They are usually young soils that vary widely in terms of texture and depth. There is little or no texture or colour change with depth unless stratified or buried soils are present.
Black Soil & Clay Plains & Ephemeral lakes	Vertosols	Soils in this order have a field clay texture of 35% or more with clay throughout the solum except for thin, surface crusty horizons 0.03 m or less thick, and Have open cracks at some time in most years that are at least 5 mm wide and extend upward to the surface or to the base of any plough layer, self-mulching horizon, or thin, surface crusty horizon, and At some depth in the solum (surface & sub-surface layers), have slickensides and/or lenticular peds.
Calcareous & Limestone Outcrops	Calcarosols	Soils that are normally calcareous throughout the profile or calcareous at least directly below the A1 or Ap horizon, or within a depth of 0.2 m (whichever is shallower). Carbonate accumulations must be pedogenic not fragments of calcareous rock such as limestone or shell fragments.

5.8 Site Description Summaries – Soil Erosion

Erodibility of soils was assessed through combining erosivity potentials of classified soils in accordance with descriptions of arid land soils and topography. Most soils were found to have low erodibility potentials, except deep soils (mostly Rudosols with loose rock aggregations) on sloping terrains overlain by deep clayey sands. These soils are most at risk from road construction, and road building techniques to mitigate erosion are provided in Appendix Forty-four.

An erosion gully was noted along the existing exploration track between the Main and Arruwurra zones; it occurred within the Shallow Sand Plain land unit along a slope at coordinates (S20.06971 E136.45474).

Winrows were recorded along the existing exploration track between the Main and Arruwurra prospects within the Shallow Sand Plain land unit at coordinates (S20.11501 E136.38703) (see Appendix Forty-five for photos). Winrows impact on natural water distribution and generally should not be formed.

5.9 Indigenous Values

Traditional Owners were consulted regarding flora and fauna of Indigenous value (e.g. mythical, cultural or utilitarian) within the Wonarah Phosphate Project area during the Wet Season 2009 survey (see Appendix Thirty-six for summary). Mature trees, especially Coolabah and Bloodwood, tend to be culturally significant.

Many ephemeral lakes within the project area are culturally significant sites and have been classed as exclusion zones by the CLC.

Traditional Owners identified fauna of cultural significance within the project area for utilitarian values, such as hunting. These include: red kangaroo, Australian bustard, sand goanna and large dragons. Large ephemeral lakes were identified as important hunting grounds which act as seasonal refuges for populations of larger fauna. No species of mythological significance were identified; however, the Traditional Owners consulted were not senior members of their community and may not have had authority to provide such information. The dingo has mythical significance for people in the nearby Tanami desert, and it is known that dingo dreamings extend into the Barkly region.

5.10 Bushfires

The Northern Territory Bushfires Council maps fires within the Northern Territory and for all Australia. Fire data in the Barkly region has been collected on an annual basis using raster data over a 10 year period and has been collated to provide a map of fire frequency (Appendix Forty-six). While this map provides broad information for a limited time frame, it is still useful in understanding recent regional fire characteristics. The Wonarah Phosphate Project area is shown to have a fire frequency of 1 to 2 events per 10 year period. However, this information does not include small scale fires due to the low resolution of the technique. Bushfires are caused by natural and anthropogenic sources, although it was noted by the Traditional Owners consulted that traditional burning occurs within the local region although it was not confirmed that this includes the Wonarah Phosphate Project area.

6 Impact Assessment

6.1 Legislative Component

The proposed operations will be subject to the following legislation and land clearing guidelines

Key Legislation:

- Environmental Assessment Act 1982;
- Territory Parks and Wildlife Conservation Act 2000;
- Weeds Management Act 2001;
- Environment Protection and Biodiversity Conservation Act 1999;
- Environmental Offences and Penalties Act 1996;
- Soil Conservation and Land Utilization Act 2001 of the Northern Territory;
- Heritage Conservation Act 2000;
- Meteorites Act 2000;
- Weed Management Act; 2001;
- Environmental Offences and Penalties Act; 1996;
- Environment Protection (National Pollutant Inventory) Objective;
- Litter Act;
- Water Act; and,
- National Environment Protection Council (Northern Territory) Act.

Land Clearing Guidelines:

- Northern Territory Planning Scheme – Land Clearing Guidelines 2006 (Technical Report No 27/2006)

Other:

- Minimum Construction Requirements for Water Bores in Australia

6.2 Potential Impacts of the Proposed Operation:

The extent to which the proposed operations will affect the environment will depend on the size of the operation. To determine whether the operation will affect the environment at a national level, criteria from the EPBC Act are reviewed; for effects on the environment at a bioregional level, criteria for identifying important habitats (Neave *et al.* 2006) are reviewed; to determine whether the operation will affect the environment at a local level, survey data provided herein is reviewed.

6.3 Potential Impacts of the Proposed Operation: National Level

The EPBC Act (revised 2005) came into force in July 2000. Since the inception of the Act, any proposed project that will have a significant impact on a matter of national environmental significance must be approved by the federal Minister for the Environment.

There are seven areas in which a project may have an impact of national environmental significance. These include:

- Impact on World Heritage properties;
- Impact on National Heritage properties;
- Impact on Ramsar wetlands of international importance;
- Impact on listed threatened species and communities;
- Impact on migratory species protected under international agreements;
- Nuclear actions, and;
- Impacts on the Commonwealth marine environment.

Of these seven areas only two areas, protected migratory species, and threatened species and communities, were potentially of interest for the current project.

No protected migratory species have been identified within the project area or surrounding region in on-site investigations including LES field surveys and the NT Fauna Atlas (2007), though eight migratory bird species are listed by DEWHA in the EPBC Act as potentially occurring in the area (Appendix Nine). As there are no large drainage channels or drainage basins within the project area or surrounding region, there is not a significant amount of potential habitat for these species in the area, although ephemeral areas may be important in good seasons. Hence, migratory avifaunas are only likely to appear during significant wet seasons when rainfall is large enough to cause local flood events.

No listed threatened ecological communities or flora species were recorded within the Wonarah Phosphate Project area, although eight flora species of significance (i.e. with near threatened or data deficient conservation codes) under the TPWC Act were recorded during LES field surveys and in the

NT Flora Atlas (2007) (Appendix Thirty-seven). Of these species, the SSOBS conservation codes, as defined by White *et al.* (2000), suggest that only *Sporobolus latzii* may be reliant on the project area for its continued persistence; however as discussed in Section 5.3, the known record is within a cultural exclusion zone associated with the ephemeral lake land unit which will not be disturbed by mining operations.

No fauna species listed under the EPBC Act were recorded within the Wonarah Phosphate Project area; however the *Ardeotis australis* (Australian bustard) listed as vulnerable under the TPWC Act was recorded in both LES field surveys and the NT Fauna Atlas (2007) (Appendices Fifteen and Thirty-nine). A further three species of significance (i.e. with near threatened or data deficient conservation codes) under the TPWC Act were recorded in on-site investigations (LES field surveys and NT Fauna Atlas (2007)) within the project area, while a further eight species listed under both the EPBC and/or the TPWC Acts were recorded within the surrounding region in the NT Fauna Atlas (2007) (Appendix Thirty-nine). Targeted surveys for significant species and in particular bilby and mulgara were conducted during the Wet Season 2009 survey, but no evidence was detected, as discussed in Section 5.4. Whilst we cannot rule out that these species could occur within the project area, LES field surveys, consultation with Traditional Owners and reference to the literature indicate that significant or major populations are unlikely to occur within the Wonarah Phosphate Project Area.

Based in the above research, the proposed mine operations will not impact flora or fauna at a national level.

6.4 Potential Impacts of the Proposed Operation: Bioregional Level

The following is an assessment of the importance of the Wonarah Phosphate Project area against criteria for important habitats developed by Neave *et al.* (2006**)** utilising data of the project area and surrounding region from LES field surveys and the NT Flora and Fauna Atlases (2007).

Criteria for identifying important habitats include:

1. Habitat with high species richness that supports a high abundance of native species and/or is structurally complex. These attributes may relate to: the number of vegetation types and the degree of contrast between them; availability of shelter sites (e.g. nesting sites, ground litter and logs, rock crevices) and water and food resources (e.g. presence of nectar producing shrubs); and/or topographic and geological complexity creating a range of micro-habitats.

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. The main vegetation community of the project area is described as *Eucalyptus (*now *Corymbia) opaca*, (bloodwood) low open-woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey (Wilson *et al*. 1990). This particular vegetation community covers 28095.3 km^2 in the Northern Territory (Wilson *et al.* 1990), of which the proposed disturbance area constitutes 0.1 % of this area. On a regional scale the vegetation and landscape of the project area is not considered threatened or significant. This is highlighted by the relatively low number of flora and fauna species of conservation significance identified by existing data sets and LES field surveys, and the relatively low number of survey sites with multiple height classes.

2. Habitat supporting species of high conservation value (e.g. threatened species, endemic species, poorly reserved species and/or rare species).

Assessment:

The project area and surrounding region partially meets the characteristics of this criterion. Species of conservation significance were recorded within the Wonarah Phosphate Project area during on-site surveys (LES field surveys and NT Flora and Fauna Atlases (2007)) and are listed and discussed in Section 6.4. As discussed above, only one species *Sporobolus latzii*, is potentially reliant on the project area for its persistence, however, the location of the single record is located within a cultural exclusion zone (which prohibits access and disturbance) and the associated ephemeral lake land unit will not be disturbed by mining activities. LES field surveys did not identify any fauna species of conservation significance that would solely rely on habitats within the Wonarah Phosphate Project area.

3. Habitat that is of good quality (i.e. its compositional and structural integrity and ecological processes have not been undermined). The level of habitat integrity is influenced by:

- The presence/absence (or low cover abundance) of environmental weeds, especially buffel grass and couch grass, both of which are known to outcompete native plant taxa and alter habitat parameters for native fauna;
- The presence/absence (or low abundance) of introduced animal species;

- The presence/absence of an appropriate fire regime (inappropriate regimes are known to have an impact on species composition and canopy condition);
- Degree of isolation from infrastructure such as roads and water points (reduced risk of weed invasion and over-grazing); and,
- The state of the hydrological regime (altered regimes may lead to changes in site species composition).

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. Whilst only 2 weed species were recorded at low densities during LES field surveys, several species are known to occur in the surrounding region. Furthermore, high density Buffel Grass populations line the Barkly Highway road verge and occurs in low lying depressions on the lease. The project area is adjacent to infrastructure (major highway) increasing its susceptibility to invasion by introduced species. Five introduced species were recorded during LES field surveys within the project area, albeit at low numbers. Despite these indicators of diminished habitat integrity, it is important to note that the Wonarah Phosphate Project area supports suitable and varied habitats to support good native biodiversity and it is important that future land management sustains this.

4. Habitat that is poorly reserved elsewhere.

Assessment:

The project area and surrounding region do not fully meet the characteristics of this criterion. Although the closest reserve is the (proposed) Davenport Range National Park, habitat found within the project area is characteristic of typical habitat found widely in the surrounding bioregion. The area does contain several diverse plant communities with a high number of young seedlings due to drought and fire recovery, but flora and fauna in the area are generally common and widespread.

The project area occurs within vegetation community 42 which is described as *Corymbia (*formerly *Eucalyptus) opaca* (Bloodwood) low open-woodland with *Triodia pungens* (Soft Spinifex) hummock grassland understorey (Wilson *et al.* 1990). Vegetation community 42 occupies 28095.3 km^2 within the Northern Territory of which the Wonarah Phosphate Project area constitutes ~100 km^2 and the area of the proposed disturbance (i.e. mine area) is 27 km^2.

This impact assessment for determining important habitat at a bioregional scale against four criteria developed by Neave *et al.* (2006**)** found that three of the four criteria were not met. Criteria number 2 was partially met because of the presence of *Sporobolus latzii* within the project area, which is suggested to be dependent on the project area for its continued persistence. However, the proposed works will not disturb the known location of *S. latzii*, nor the associated ephemeral lake land unit, thereby not impacting upon Criterion 2. Therefore, based on this impact assessment, the proposed mine operations will not impact flora or fauna at a bioregional level.

6.5 Potential Impacts of the Proposed Operation: Local Level

Five vegetation communities exist within the project area, of which 3 (vegetation communities 1, 3 and 5 as described in Appendix Forty-one) will be affected by the proposed works. These vegetation communities are dominated by common species of *Aristida, Acacia*, Eucalypts, *Grevillea, Hakea, Melaleuca* and *Triodia* and the proposed operations will result in localised loss of habitat for these species and local alteration of landscape. LES field surveys did not identify any flora species of high conservation value under the TPWC Act/EPBC Act and most of the plants and associated vegetation communities are widespread throughout the region (Baker *et al*., 2005). However, LES field surveys and the NT Flora Atlas (2007) recorded flora species of conservation significance under the TPWC Act occurring within the project area and/or within a 50 km buffer, (Appendix Thirty-seven). These include 3 near threatened species, 12 data deficient species and 1 non-evaluated species. White *et al.* (2000) further classifies nine of these species to be of significance at the Northern Territory level and three at a national level. Five of the aforementioned species have been recorded on-site with coordinates provided in Appendix Thirteen. Furthermore, ephemeral areas, and also run-on and run-off areas, are likely to be important for both annual and perennial species. The proposed operations may result in disturbance to these areas, although a number of management strategies can be adopted to minimise disturbance. These are outlined in sections to follow.

Vegetation clearing for the proposed operation will result in localised habitat loss for the fauna living in the affected area, particularly those in the area of the pit, campsite and access roads. Mining will also indirectly impact on the local fauna through increased noise, vibration, dust, lights, roads, increased human activity, possible creation of artificial resources, and possible alteration of the natural drainage patterns. Although these disturbances may reduce populations in the affected parts of the project area, most species are common and widespread throughout their range and their status is unlikely to be altered.

Only one fauna species, (Australian bustard, *Ardeotis australis*) listed as threatened under the TPWC Act was identified during LES field surveys within the Wonarah Phosphate Project area, although there are a number species of conservation significance that have been previously identified within the project area and/or surrounding region (Appendix Thirty-eight). Those species that have a conservation status at or above vulnerable (TPWC Act/EPBC Act) are discussed below. The preferred habitat, distribution, preferred fire regimes and threatening processes to significant fauna species potentially occurring within the Wonarah project area are outlined in Appendix Forty.

The Australian bustard (*Ardeotis australis*) is listed as vulnerable under the TPWC Act and is known to occur widely in the project area. Distribution of the generally scarce bustard is widespread, though it is more common in the north of Australia and tend to occur in loose aggregations with the Barklys being one of the strongholds (Woinarski *et al.* 2007). Numbers are likely to fluctuate depending on seasons, and due to the highly mobile nature of the species, small, localised disturbance is not likely to affect its status. Threatening processes include predation, altered fire regimes, hunting, disturbance, habitat alteration (e.g. woody weed infestation), pesticides and grazing although the relative effects of each of these threats are still being researched (Ziembiki, 2006). Hunting by indigenous populations is identified as a potential threatening process due to breakdown of controls, compounded by access to modern weapons and vehicles, and a low reproductive rate (usually one young per year) increasing pressure on populations (Ziembiki, 2006). Impacts of potential mining operations on the Australian Bustard populations will be minor; however, protocols to minimise impacts are outlined below.

The Australian painted snipe, (*Rostratula australis*) is listed as vulnerable under the EPBC and TPWC Acts and has been recorded within the 50 km buffer of the project area. Threatening processes include wetland drainage and other forms of wetland and swampland degradation including that by cattle (Taylor *et al.,* 2006). Ephemeral lakes constitute the only possible habitat within the project area for the Australian painted snipe, although this is not ideal habitat. The main ephemeral lakes are within exclusion zones and will not be accessed by the proposed mining operations. Therefore, should the Australian painted snipe inhabit these areas; they will not be directly affected by mining operations.

The Alligator Rivers subspecies of the yellow chat, (*Epthianura crocea tunneyi*) is listed as Endangered under the TPWC Act and Vulnerable under the EPBC Act. This subspecies has not been recorded south of about Katherine and is restricted to a small geographic area encompassing floodplains from the Adelaide River to the East Alligator River (Woinarski *et al.* 2007). However, *Epthianura crocea* occurs across northern Australia, typically in chenopod shrublands and grasslands around water sources (Woinarski *et al.* 2007). The more common subspecies, *Epthianura crocea crocea* (inland subspecies) is listed as least concern under the TPWC Act and was recorded about 20 km north-east of the project area in cracking clay country with swamp depressions, a habitat not found within the project area. The status of yellow chats on a local, regional or national scale is therefore not likely to be affected by the proposed operations.

The bilby (*Macrotis lagotis*) is listed as vulnerable under the TPWC Act and EPBC Act. Bilbies have not been recorded in the project area and no signs of bilbies were identified during LES field surveys, despite targeted surveys. Local Traditional Owners did not know the species. However, bilbies have been recorded 40 km south-west of the project area (in 1994), and habitat is suitable within the project area for bilbies to occur. Potentially suitable habitat is identified in Appendix Forty-one. However, there are very few records post 1970 in the Barkly area. Woinarski *et al.* (2007) describes the suitable habitat as sandy soils dominated by hummock grasslands covered predominantly by spinifex and an overstorey of low shrub cover dominated by *Acacia* and *Melaleuca*. The sandy landscape also often comprises rocky outcrops, lateritic rises and low-lying drainage depressions. As there was no sign of bilbies in the project area, it is unlikely that the status of this species will be affected on a local scale. However, ongoing monitoring should occur to identify potential populations of this mobile species.

The mulgara (*Dasycercus cristicauda* and *D. blythi*) are listed as vulnerable under the TPWC Act and endangered and vulnerable respectively under the EPBC Act. Mulgaras have not been recorded in the project area and no sign of mulgaras were identified during LES field surveys, despite targeted surveys, good conditions for tracking during the Wet Season 2009 survey and consultation with Traditional Owners. However, mulgaras were recorded 40 km west-south-west of the project area in 1993, and habitat suitable for mulgaras occurs within the project area. Potentially suitable habitat is identified in Appendix Forty-one. Masters *et al*. (2003) describes the principle habitat for mulgara as hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens*. As there was no sign of mulgara in the project area, it is unlikely that the status of this species will be affected by mining operations on a local scale. Ongoing monitoring should occur to identify potential populations of this mobile species that prefers disturbed and variable habitats.

Bushfire impacts

Fire frequency, intensity and timing are determining factors for ecological community composition and structure. Alterations to current fire regimes are recognised as a threatening process for many significant species recorded within the Wonarah project area and/or surrounding region (Ingleby 1991; Pavey 2006; Pavey *et al.* 2006; Ziembicki 2006). Unfortunately, research on beneficial fire regimes for the persistence of significant species is limited. However, generally fire is necessary for initiating the growth and reproductive cycles of fire promoted plants, of which many provide important habitat and dietary requirements for faunal species.

Beneficial habitat conditions resulting from fire were found for three threatened or near threatened species recorded in or within 50 km buffer of the Wonarah Phosphate Project area. The Australian bustard readily responds to fire as it promotes food and provides large areas of open space, which males seek for their courtship displays (Ziembicki 2006). Fire is necessary for the production of seeds of some species that are an important dietary component for bilbies (Pavey 2006) and the spectacled hare-wallaby frequently feeds in recently burnt country (Ingleby and Westoby 1992). Generally, low intensity mosaic patch burning, conducted in cooler months, ensures that spatial biodiversity is maintained and provides a higher likelihood of survival for many species of both flora and fauna (Preece *et al*. 1989).

Fire frequency models from the Northern Territory Bushfires Council broadly indicate a 1 to 2 in 10 year fire frequency within the region of the Wonarah project area. Alterations to this regime are likely to encourage alterations within the local ecological communities; however, it is not clear if this regime reflects traditional burning regimes and whether changes would therefore be detrimental to flora and fauna populations. No sites within the project area were identified as being important for the persistence of threatened species; therefore fire within the project area is unlikely to affect the persistence of these threatened species. Ephemeral lakes (especially the area within the CLC exclusion zone) are likely to be seasonally important to fauna as refuges and their disturbance may have substantial negative impacts on regional fauna populations in the event of wildfires. It is therefore appropriate to incorporate fire management for ecological protection/improvement into the mine management plan as discussed in Section 7.7.

7 Management Recommendations

One of the aims of environmental surveys is to identify features of the landscape and biota that should be considered during the project development and operation in order to avoid or minimise potential adverse impacts and optimise rehabilitation. Furthermore, survey data may be used as a baseline against which future monitoring may detect impacts of mining operations. The aim of rehabilitation is to return the landforms and wildlife to a stable condition, as near as possible to their original state. Rehabilitation needs to be an integral part of the mining plan and be applied progressively throughout mine development and operation. The following are guidelines for site planning and management.

7.1 Management of Significant Species

Species of conservation significance that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlases (2007)) include flora species *Bonamia alatisemina, Distichostemon barklyanus, Heliotropium ballii, Heliotropium pulvinum, Sporobolus latzii, Triumfetta deserticola, Bergia barklyana* and *Hibiscus brachychlaenus* and fauna species, Australian bustard (*Ardeotis australis*), northern nailtail wallaby (*Onychogalea unguifera*), long-haired rat (*Rattus villosissimus*) and woma (*Aspidites ramsayi*). Additional fauna species of conservation significance recorded within the surrounding region (50 km buffer) in other studies, or are listed as potentially occurring in the project area under the DEWHA *Matters of Environmental Significance Report* are; Australian painted snipe (*Rostratula australis*), yellow chat, (*Epthianura crocea*), square-tailed kite (*Lophoictinia isura*), mulgara (*Dasycercus cristicauda* or *D. blythi*), bilby (*Macrotis lagotis*), flock bronzewing (*Phaps histrionica*), northern snapping frog (*Cyclorana australis*) and spectacled hare wallaby(*Lagorchestes conspicillatus*)

Flora:

White *et al.* (2000) note that the Wonarah Beds location is of bioregional significance and there is potential for a number of species of conservation significance to occur in this area. Land unit mapping derived herein suggested that *Sporobolus latzii* occurs within the ephemeral lakes land unit, the largest of which occurs 5 km to the north of the Arruwurra prospect and 13 km south-west of the Main Zone (Wonarah Prospect). This area is currently within a cultural exclusion zone which prevents mining activities within the area, limiting the likelihood of works impacting upon this known record. Furthermore, proposed works are located away from the ephemeral lake land unit thus minimising impacts on this species potentially occurring elsewhere in this land unit. However, there is also potential for *Sporobolus latzii* to occur in other drainage depressions and areas subject to prolonged water inundation including the ephemeral lake land unit. The lower areas of the alluvial (low lying) sand plain and shallow sand plain land units would be potential areas where *S. latzii* could occur. Low lying areas within impact areas that are inundated during wet periods should be noted by Minemakers and where possible, works should be restricted or impacts minimised in these areas to reduce impacts on potential individuals. Rio Tinto prepared a procedure for protecting S*porobolus latzii* on the Wonarah tenements, and this should be adopted (see Appendix Forty-seven).

Disturbance within the project area should minimise impacts to land units identified as potentially supporting flora species of conservation significance listed in Appendix Thirty-seven. Fauna species of conservation significance recorded within the project area are dispersive (i.e. Australian bustard, northern nailtail wallaby and long haired rat) and not specifically correlated to land units within the project area. Land units identified to be potentially impacted by the proposed works are; Alluvial Low Lying Sand Plains, Calcareous Plains, Deep Sand Plains, Ironstone Rocky Rises and Shallow Sand Plains. Land units identified to potentially support flora of conservation significance are; Alluvial Low Lying Sand Plains, Deep Sand Plains, Ironstone Rocky Rises, Silcrete Rocky Rises and Ephemeral Lakes (Appendix Thirty-seven). Coordinates of flora species of conservation significance are provided in Appendix Thirteen.

A general induction manual for all flora species of conservation significance listed in Appendix Thirty-seven should be prepared so that all workers are aware of the key plant species of conservation significance and their potential distributions.

Fauna:

To mitigate impacts on all native fauna, including significant species, the following techniques should be implemented:

- If areas must be disturbed, a walk-over survey of all areas should be conducted prior to the commencement of any work to locate possible individuals or presence (i.e. tracks, scats, digs, dens etc). This must be conducted by experienced personnel.

- Establish monitoring programs utilising sites established during the Wet Season 2009 survey to assess potential impacts of mining operations and include further monitoring during different seasons to identify seasonal species variations through time. Recommendations for future monitoring programs are outlined in Section 7.9.
- Manage artificial resource points (i.e. dams, bores, rubbish points and food storages) to avoid attracting and increasing populations of predators (native and feral) and introduced herbivores (discussed in Sections 7.2 and 7.3). A detailed management plan to avoid attracting dingos (a potential culturally significant species) to artificial resource points is provided in Appendix Forty-eight. The guiding principals of this plan are suitable for deterring non-target predators and introduced herbivores; however further actions may be required to suit the characteristics of specific feral animals.
- Provide a manual and implement an induction program so all employees and contractors are able to identify significant species and are aware all sightings must be reported to the Environmental Manager and/or consultant or the Parks and Wildlife Service of the Northern Territory. Furthermore, observations of plant or animal species of unknown identity should also be reported; where possible, reports should be accompanied with a detailed description, including location and, if possible, a photo.
- Review management protocols if additional significant species or known locations are recorded so that impact on these species can be considered and minimised if necessary.
- Train key staff in identification of threatened species and provide for rescue and relocation of species of conservation significance. All rescue and relocation protocols should be developed in consultation with Parks and Wildlife Service of the NT.
- To minimise fauna death on roads, restrict speeds on haulage routes and mine roads, particularly during periods when it is known wildlife may be using the roads or nearby areas.
- If it is deemed appropriate, Minemakers may develop and implement a fire management program in collaboration with Traditional Owners and Bush Fires Council to produce mosaic patterns enhancing spatial diversity of habitat and improving habitat quality for some significant species (as identified in Appendix Forty-one). Such fire management programs are implemented by some mining companies in the Northern Territory and utilise knowledge and expertise of the Traditional Owners. However, it is the responsibility of the mining company to

ensure protection of their assets and of human lives, and therefore fire management plans must consider these aspects carefully.

7.2 Management of Native Predator Species

Dingoes were recorded throughout the project area, and, although they are likely to be present at low numbers, several management strategies can be introduced to minimise access to food and water resources which will, in turn, reduce the chance of animal and human welfare incidents. In particular these include:

- Undertaking inductions for all workers on site about not feeding or interacting with dingoes;
- Separating food from normal waste and burning in a separate location;
- Installing predator-proof fencing around all food waste areas;
- Installing dingo proof bins;
- Maintaining clean work and camp sites;
- Minimising access to artificial water sources; and
- Monitoring dingo movements and behaviour.

A detailed management plan to avoid attracting dingos to artificial resource points is provided in Appendix Forty-eight, and should be incorporated into the planning phase of the Wonarah Phosphate Project.

7.3 Management of Introduced Species

Introduced species of flora and fauna already existing within the project area and surrounding region are listed in Appendices Thirty-six & Thirty-seven. Management practices should minimise the potential for spreading or increasing introduced species. Control of weeds and feral species will minimise disturbance to the local environment and greatly assist rehabilitation programs.

Weeds: Mining development will lead to increased disturbance and potential for the introduction and spread of weed species. A program for weed identification and control should be implemented. Control of existing weed species prior to mine activity, particularly in areas used by mine vehicles, will reduce weed spread. Potential invading weed species are listed in Appendix Fourteen. The presence and spread of these species should be reported to the district Weeds Officer (Dept of Natural Resources, Environment, The Arts and Sport, DNRETAS). The area should be examined by a weeds officer annually. Identification pictures and description of expected weed species should be provided to staff as a part of the mine site induction so they can easily distinguish between natives and weedy plants and avoid spreading seeds from weeds.

Machinery brought into the lease areas should be “washed down” before use on-site. Topsoil from weed-infested areas should not be used in revegetation work. Any weeds establishing in rehabilitation areas should be immediately eradicated before they set seed. Monitoring of weed spread by periodic mapping at the beginning of the wet season is advisable. Preventative and control measures for weed spread should be developed in consultation with DNRETAS or a qualified weeds officer. Any landscaping within the project area should only use local native species.

Feral animals: Mining operations have the potential to significantly increase the feral animal populations in the area. Feral cats and rodents may be attracted to exposed rubbish dumps and artificial water resources. Rubbish tips should be covered and fenced to avoid attracting these animals. Control of feral animals (e.g. by fencing out stock) may be necessary to prevent damage to sites undergoing rehabilitation.

Access to artificial resources that may attract other feral animals, such as camels and donkeys, should be minimised so that the mine does not aid in population increases. Efforts to control these species should be considered when developing a feral animal control program as part of the mine management plan. Many of the techniques outlined in the dingo management strategy in Appendix Forty-eight are useful for controlling feral animals in general; however, further actions, may be required to suit the characteristics of specific feral animals. For example, camels and donkeys are large and strong and therefore capable of knocking down inappropriate fencing to access resources (e.g. water). Camels accustomed to humans have become aggressive towards humans in some central Australian indigenous communities and have also chewed off water taps to access water. Such examples illustrate why incorporating feral animal management strategies into the planning process is critical to avoid feral animals developing associations between human settlements and resources. Feral animal control programs would require appropriate authorisation from CLC and NT government.

7.4 Vegetation Removal

To minimise clearing of vegetation, mineral exploration operations should attempt to use existing disturbed areas and roads where possible. Clearing of vegetation should be minimal and should be avoided in the ephemeral land systems and areas subject to inundation. Areas to be cleared should be clearly marked with flagging tape prior to any works. The Central Land Council must be consulted for clearance and/or modification to all trees that meet the criteria for cultural significance. Culturally significant trees are defined by the Central Land Council (CLC) as having trunk diameters equal to or greater than 12.5 cm and being at least 1.5 m tall. Removal and/or modification of such trees may require Traditional Owner approval. Vegetation clearing for the mining operation should be progressive, and conducted in stages as cleared areas are required, rather than initially clearing the complete footprint. This will avoid superfluous clearing, reduce dust and erosion potential, retain seed sources for rehabilitation and allow local fauna to adapt to loss of habitat. Vegetation removed can be used for minor constructions such as ponding and sediment banks. Trees and shrubs could be stockpiled within waste dumps or placed on top to assist rehabilitation and create habitat for microfauna. This option is preferred to burning and results in less nutrient loss from the environment as well as reducing green house gas production.

7.5 Rehabilitation

Rehabilitation of the project is best achieved through careful management of top soils, facilitating revegetation from the seed bank. In areas targeted for earthworks the topsoil (top 100 mm), including groundcover plants, and subsoil (to about 300 mm) should be stripped and stockpiled separately for use in rehabilitation programs. Stripping and other earthworks should be performed during the dry season when chances of runoff erosion and destruction of soil structure is minimal. It is best to double-strip the topsoils by removing and separately storing the top 100 mm of the soil, which contains the significant proportion of the seed bank, nutrients and microfauna. Immediate use of topsoil on areas awaiting rehabilitation is the most productive option, because soil components such as micro-organisms, seeds and organic matter will deteriorate during storage. If stockpiling of the soils is necessary, stockpiles should be stored away from drainage areas to reduce erosion and loss of useful soil material. Topsoil should be stored in low mounds, preferably less than 1 to 2 m high, to allow the seed bank to germinate. Stockpiles should be allowed to revegetate to protect against erosion and sustain microbe populations, which are essential to maintaining nutrient composition.

It is recommended that the revegetation of waste rock landforms involve the laying of 5 to 10 cm of stripped topsoil (preferably less than 4 months old) over the waste rock, followed by contour furrowing or ripping. This will allow infiltration of rainfall, mixing of waste rock and topsoil and loosen the soil surface for sowing or planting of tube stock if required. Ripping should be carried out prior to the wet season (i.e. in October - November). Minemakers propose to progressively backfill pits during mining operations, thus limiting the creation of wasterock landforms.

Early in the mine development plant revegetation trials (based on stripped topsoil) should be established to determine if natural revegetation will be adequate for rehabilitation purposes. Should trials show inadequate revegetation, a seed collection program will be required based on local provinance material and care needs to be taken to exclude weed species. Plant species to be used for revegetation must be appropriate to the land unit. A plant species list is provided indicating potentially suitable species for rehabilitation specific to land units within the project area, Appendix Forty-two. It is recommended that Traditional Owners are consulted and employed to collect local seeds.

Rehabilitation should be progressive so disturbed areas are stabilised before erosion develops. This will minimise the impact on the local environment and maximise the extent of rehabilitation completed during the mine operation period. The rehabilitation program needs to combine the application of standard methods of monitoring and research in order to customise techniques. Progressive revegetation should begin as early as possible in the mining operation, so the area will end up as a mosaic of various regrowth stages of local vegetation types.

Opportunities to improve habitat availability and quality for EPBC and TPWC listed species essentially do not apply to the project areas since only one species of conservation significance (*Sporobolus latzii*) was identified to be potentially reliant on the project area for its persistence and this occurs in the ephemeral lakes areas which are in restricted locations or in areas where there is limited or no ore body. However, habitat enhancement for most local species can be achieved by ensuring that rehabilitation is undertaken as early as possible in order that top soils and contained seed remain fresh and are used in locations specific to the land unit in which rehabilitation is undertaken.

Opportunities to improve habitat for local species is a vexed question in that it implies that habitat will be improved for particular obvious species. Little is known of the general ecology of the region and it would require more intensive studies to determine the impact on non-target species. One major requirement for management of the operation will be to avoid attracting predators such as dingoes, foxes, cats as well as raptors which could prey on local species such as Nail-tail Wallabies in the southern portion of the lease. This requires management of artificial resource sources to avoid attracting and increasing wild animal populations as discussed in Section 7.3.

7.6 Fire Management

Fire is an inevitable and common environmental feature of the desert country south of the Barkly. The approach of "letting nature take its course" is an unreasonable option (Preece *et al*. 1989). This ignores the fact that humans have been influencing fire regimes for al least 40,000 years (Preece *et al*. 1989). Australian ecosystems and species are adapted to a dynamic fire regime but rehabilitating areas need to be protected from fire to assist revegetation.

Fire intensity, frequency and timing are important factors influencing ecological communities. Excessive burning (i.e. greater than once every 2 to 5 years) in open woodlands may result in reduced complexity of flora and predominance of grasses in the understorey. Mott and Andrew (1985) determined that a number of perennial grasses such as *Sorghum plumosum*, *Heteropogon contortus* and *Themeda australis* prefer biennial burns. However, a fire management plan should be developed in consultation with and approved by NT Bush Fires Council and traditional owners who may determine that a lower fire frequency is required for the project area. Active management can regulate and moderate wildfires so they have an acceptable impact on the environment (Preece *et al.* 1989). The establishment of a local fire management control program will assist containment of wildfires.

Fire will not normally be a part of the project management plan; however, hazard reduction may be necessary when fuel load increases within the operational areas. Patch burning is the preferred method of reducing fire hazard. This method of fire management results in small fires which flora and fauna have a better chance of surviving. In addition to reducing the risk of intense or large-scale fire, a mosaic pattern of burning will produce a diverse range of habitats and hence maintain local biotic diversity (Preece *et al.* 1989).

Fire management plans should be developed in consultation with the NT Bushfires Council and may utilise the knowledge and expertise of Traditional Owners. Hazard reduction burning should be conducted at the beginning of the dry season (March to May), when the vegetation is less flammable and the soils are moist; this will favour the survival of stressed trees. Areas of severe erosion should be protected from burning, as removal of vegetation and intense heat will reduce soil stability and accelerate erosion. Appropriate permits are required from the NT Bushfires Council.

7.7 Recommended Future Environmental Monitoring

During the Wet Season 2009 survey, 46 more fauna species and 102 more flora species were recorded than in the Dry Season 2008 survey. Although it was known that the Dry 2008 Season survey would have limited plant species due to the fire, the increased values emphasise the importance of follow-up surveys to capture changes in seasonal species composition, including species occurring in response to fire. Furthermore, the spatial, temporal and seasonal variability of arid rangelands necessitates future environmental monitoring to detect the presence of significant species not previously recorded within the project area, to detect delayed impacts of mining operations and to assess the effectiveness of rehabilitation works.

Recommended future monitoring should replicate the methods described herein for the flora and fauna component of the Wet Season 2009 survey. Additionally, it is recommended that as additional access tracks are installed, more survey sites (or quadrats) are added so sites can be stratified equally across land units and impact and non-impact areas. The current survey quadrats represent 6 land units, with 6 survey quadrats in proposed impact sites, and 2 in non-impact sites. This has initiated the collection of baseline data, although the establishment and stratification of additional sites will provide a more extensive and robust data set. As a general rule of thumb in broad scale surveys, at least 20 monitoring sites are required to establish biological and landscape information against which the impacts of mining activity can be effectively and statistically assessed (Pers. comm., February, 2009, R. B. Cunningham, Adjunct Professor (Statistics), Fenner School of Environment and Society, ANU, Canberra)

Long term environmental monitoring should pursue three main objectives:

1) Describe the pre-development environment to provide a basis for identifying potential impacts and associated remedial action.

2) Monitor the project's environmental impacts and identify unforeseen impacts.

3) Assess environmental management strategies and compliance with regulatory permits and licenses.

Further, it is important to update maps with weed sightings and details of weed eradication efforts within the project area to avoid using weed-infested soils in revegetation programs, and to monitor the effect of development on weed abundance.

Ongoing monitoring programs will be required to assess impact and identify management issues concerning:

- Surface and ground waters
- Disturbed catchment areas
- Relative abundance of introduced species (flora and fauna)
- Wildfire control
- Dust deposition
- Weathering products of mine waste (i.e. acid drainage)
- Revegetation and rehabilitation techniques

It is recommended that adaptive management plans are developed to incorporate findings from the future monitoring programs. This may include scheduled reviews of management plans that facilitate their assessment in light of results from continued monitoring. In turn, management plans should contain tools to review and adapt monitoring programs to incorporate new data as appropriate.

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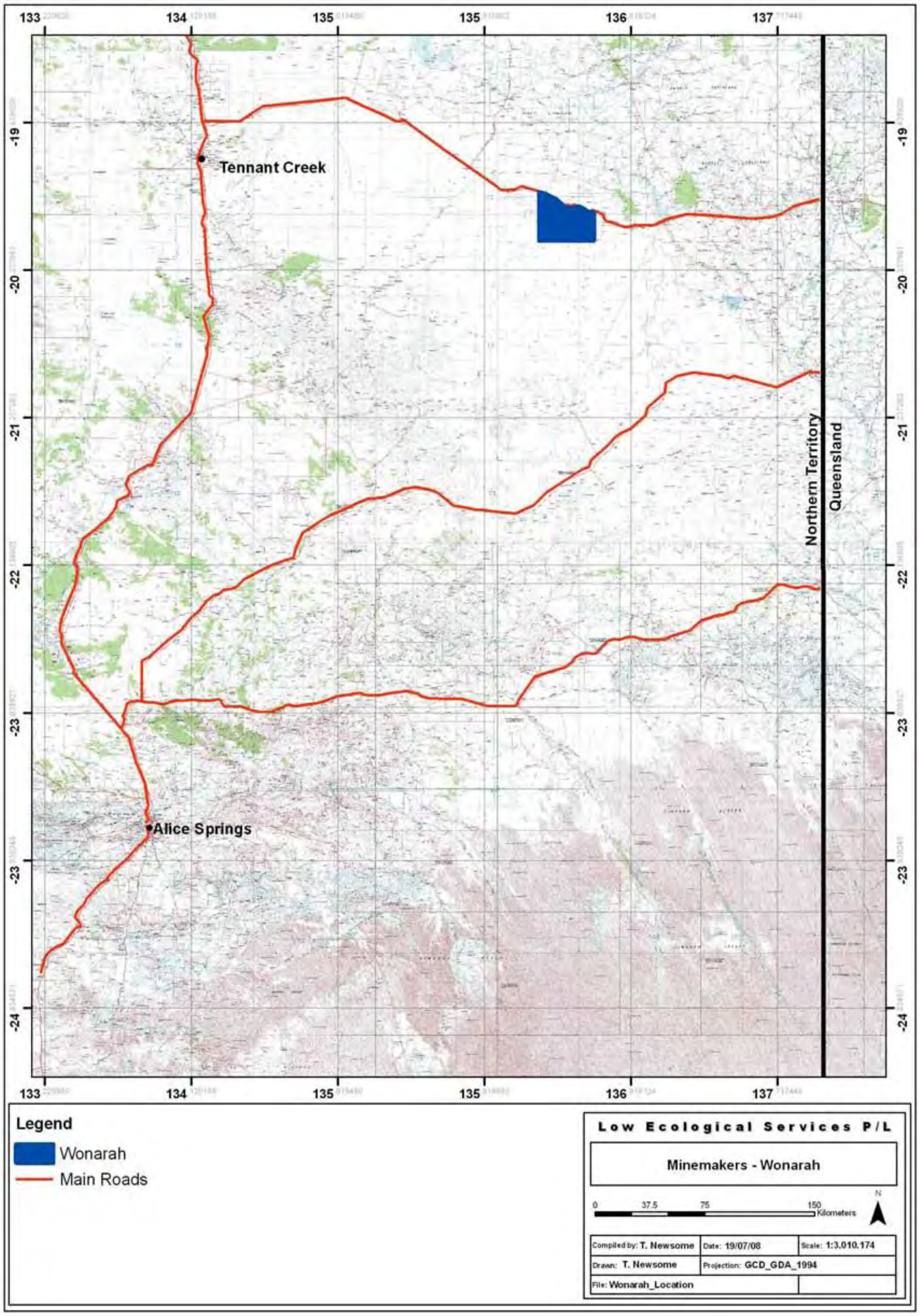
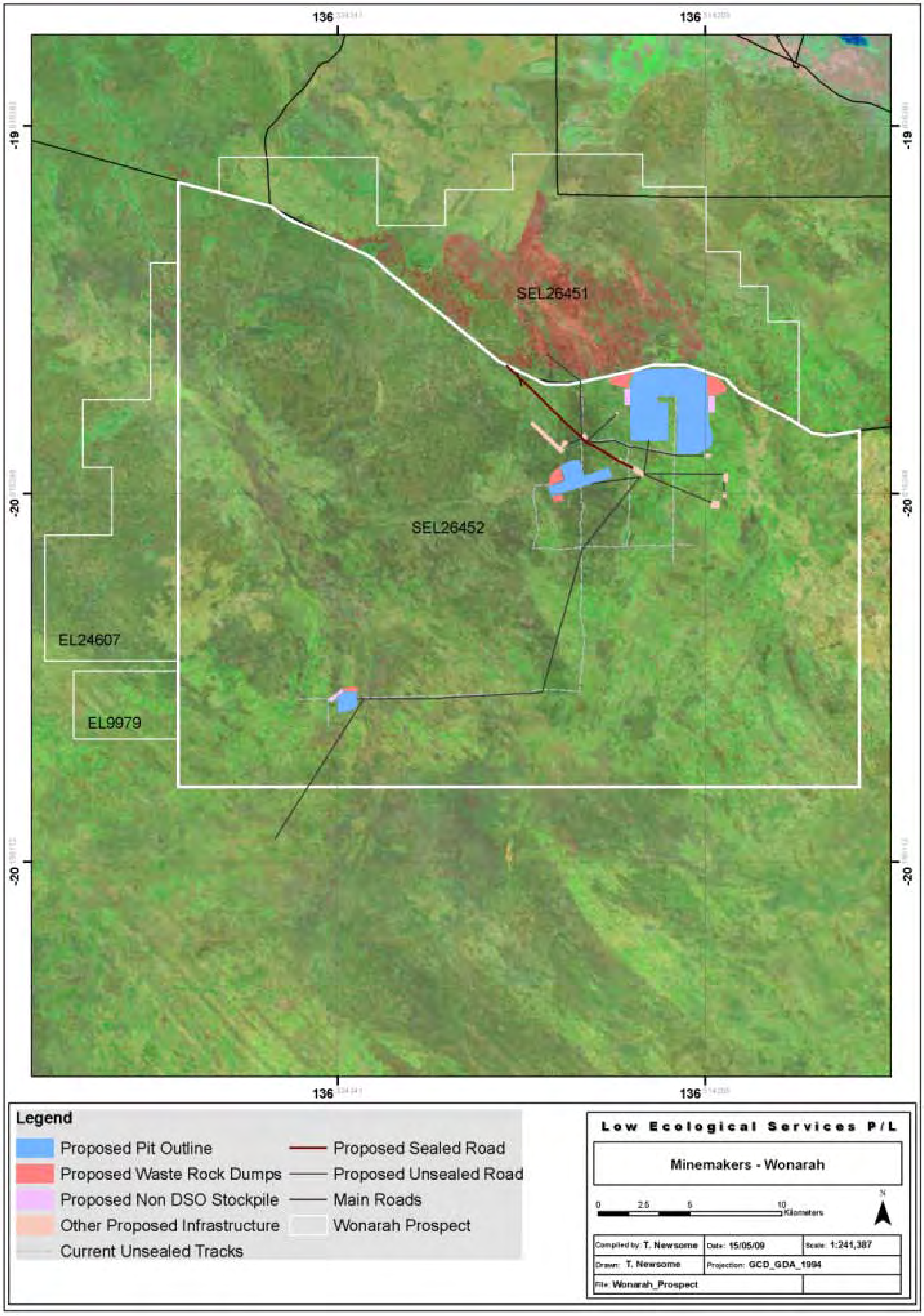
9 Appendices

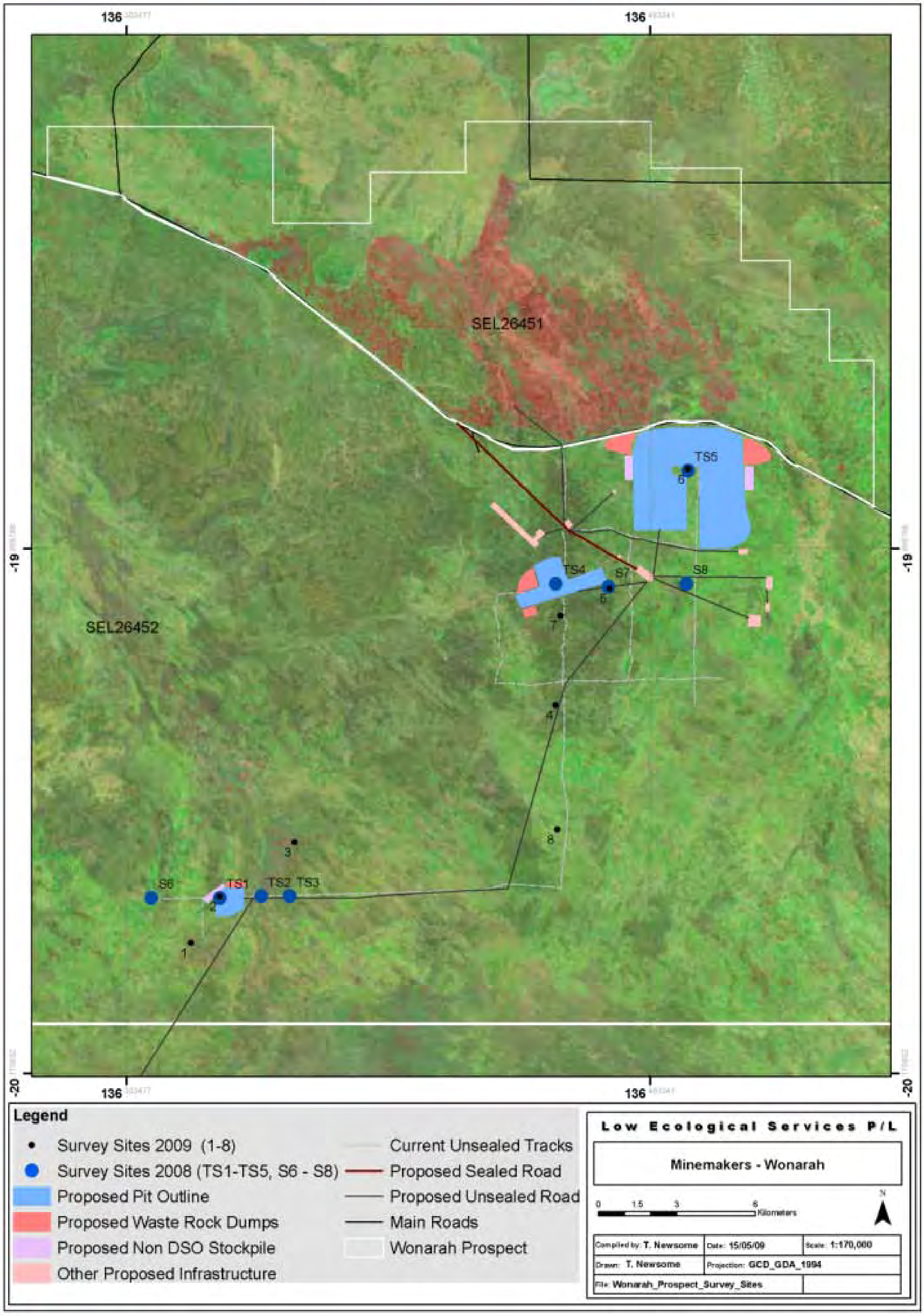
9.1 Appendix One: Location of Minemakers Wonarah Phosphate Project in relation to Alice Springs and Tennant Creek, Northern Territory.



9.2 Appendix Two: Minemakers Wonarah prospect zones over Landsat 5 image. The Wonarah Phosphate Project area occurs within of exploration licence SEL 26452.

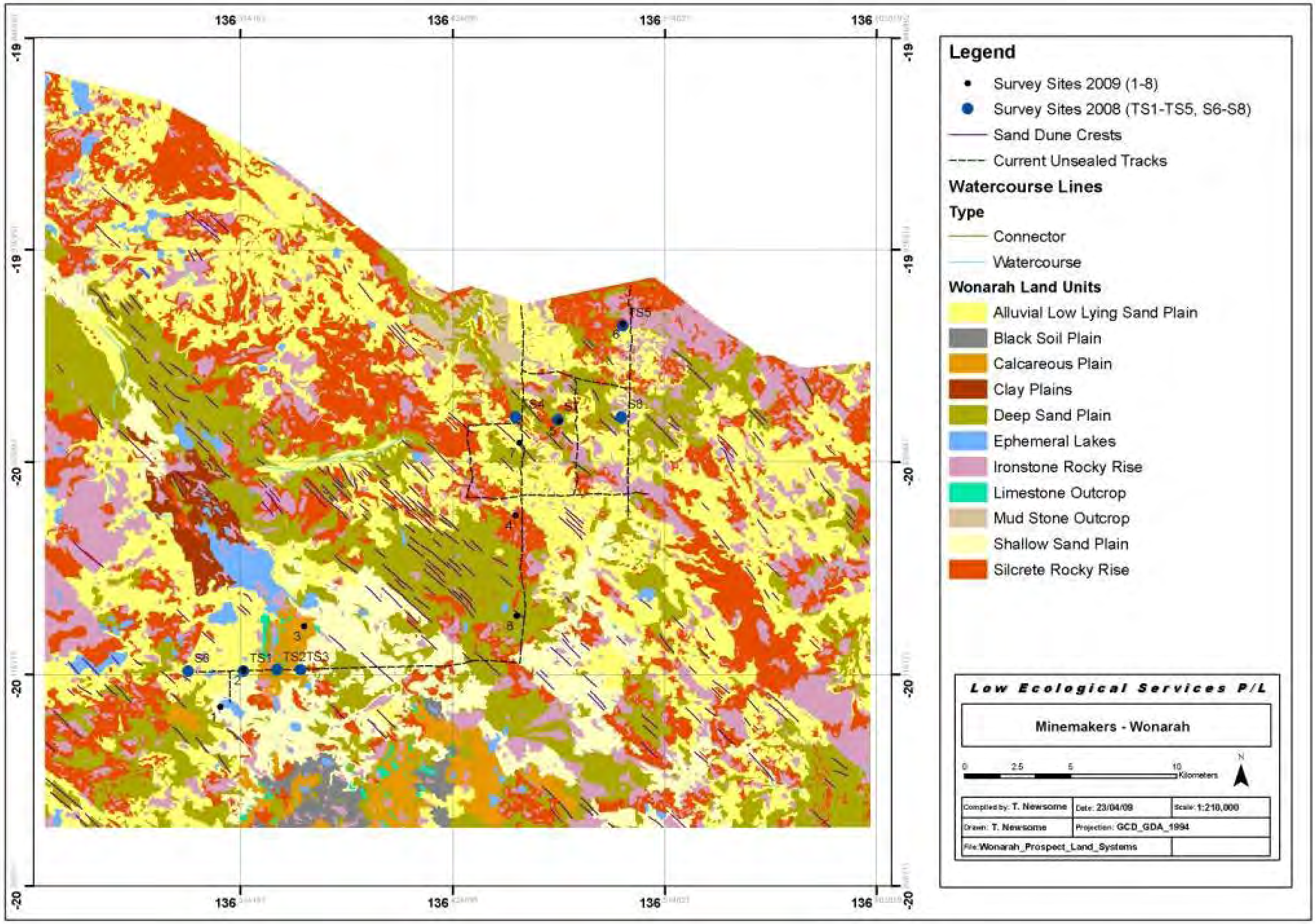


9.3 Appendix Three: Location of survey quadrats studied during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys) and proposed disturbance areas over Landsat 5 image.

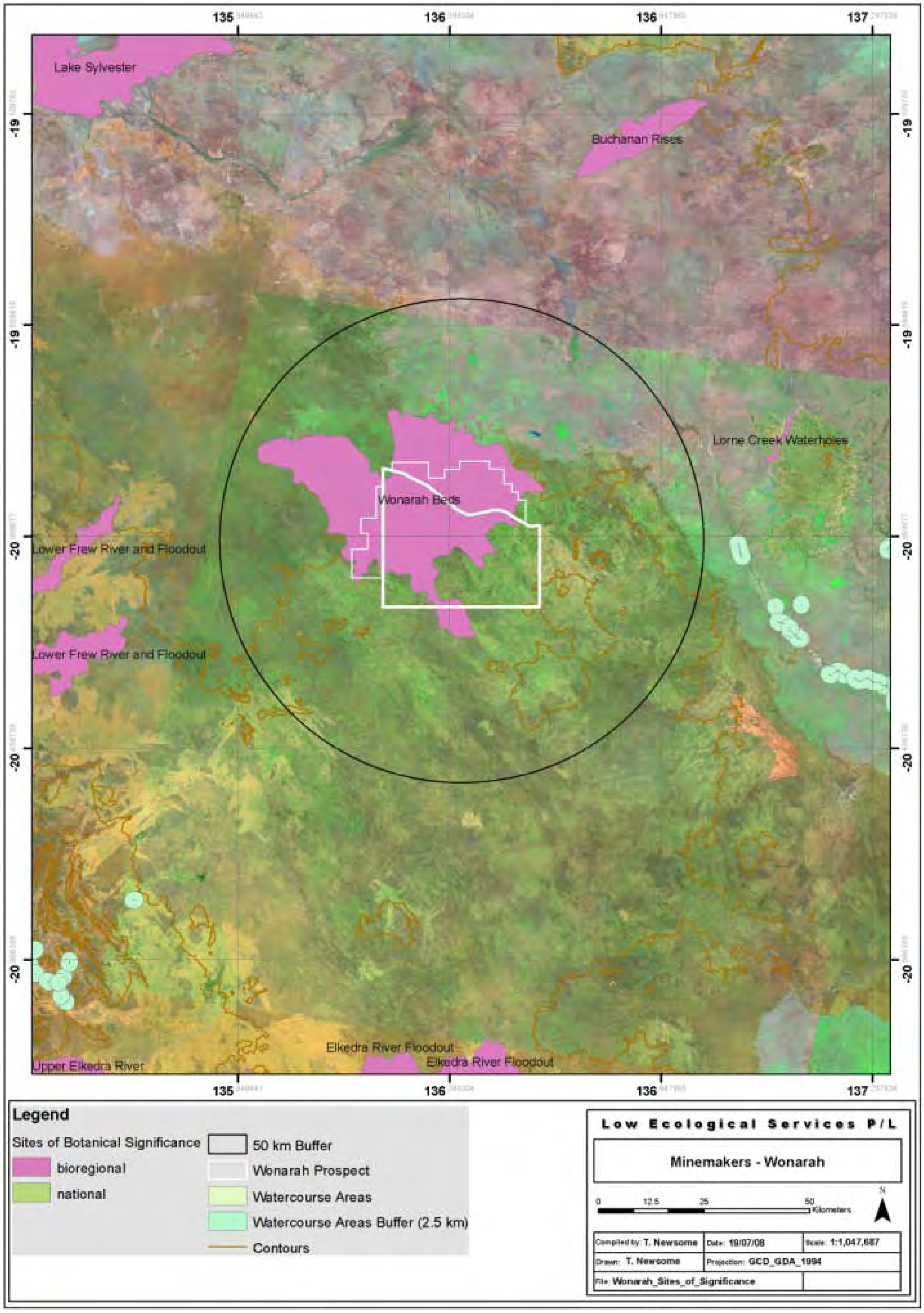


9.4 Appendix Four:

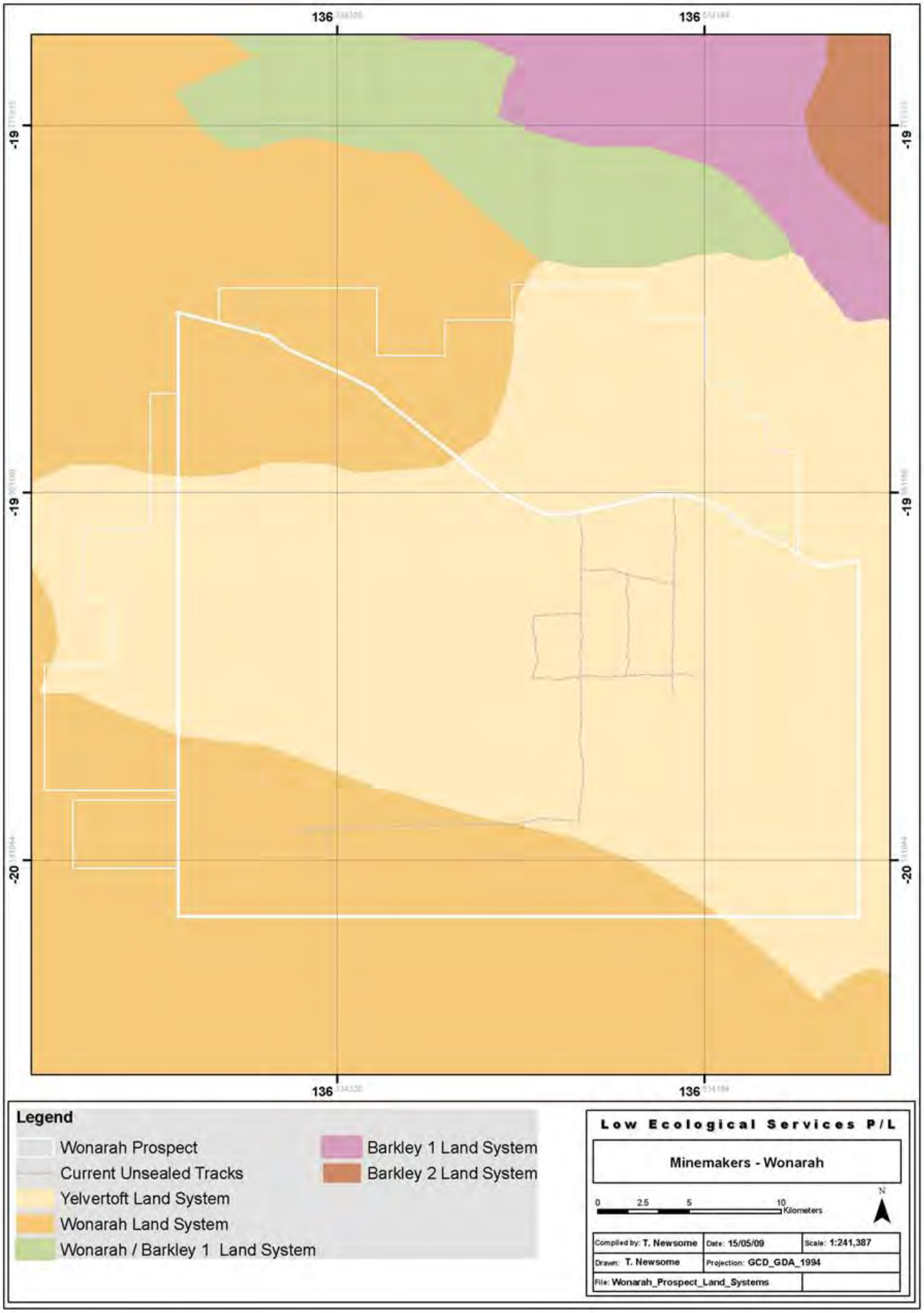
Appendix Four: Land units and survey quadrat locations utilised in LES field surveys (Dry Season 2008 and Wet Season 2009 surveys) within the Wonarah project area. Land units were developed by LES utilising regolith units surveyed by Rio Tinto and were verified on-site during the Wet Season 2009 survey, as discussed in Section 5.5.



9.5 Appendix Five: Location of Wonarah Phosphate Project area in relation to sites of significance as determined by the Northern Territory Parks and Conservation Masterplan and watercourse areas over Landsat 5 image.

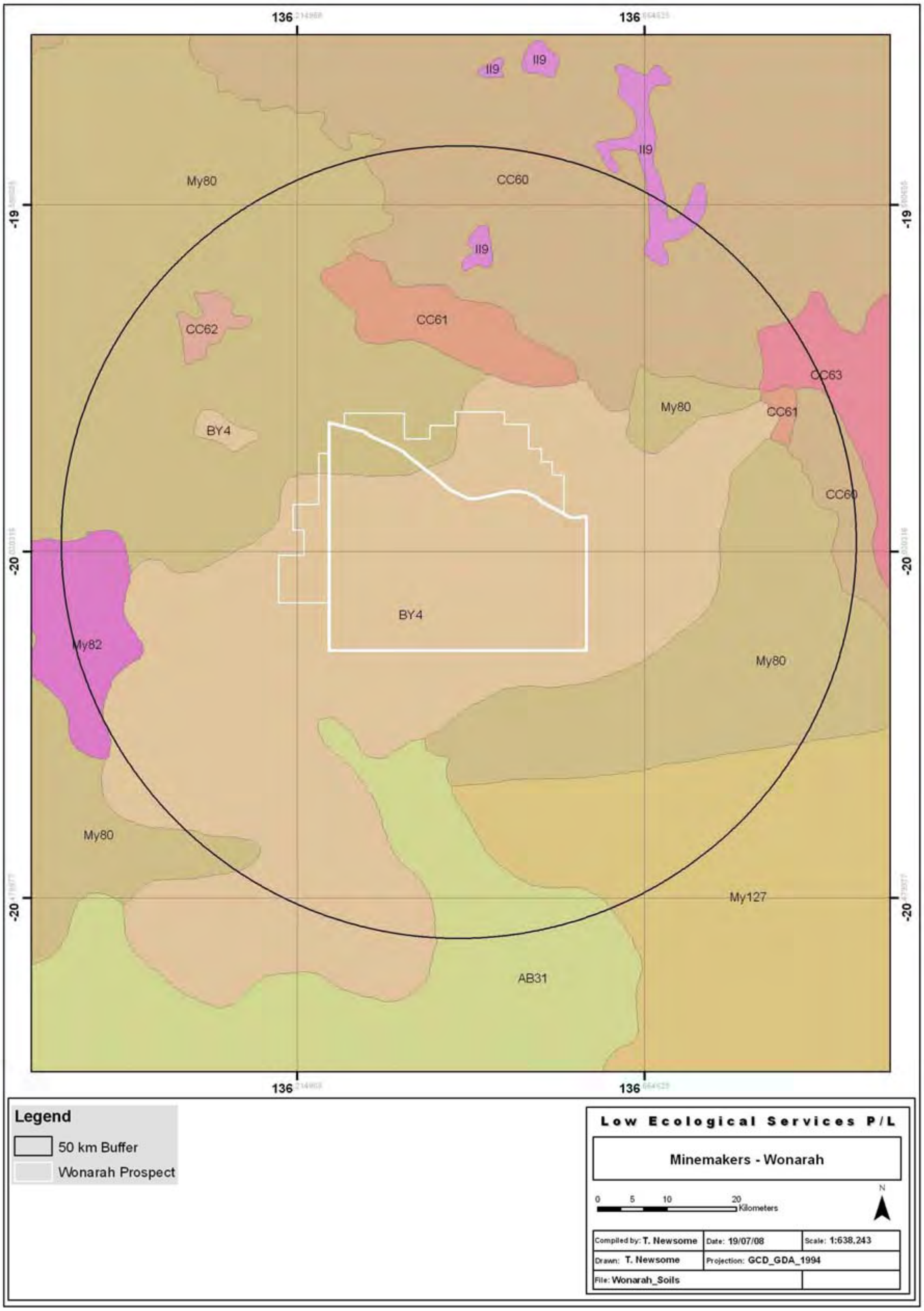


9.6 Appendix Six: Land Systems of the Wonarah Phosphate Project area. Modified after Perry et al. (1962) and Stewart et al. (1954).



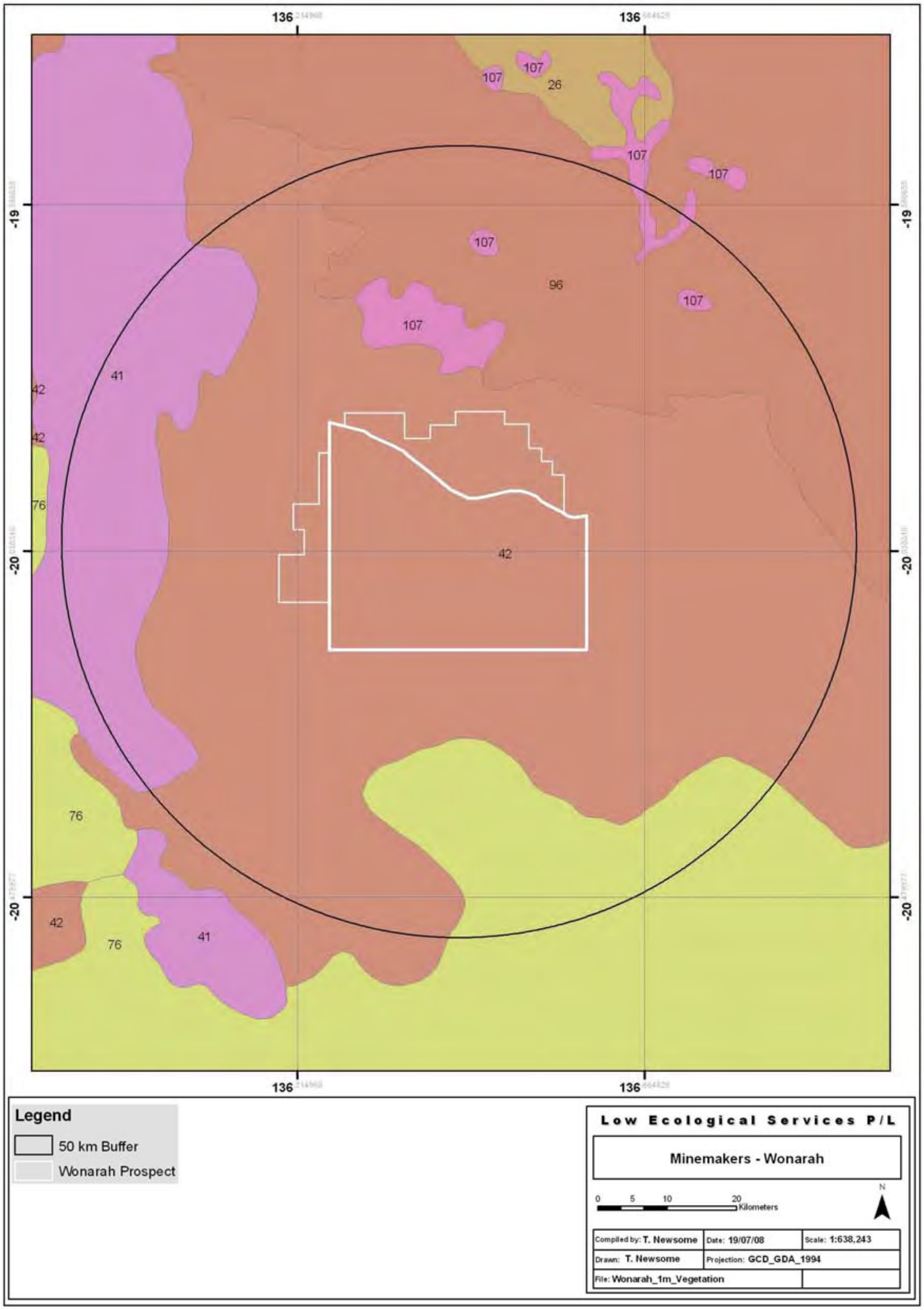
9.7 **Appendix Seven:** Classification of soils in the Wonarah Prospect and surrounding region (50 km buffer) (Bureau of Rural Sciences 1991).

Refer to section 4.5 for descriptions of codes.



9.8 Appendix Eight: ARC/INFO coverage's for the 1:1,000,000 NT vegetation map (Conservation Commission of the NT, 1991) in the Wonarah Prospect and surrounding region (50 km buffer).

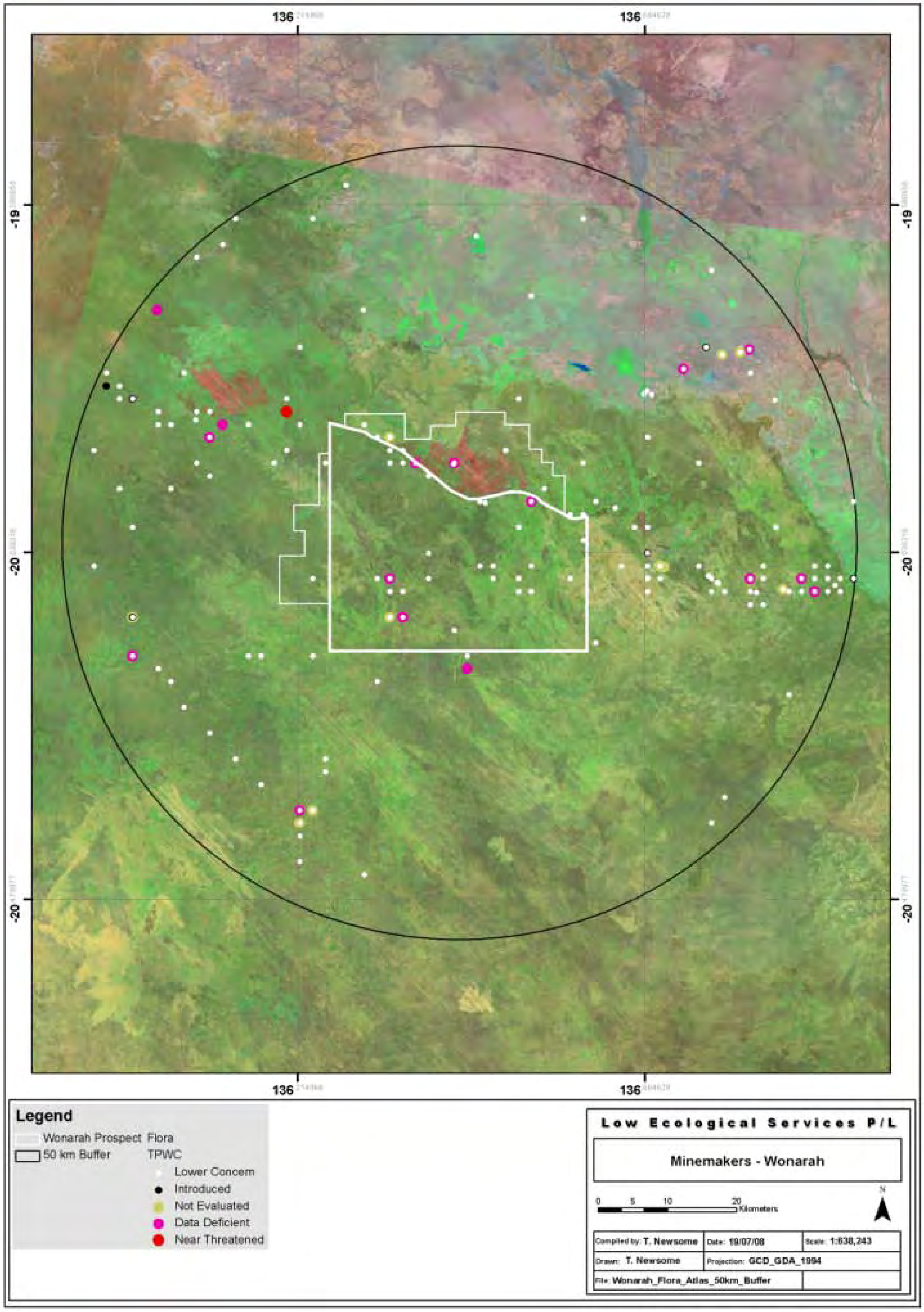
See text section 4.6 for description of codes.



9.9 Appendix Nine: Matters of Environmental Significance (Department of Environment Water Heritage and the Arts): Species of Conservation Significance listed under the Environmental Protection and Biodiversity Conservation Act (1999), (EPBC) and Territory Parks and Wildlife Conservation Act (2000) (TPWC), that occur or could possibly occur within a 50 km buffer of the Wonarah Prospect. Note the category "migratory" includes terrestrial, migratory marine and migratory wetland species.

Species Name and Status	Common Name	Level of Status	Present during the survey / known to occur within 50 km buffer	Preferred habitat
VULNERABLE				
Mammals				
Dasycercus cristicauda	mulgara	EPBC TPWC	Not Recorded / known to occur in the region	Arid and semi arid sandy regions particularly mature hummock grasslands
Birds				
Rostratula australis	Australian painted snipe	EPBC	Not Recorded / known to occur in the region	Well vegetated ephemeral areas
MIGRATORY – Species or species habitat may occur within the area				
Birds				
Apus pacificus	fork-tailed swift	EPBC	Not Recorded / not known to occur	Boreal and temperate forests
Ardea alba	great egret, white egret	EPBC	Not Recorded / not known to occur	Wet areas and damp grasslands
Ardea ibis	cattle egret	EPBC	Not Recorded / not known to occur	Grasslands, woodlands and wetlands
Charadrius veredus	oriental plover	EPBC	Not Recorded / not known to occur	Timbered Habitats
Glareola maldivarum	oriental pratincole	EPBC	Not Recorded / not known to occur	Creeklines
Merops ornatus	rainbow bee-eater	EPBC	Not Recorded / not known to occur	Open forests, woodlands and shrublands, and cleared areas, usually near water. Migratory in summer.
Numenius minutus	little curlew, little whimbrel	EPBC	Not Recorded / not known to occur	Dry grasslands and ephemeral areas
Rostratula australis	Australian painted snipe	EPBC	Not Recorded / not known to occur	Well vegetated ephemeral areas

9.10 Appendix Ten: Flora species of conservation significance within the Wonarah prospect and surrounding region (50km), recorded in the Northern Territory Parks and Wildlife Flora Atlas (2007), over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Eleven.



9.11 **Appendix Eleven:** Flora species list for the Wonarah prospect and surrounding region based on the Northern Territory Parks and Wildlife Flora Atlas (2007) records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes (SSOBS) defined by White et al. (2000).

Where:
LC = least concern (TPWC);
INTRO = introduced species;
DD = data deficient (TPWC);
NT = near threatened (TPWC);
NE = not evaluated (TPWC).
Codes and classifications (SSOBS) are defined in White *et al*. (2000), where:
1 = Poorly known taxonomic records or taxa known only from the type collection;
3 = Taxa with a geographic range within Australia exceeding 100 km;
C = Indicates that the species occurs with a conservation reserve;
k = These taxa have the potential to belong in a conservation category but there is presently insufficient information;
R = Nationally, these species are rare but not currently considered to be threatened;
r = Within the NT, these species are rare but not currently considered to be threatened; and
- = Indicates that the taxon has been recorded from a reserve but that the population size within the reserve in unknown.

Codes for bioregions are as follows:

BRT	Burt Plain
CR	Central Ranges
DMR	Davenport Murchison Ranges (NB you used DAV – I corrected)
GSD	Great Sandy Desert
MAC	MacDonnell Ranges
SSD	Simpson Strzelecki Dunefields
TAN	Tanami

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Abelmoschus ficulneus	native rosella	LC			
Abutilon fraseri subsp. fraseri	dwarf lantern-bush	LC			
Abutilon hannii		LC			
Abutilon otocarpum	keeled lantern-bush, desert Chinese lantern, desert lantern	LC			
Acacia acradenia		LC			
Acacia adoxa var. adoxa		LC		bioregional	TAN (eastern range limit)
Acacia adsurgens	whipstick wattle, sugar brother	LC			
Acacia ancistrocarpa	Fitzroy wattle, pirraru	LC			
Acacia aneura	mulga	LC			
Acacia cambagei	gidgee, stinking wattle	LC			
Acacia chippendalei	Chippendales wattle	LC		bioregional	CR (southern range limits)
Acacia cowleana	Halls Creek wattle	LC			
Acacia drepanocarpa subsp. latifolia		LC			
Acacia elachantha		LC			
Acacia hilliana	flying-saucer bush	LC		bioregional	CR (southern range limit)
Acacia lysiphloia	turpentine, turpentine bush, turpentine wattle	LC		bioregional	GSD (disjunct and southern range limit)
Acacia melleodora	waxy wattle	LC			
Acacia monticola	hill turpentine	LC		bioregional	CR (southern range limit)
Acacia sericophylla	dogwood, wirewood	LC			
Acacia stipuligera	scrub wattle, kurapuka	LC			
Acacia tenuissima	broom wattle, minyana	LC		bioregional	CR (disjunct)
Acacia victoriae	acacia bush, bramble wattle, Victoria wattle	LC			
Acacia victoriae subsp. victoriae	acacia bush, bramble wattle, Victoria wattle	LC			
Acrachne racemosa		DD		Northern	3k

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
				Territory	
Aerva javanica	kapok bush, snow bush	INTRO			
Aeschynomene indica	budda pea, kath sola	LC			
Alternanthera angustifolia	narrow-leaf joyweed	NE			
Alternanthera nodiflora	common joyweed	LC			
Alysicarpus muelleri	rough chain-pea	LC			
Amaranthus cochleitepalus		LC			
Amaranthus mitchellii	boggabri	LC			
Ammannia multiflora	jerry jerry	LC			
Amphipogon caricinus var. caricinus	grey-beard grass, long grey-beard grass	LC			
Amyema sanguinea var. sanguinea	blood mistletoe	LC			
Aristida contorta	bunched kerosene grass, mulga grass	LC			
Aristida holathera var. holathera	erect kerosene grass, white grass, arrow grass	LC			
Aristida latifolia	feathertop wiregrass	LC			
Aristida pruinosa	blue wiregrass, Gulf feathertop wiregrass	LC			
Astrebla elymoides	hoop Mitchell grass, weeping Mitchell grass, slender Mitchell grass	LC			
Astrebla pectinata	barley mitchell grass	LC			
Bergia ammannioides	water-fire	LC		bioregional	BRT (apparently rare), SSD (disjunct)
Bergia henshallii		LC		bioregional	CHC (eastern range limit)
Bergia trimera	small water-fire	LC			
Blumea tenella		LC			
Boerhavia burbidgeana		LC		bioregional	DMR (apparently rare)
Boerhavia coccinea		LC			
Boerhavia paludosa	black-soil tar vine	LC		bioregional	BRT (disjunct), MAC (disjunct
Boerhavia repleta		LC			
Bonamia alatisemina		DD		national	3K
Bonamia deserticola	creep weed	LC			
Bonamia media var. media		LC			
Bonamia pannosa		LC			
Brachyachne convergens	spider grass, false couch, annual couch	LC		bioregional	BRT (disjunct), GSD (disjunct)
Cajanus marmoratus		LC			
Calandrinia pumila	tiny purslane, tiny parakeelya	LC			
Calotis porphyroglossa	channel burr-daisy	LC			
Calytrix carinata		LC			
Capparis lasiantha	split-arse-jack, wait-a-while, nepine, maypan	LC			
Capparis umbonata	northern wild orange, wild orange, bush orange, native pomegranate	LC		bioregional	MGD (southern range limit)
Carissa lanceolata	conkerberry, conkle berry, kungsberry bush	LC			
Cassytha capillaris	hairless dodder-laurel, snotty gobble	LC			
Centipeda racemosa	erect sneezeweed	LC			
Chamaecrista symonii	dwarf cassia	LC			
Chenopodium auricomum	northern bluebush, swamp bluebush	LC			
Chloris pectinata	comb chloris	LC			
Chrysocephalum apiculatum	small yellow button, common everlasting, yellow buttons	LC			
Cleome viscosa	tickweed, mustard bush	LC			
Clerodendrum floribundum	smooth clerodendrum, smooth spiderbush, lollybrush, lolly bush	NE			
Corchorus aestuans		LC			

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Corchorus sidoides subsp. vermicularis	flannel weed	LC			
Corchorus tridens		LC		bioregional	SSD (southern range limit)
Corymbia aparrerinja	ghost gum, white gum, desert white gum	LC			
Corymbia deserticola subsp. mesogeotica	desert bloodwood	LC		bioregional	MGD (eastern range limit), TAN (northern range limit), GSD (western and southern range limits)
Corymbia flavescens		LC			
Corymbia opaca	bloodwood	LC			
Crotalaria crispata		LC			
Crotalaria dissitiflora	grey rattlepod	DD			
Crotalaria dissitiflora subsp. rugosa	grey rattlepod	LC			
Crotalaria medicaginea		LC			
Crotalaria medicaginea var. neglecta		LC			
Crotalaria montana		LC			
Crotalaria novae-hollandiae subsp. lasiophylla	New Holland rattlepod	LC			
Croton aridus		LC			
Cucumis melo	bush cucumber, wild cucumber, native cucumber, ulcardo melon	LC			
Cullen cinereum	annual verbine	LC			
Cuscuta victoriana		LC			
Cyperus bifax	Downs nutgrass	LC		bioregional	MAC (disjunct)
Cyperus bulbosus	yalka, nutgrass	LC			
Cyperus concinnus	trim sedge	LC			
Cyperus cuspidatus		LC		southern NT	(disjunct & apparently rare)
Cyperus difformis	variable-leaf sedge, variable flat-sedge, dirty dora	LC			
Cyperus gilesii		LC			
Cyperus iria		LC			
Cyperus victoriensis		LC			
Dactyloctenium radulans	button grass, finger grass, toothbrush grass	LC			
Desmodium campylocaulon	creeping tick-trefoil	LC		bioregional	BRT (disjunct), MAC (disjunct), TAN (disjunct)
Desmodium muelleri		LC		bioregional	CHC (disjunct), TAN (disjunct and apparently rare)
Dichanthium sericeum	silky bluegrass, Queensland bluegrass	LC			
Dichanthium sericeum subsp. sericeum	silky bluegrass, Queensland bluegrass	LC			
Digitaria brownii	cotton panic grass	LC			
Digitaria coenicola	umbrella grass, finger panic grass	LC			
Digitaria ctenantha	comb finger grass	LC			
Diplatia grandibractea	royal mistletoe	LC		bioregional	SSD (disjunct and apparently rare)
Diplopeltis stuartii var. glandulosa		DD		Northern Territory	3k
Distichostemon barklyanus		DD		Northern Territory	3k
Dodonaea coriacea	hopbush	LC			
Dolichandrone heterophylla s.lat.	dohwa, lemonwood	LC			
Ehretia saligna s.lat.	coonta, false cedar, peachwood, peachbush	NE			
Einadia nutans subsp. eremaea	climbing saltbush	LC			
Eleocharis atropurpurea		LC		bioregional	GSD (disjunct and apparently rare)

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Eleocharis pallens	pale spike-rush	LC			
Elytrophorus spicatus	spikegrass	LC			
Enchylaena tomentosa	ruby saltbush, Sturts saltbush, plum puddings, berry cottonbush	LC			
Enneapogon cylindricus	jointed nine-awn, limestone oat-grass, jointed bottlewasher	LC			
Enneapogon pallidus	conetop nine-awn, pale bottlewasher	LC			
Enneapogon polyphyllus	woolly oat-grass, oat-grass, leafy nine-awn	LC			
Enneapogon purpurascens	purple nine-awn, purple bottlewasher	LC		bioregional	TAN (southern range limit)
Enteropogon acicularis s.lat.	curly windmill grass, umbrella grass, spider grass	LC			
Eragrostis cumingii	fairy grass, Cumings lovegrass	LC			
Eragrostis eriopoda subsp. Red earth (D.J.Nelson 1651)		LC			
Eragrostis eriopoda subsp. Sandy fire-weed (P.K.Latz 12908)		LC			
Eragrostis falcata	sickle lovegrass	LC			
Eragrostis kennedyae	small-flowered lovegrass	LC			
Eragrostis olida		LC		bioregional	DMR (eastern range limit)
Eragrostis setifolia	neverfail, narrow-leaf neverfail	LC			
Eragrostis tenellula	delicate lovegrass	LC			
Eremophila latrobei var. glabra	native fuchsia	LC			
Eremophila longifolia	emu bush, weeping emu bush, long-leaved desert fuchsia	LC			
Eriachne aristidea	three-awn wanderrie	LC			
Eriachne armitii	longawn wanderrie	LC			
Eriachne ciliata	slender wanderrie, wiregrass	LC			
Eriachne melicacea	fire grass	LC		bioregional	DMR (southern range limit)
Eriachne mucronata	mountain wanderrie	LC			
Eriachne obtusa	northern wanderrie, wiregrass	LC			
Eriachne pulchella subsp. pulchella	pretty wanderrie	LC			
Erythrina vespertilio	bean tree, batswing coral tree	LC			
Eucalyptus chlorophylla	green-leaf box	LC			
Eucalyptus coolabah		LC			
Eucalyptus coolabah	coolabah	LC			
Eucalyptus coolabah subsp. arida	coolabah	LC		bioregional	TAN (tentative western range limit)
Eucalyptus odontocarpa	Sturt Creek mallee	LC		bioregional	GSD (southern range limit)
Eucalyptus pachyphylla	red-bud mallee	LC		bioregional	DMR (northern range limit)
Eucalyptus pruinosa subsp. pruinosa	silver box, silver-leaf box, apple box, smoke tree	LC			
Eucalyptus victrix	smooth-barked coolibah, ghost gum coolibah, gum-barked coolibah	LC		bioregional	MGD (eastern range limit)
Eulalia aurea	silky browntop, sugar grass	LC			
Euphorbia alsiniflora		LC			
Euphorbia drummondii	caustic weed, caustic creeper, mat spurge	LC			
Evolvulus alsinoides	blue periwinkle, tropical speedwell	LC			
Evolvulus alsinoides var. decumbens	blue periwinkle, tropical speedwell	LC			
Evolvulus alsinoides var. villosicalyx	blue periwinkle, tropical speedwell	LC			
Exocarpos sparteus	slender cherry, broombush	LC		bioregional	DMR (northern range limit)
Fimbristylis ammobia		LC		bioregional	MGD (eastern range limit)
Fimbristylis dichotoma	eight day grass, common fringe-rush	LC			
Fimbristylis eremophila	desert fringe-rush	LC		bioregional	TAN (eastern range limit)
Fimbristylis microcarya		LC			
Fimbristylis oxystachya	iukarrara	LC			

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Flaveria australasica	yellow twin stem, speedy weed	LC			
Gomphrena breviflora		LC			
Gomphrena conica (southern NT populations)		DD			
Gomphrena lanata		LC			
Goodenia armitiana	narrow-leaved goodenia	LC			
Goodenia fascicularis	silky goodenia	LC			
Goodenia heterochila	serrated goodenia	LC			
Goodenia lamprosperma		LC			
Goodenia modesta		LC		bioregional	TAN (northern range limit)
Goodenia ramelii		LC			
Goodenia strangfordii		LC		bioregional	MGD (southern range limit)
Goodenia triodiophila	spinifex goodenia	LC			
Gossypium australe	native cotton, tall desert rose	LC			
Grevillea dryandri subsp. dryandri	Dryanders grevillea	LC			
Grevillea juncifolia subsp. juncifolia	desert grevillea, honey grevillea, honeysuckle grevillea	LC			
Grevillea refracta	silver-leaf grevillea	LC			
Grevillea refracta subsp. refracta	silver-leaf grevillea	LC			
Grevillea striata	beefwood	LC			
Grevillea wickhamii subsp. aprica	holly-leaf grevillea	LC		bioregional	CR (southern range limit)
Hakea chordophylla	northern corkwood, bootlace tree, bull hakea, whistling tree	LC			
Hakea macrocarpa	flat-leaved hakea	LC		bioregional	SSD (southern range limit)
Haloragis aspera	rough raspwort	LC			
Haloragis glauca forma glauca	grey raspwort	LC			
Haloragis uncatipila		LC			
Heliotropium ballii		DD		Northern Territory	3k
Heliotropium conocarpum	white heliotrope	DD			
Heliotropium haesum		LC			
Heliotropium ovalifolium		LC			
Heliotropium pulvinum		DD		Northern Territory	3K
Heteropogon contortus	bunch speargrass, black speargrass	LC			
Hibiscus leptocladus	variable-leaf hibiscus	LC			
Hibiscus sturtii var. campylochlamys	Sturts hibiscus	LC			
Hibiscus sturtii var. grandiflorus	Sturts hibiscus	LC			
Hibiscus sturtii var. platychlamys	Sturts hibiscus	LC			
Hibiscus trionum var. vesicarius	bladder ketmia	LC		bioregional	SSD (disjunct and southern range limit), BRT (disjunct)
Hybanthus aurantiacus	orange spade flower	LC			
Indigastrum parviflorum	small-flower indigo	LC			
Indigofera colutea	sticky indigo	LC			
Indigofera ewartiana		LC			
Indigofera linifolia	native indigo	LC			
Indigofera linnaei	Birdsville indigo, nine-leaved indigo	LC			
Indigofera trita		LC		bioregional	BRT (disjunct)
Ipomoea coptica		LC			
Ipomoea costata	bush potato, potato vine, desert yam	LC			
Ipomoea lonchophylla	common cowvine	LC		bioregional	BRT (disjunct), SSD (disjunct)
Ipomoea plebeia	bellvine	LC		southern NT	(apparently rare)
Ipomoea polymorpha	silky cowvine	LC			
Iseilema membranaceum	small Flinders grass	LC			
Iseilema vaginiflorum	red Flinders grass	LC			
Iseilema windersii	scented Flinders grass	LC			
Isoetes muelleri	quillwort	LC		bioregional	DMR (disjunct and apparently

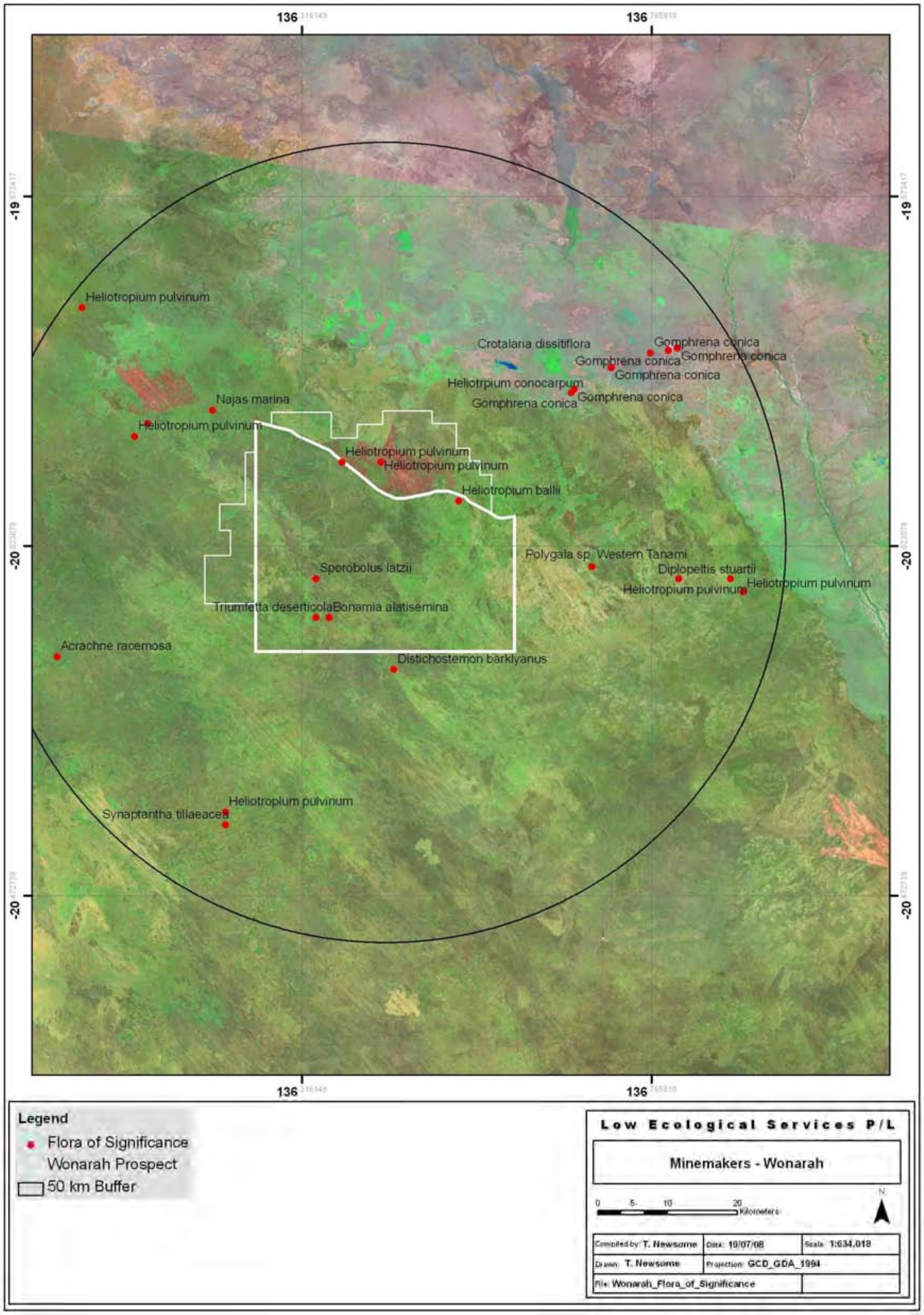
Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
					rare)
Isotropis atropurpurea	poison sage	LC		bioregional	TAN (eastern range limit)
Isotropis winneckei		LC		bioregional	GSD (western range limit)
Jatropha gossypifolia	cotton-leaf physic nut, bellyache bush	INTRO			
Keraudrenia nephrosperma		LC			
Leptochloa fusca subsp. fusca	small-flowered beetle grass	LC			
Leptosema anomalum		LC		bioregional	TAN (eastern range limit)
Leptosema chambersii	upside-down plant, Chambers leptosema	LC		bioregional	DMR (northern and eastern range limits)
Lipocarpha microcephala	button rush	LC			
Lysiana spathulata	flat-leaved mistletoe	LC			
Maireana villosa	silky bluebush	LC			
Malvastrum americanum	malvastrum, spiked malvastrum	INTRO			
Marsilea costulifera	narrow-leaf nardoo	LC		Northern Territory	3k
Marsilea crenata		LC		southern NT	(disjunct)
Marsilea exarata	swayback nardoo, little nardoo	LC			
Melaleuca lasiandra	sandhill tea-tree	LC			
Melaleuca viridiflora	green paperbark, broad-leaved paperbark, large-leaved paperbark	LC			
Melhania oblongifolia	velvet hibiscus	LC			
Merremia davenportii	white morning glory	LC		bioregional	BRT (southern range limit)
Mirbelia viminalis	yellow broom	LC			
Mukia maderaspatana	head-ache vine	LC			
Najas marina	prickly waternymph, prickly naiad	NT		Northern Territory	3rC-
Najas tenuifolia	waternymph, thin-leaved naiad	LC		southern NT	(disjunct)
Neptunia dimorphantha	sensitive plant, nervous plant	LC			
Oldenlandia argillacea		LC		bioregional	MGD (apparently rare), TAN (apparently rare), BRT (disjunct)
Oldenlandia mitrasacmoides		LC			
Oldenlandia mitrasacmoides subsp. mitrasacmoides		LC		bioregional	BRT (southern range limit)
Operculina aequisepala		LC		bioregional	CHC (southern range limit), TAN (disjunct and apparently rare)
Opuntia elatior		LC			
Panicum decompositum	native millet, native panic, Australian millet	LC			
Panicum decompositum var. decompositum	native millet, native panic, Australian millet	LC			
Panicum laevinode	pepper grass	LC			
Paraneurachne muelleri	spinifex couch, northern mulga grass	LC			
Paspalidium jubiflorum	Warrego summer grass	LC			
Paspalidium rarum	bunch paspalidium	LC			
Paspalidium retiglume		LC		bioregional	MGD (southern range limit)
Peplidium muelleri		LC		bioregional	BRT (apparently rare), MGD (apparently rare), SSD (apparently rare), STP (apparently rare)
Perotis rara	comet grass	LC			
Petalostylis cassioides	butterfly bush, petalostylis	LC			
Phyllanthus exilis		LC			
Phyllanthus maderaspatensis var. angustifolius		LC			
Polycarpaea corymbosa		LC			
Polygala sp. Davenport Range		LC		bioregional	BRT (apparently rare), TAN

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
(C.R.Dunlop 6042)					(western range limit)
Polygala sp. Western Tanami (D.E.Albrecht 10660)		NE		Northern Territory	3k
Polygala tepperi		LC		bioregional	DMR (southern range limit)
Portulaca filifolia s.lat.	slender pigweed	LC			
Portulaca oleracea	pigweed, common purslane, munyeroo	LC			
Portulaca sp. Clay soil (S.T.Blake 17854)		LC			
Pseudoraphis spinescens	swamp grass, spiny mudgrass, water couch	LC			
Psydrax ammophila		LC			
Psydrax attenuata var. myrmecophila forma myrmecophila		LC			
Psydrax attenuata var. myrmecophila forma myrmecophila		LC			
Pterocaulon serrulatum var. serrulatum	fruit-salad bush, apple bush	LC			
Ptilotus calostachyus	weeping mulla mulla	LC			
Ptilotus calostachyus var. calostachyus	weeping mulla mulla	LC			
Ptilotus clementii	limestone pussycats tails, tassel top	LC			
Ptilotus fusiformis	skeleton plant	LC			
Ptilotus obovatus	smoke bush, silver bush, silver tails	NE			
Ptilotus obovatus var. obovatus	smoke bush, silver bush, silver tails	LC			
Ptilotus polystachyus	long pussy-tails	NE			
Ptilotus polystachyus var. polystachyus	long pussy-tails	LC			
Ptilotus schwartzii var. schwartzii forma schwartzii		LC			
Ptilotus spicatus		NE			
Rhagodia eremaea	tall saltbush	LC			
Rhynchosia minima	native pea, rhynchosia	LC			
Rothia indica subsp. australis		LC		southern NT	(disjunct and apparently rare)
Rutidosis helichrysoides subsp. helichrysoides		LC			
Salsola tragus	buckbush, rolypoly, tumbleweed	LC			
Salsola tragus subsp. tragus	buckbush, rolypoly, tumbleweed	LC			
Santalum lanceolatum	plumbush, wild plum	LC			
Sauropus trachyspermus	slender spurge	LC			
Scaevola glabrata		LC			
Scaevola ovalifolia	bushy fanflower	LC		bioregional	GSD (western range limit)
Scaevola parvifolia subsp. parvifolia	fanflower	LC			
Schoenoplectus dissachanthus		LC			
Schoenoplectus laevis		LC		bioregional	FIN (disjunct and apparently rare)
Sclerolaena bicornis var. bicornis	goathead burr, bassia burr	LC			
Sclerolaena lanicuspis	woolly copper burr	LC			
Sebastiania chamaelea		LC			
Senna artemisioides subsp. oligophylla	oval-leaf cassia	LC			
Senna costata		LC			
Senna glutinosa subsp. pruinosa		LC			
Senna notabilis	cockroach bush	LC			
Sesbania chippendalei		LC			
Setaria dielsii	Diels pigeon grass	LC			
Setaria verticillata	whorled pigeon grass	INTRO			
Sida cunninghamii		LC			

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Sida fibulifera	silver sida, pin sida	LC			
Sida goniocarpa		LC			
Sida platycalyx	lifesaver burr, teddy bears arsehole	LC			
Sida rohlenae subsp. rohlenae	shrub sida	LC			
Sida sp. Wakaya Desert (P.K.Latz 11894)		LC		bioregional	TAN (northern range limit)
Sida spinosa	spiny sida	LC			
Sida trichopoda	high sida, narrow-leaf sida	LC			
Solanum centrale	desert raisin, kampurarrpa	LC			
Solanum chippendalei	bush tomato, ngaru	LC			
Solanum cleistogamum	shy nightshade	LC			
Solanum ellipticum var. Foothills (G.J.Leach 1145)	native tomato, potato bush, potato weed	LC			
Solanum quadriloculatum	wild tomato, tomato bush	LC			
Solanum tumulicola	black-soil wild tomato	LC			
Spathia neurosa	spathe grass	LC			
Spermacoce hillii		LC			
Sporobolus australasicus	Australian dropseed	LC			
Sporobolus latzii		DD		national	1K
Sporobolus mitchellii	rat-tail couch, swamp rat-tail grass, short rat-tail grass	LC			
Stackhousia intermedia	wiry stackhousia	LC			
Streptoglossa adscendens		LC			
Streptoglossa macrocephala	large-flowered aromatic daisy	LC			
Streptoglossa odora	aromatic daisy	LC			
Stylosanthes hamata	verano stylo, verano, carribbean stylo, stylo	INTRO			
Swainsona burkei		LC		bioregional	TAN (western range limit)
Synaptantha tillaeacea	synaptantha	DD			
Tephrosia lasiochlaena		LC		bioregional	MAC (southern range limit)
Tephrosia leptoclada		LC			
Tephrosia sp. Barrow Creek (G.M.Chippendale 921)		LC		bioregional	GSD (southern range limit)
Tephrosia sp. Willowra (G.M.Chippendale 4809)		LC			
Tephrosia stuartii		LC		bioregional	DMR (eastern range limit)
Teucrium integrifolium	green germander	LC		bioregional	TAN (disjunct and western range limit)
Themeda triandra	kangaroo grass	LC			
Tragus australianus	small burr-grass, sock grass, tickgrass	LC			
Trianthema pilosa		LC			
Trianthema triquetra	red spinach	LC			
Tribulopis angustifolia		LC			
Tribulus eichlerianus s.lat.	bindieye	LC			
Trichodesma zeylanicum	cattle bush, camel bush	LC			
Triodia pungens	soft spinifex, gummy spinifex	LC			
Triodia schinzii	feathertop spinifex	LC			
Triumfetta centralis		LC		bioregional	SSD (eastern range limit)
Triumfetta deserticola		DD		Northern Territory	3k
Urochloa piligera	hairy armgrass, hairy summer grass, green summer grass	LC			
Urochloa praetervisa	large armgrass, large summer grass	LC			
Ventilago viminalis	supplejack, vine tree	LC			
Vigna lanceolata	pencil yam, maloga bean, parsnip bean	LC			
Waltheria indica		LC			

Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code
Wedelia asperrima	sunflower daisy	LC			
Whiteochloa cymbiformis		LC			
Yakirra australiensis var. australiensis	desert Flinders grass	LC			
Zaleya galericulata subsp. galericulata	hogweed	LC			
Zornia albiflora		LC		bioregional	GSD (southern range limit)

9.12 Appendix Twelve: Northern Territory Parks and Wildlife Flora Atlas (2007) locations of conservation significance as defined by White et al. (2000) or Territory Parks and Wildlife Conservation Act (2000) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. A key to conservation codes and species status is provided in Appendix Eleven.



9.13 Appendix Thirteen: Coordinates for flora species of conservation significance (as defined by the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and Territory Parks and Wildlife Conservation Act (2000) (TPWC)) recorded in LES field surveys and the Northern Territory Parks and Wildlife Fauna Atlas (2007) within the Wonarah Phosphate Project area and surrounding 50 km buffer area. A key to conservation codes is provided in Appendix Thirteen.

Long	Lat	Species Name	Common name	TPWC	EPBC	SSOBS level	SSOBS code
136.00121	-20.16521752	*Acrachne racemosa*		DD		Northern Territory	3k
136.34425	-20.07607	*Bergia barklyana*		NT		National	3R
136.35121	-20.11521518	*Bonamia alatisemina*		DD		National	3K
136.71469	-19.79324	*Crotalaria dissitiflora*	Grey Rattlepod	DD			
136.78819	-19.77134	*Crotalaria dissitiflora*	Grey Rattlepod	DD			
136.79999	-19.76834	*Crotalaria dissitiflora*	Grey Rattlepod	DD			
136.8012	-20.06521217	*Diplopeltis stuartii var. glandulosa*		DD		Northern Territory	3k
136.43454	-20.18187452	*Distichostemon barklyanus*		DD		Northern Territory	3k
136.66319	-19.82574	*Gomphrena conica*		DD			
136.66689	-19.82154	*Gomphrena conica*		DD			
136.71469	-19.79324	*Gomphrena conica*		DD			
136.78819	-19.77134	*Gomphrena conica*		DD			
136.79999	-19.76834	*Gomphrena conica*		DD			
136.76519	-19.77474	*Gomphrena conica*		DD			
136.51788	-19.96521424	*Heliotropium ballii*		DD		Northern Territory	3k
136.71469	-19.79324	*Heliotropium conocarpum*	White Heliotrope	DD			
136.0333	-19.7167	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.11788	-19.8652171	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.10121	-19.88187719	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.41788	-19.91521499	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.36788	-19.91521533	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.86787	-20.06521171	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.8845	-20.08184158	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.21788	-20.36521579	*Heliotropium pulvinum*		DD		Northern Territory	3K
136.50192	-19.97021	*Heliotropium pulvinum*	dd	dd		Northern Territory	3K
136.50192	-19.97021	*Hibiscus brachychlaenus*	nt	nt		Northern Territory	3r
136.20121	-19.84854656	*Najas marina*	Prickly Waternymph, Prickly Naiad	NT		Northern Territory	3rC-
136.6894	-20.0497	*Polygala sp. Western Tanami (D.E.Albrecht 10660)*		NE		Northern Territory	3k
136.33454	-20.06521536	*Sporobolus latzii*		DD		National	1K
136.21788	-20.38187577	*Synaptantha tillaeacea*	Synaptantha	DD			
136.33454	-20.11521529	*Triumfetta deserticola*		DD		Northern Territory	3k

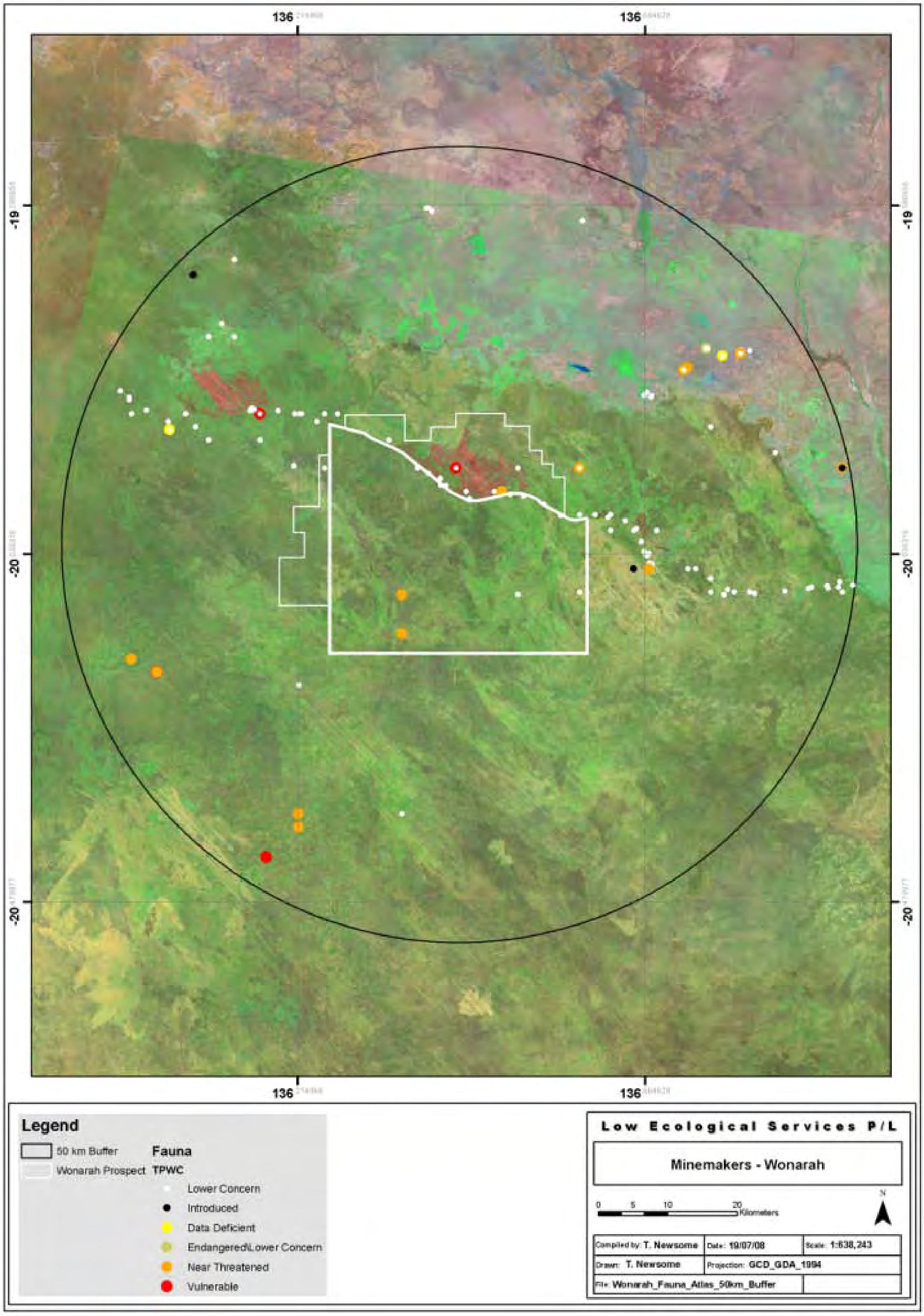
9.14 **Appendix Fourteen:** Weed species that may occur within the Wonarah project area.

Data source: 1) Northern Territory Bioregions – Assessment of key biodiversity values and threats (Baker *et al*. 2005; p66-67), and 2) NT Parks and Wildlife Flora Atlas (2007) (<50 km buffer).

Name	NT Weed Class	WONS	Habitat	Data Source
Bellyache Bush (*Jatropha gossypifolia*)	B			2
Buffel Grass (*Cenchrus ciliaris*)	not declared		Disturbed areas, towns, roads, swamp margins	1
Caribbean Stylo (*Stylosanthes hamata*)	not declared			2
Coffee Bush (*Leucaena leucocephala*)	not declared		Disturbed areas, towns	1
Kapok Bush (Aerva javanica)	not declared		Disturbed areas, roads	2
Marvel Grass (*Dichanthium annulatum*)	not declared			1
Mesquite (*Prosopis limensis*)	B	WONS	Pastoral, water ways and floodplains	1
Neem (*Azadirachta indica*)	not declared		Towns, riparian,	1
Noogoora Burr (*Xanthium strumarium*)	B		Pastoral, roads and tracks	1
Olive Hymenachne (*Hymenachne amplexicaulis*)	not declared	WONS	Water ways and floodplains	1
Paddy's Lucerne (*Sida rhombifolia*)	B		Blocks & gardens, pastoral, roads and tracks	1
Parkinsonia (*Parkinsonia aculeata*)	B	WONS	Pastoral, water ways and floodplains, blocks & gardens	1
Ruby Dock (*Acetosa vesicaria*)	not declared		Waterways and floodplains	1
Setaria verticillate	not declared			2
Spiked Malvastrum (*Malvastrum americanum*)	not declared		Water ways, pastoral and roads.	2

Note: NT Weed classes: A (to be eradicated), B (growth and spread to be controlled), Weeds of National Significance (WONS), and exotic plants of conservation importance.

9.15 Appendix Fifteen: Fauna species of conservation significance within the Wonarah prospect and surrounding region (50km), recorded in the Northern Territory Parks and Wildlife Fauna Atlas (2007), over Landsat 5 image. Note that some sites have multiple species records so this figure should be used as a guide only. A key to conservation codes is provided in Appendix Eleven.



9.16 Appendix Sixteen: Fauna species list for the Wonarah prospect and surrounding region based on the Northern Territory Parks and Wildlife Fauna Atlas (2007) records (existing data) and status under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and Territory Parks and Wildlife Conservation Act (2000) (TPWC).

Where:
LC = lower concern
DD = data deficient
VU = vulnerable
EN = endangered
NT = near threatened
INT = introduced
NL = near listed

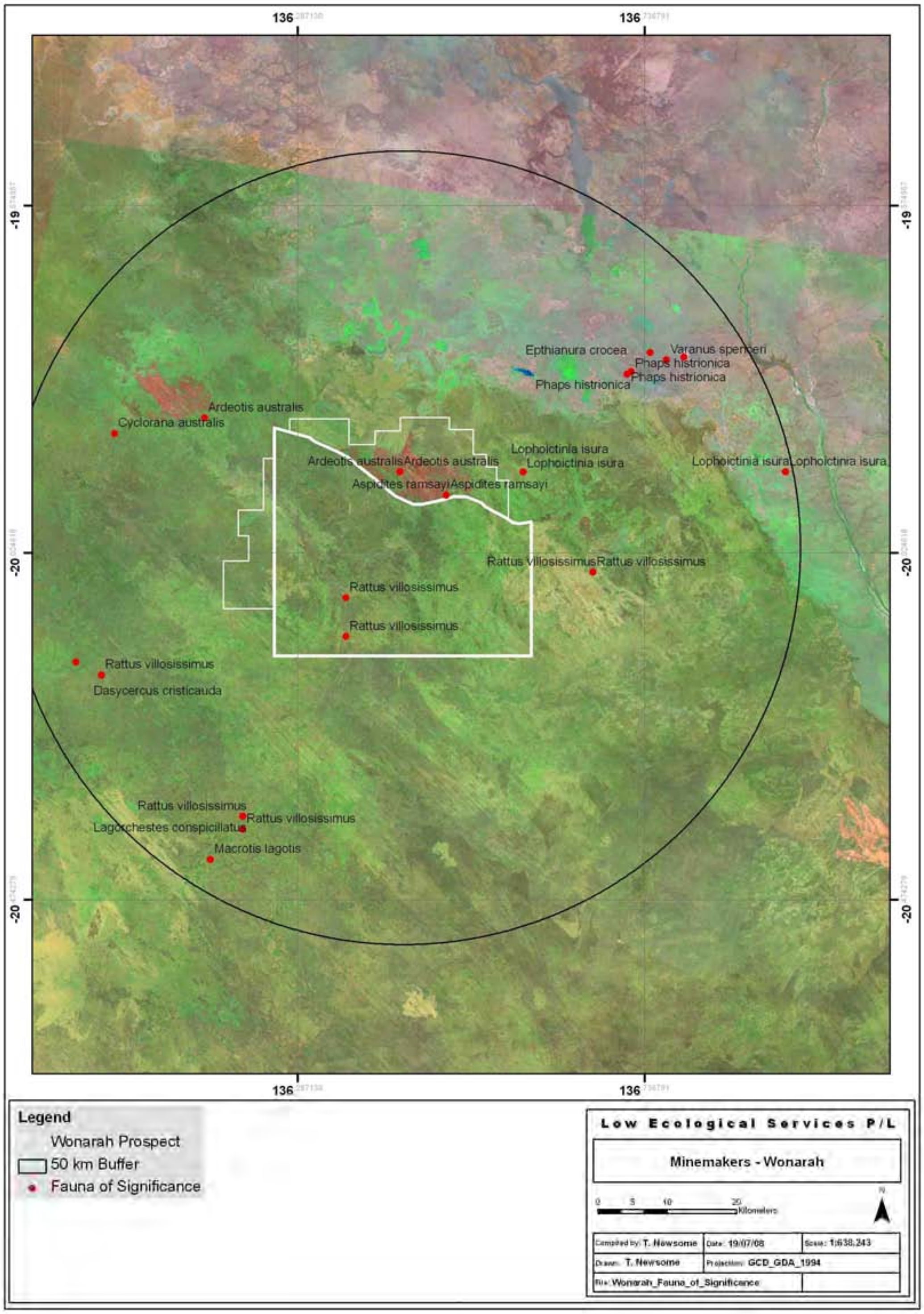
Group	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	*Acanthiza apicalis*	LC		0	0	0
Bird	*Accipiter cirrhocephalus*	LC		0	0	0
Bird	*Accipiter fasciatus*	LC		0	0	0
Bird	*Aegotheles cristatus*	LC		0	0	0
Bird	*Anas gracilis*	LC		0	0	0
Bird	*Anhinga melanogaster*	LC		0	0	0
Bird	*Anthus novaeseelandiae*	LC		0	0	0
Bird	*Aquila audax*	LC		0	0	0
Bird	*Ardea alba*	LC		1	0	0
Bird	*Ardea pacifica*	LC		0	0	0
Bird	*Ardeotis australis*	VU		1	0	1
Bird	*Artamus cinereus*	LC		0	0	0
Bird	*Artamus personatus*	LC		0	0	0
Bird	*Artamus superciliosus*	LC		0	0	0
Bird	*Aythya australis*	LC		0	0	0
Bird	*Cacatua roseicapilla*	LC		0	0	0
Bird	*Cacatua sanguinea*	LC		0	0	0
Bird	*Certhionyx niger*	LC		0	0	0
Bird	*Certhionyx variegatus*	LC		0	0	0
Bird	*Chalcites basalis*	LC		0	0	0
Bird	*Chlidonias hybridus*	LC		0	0	0
Bird	*Cincloramphus cruralis*	LC		0	0	0
Bird	*Cincloramphus mathewsi*	LC		0	0	0
Bird	*Circus approximans*	LC		0	0	0
Bird	*Circus assimilis*	LC		0	0	0
Bird	*Colluricincla harmonica*	LC		0	0	0
Bird	*Coracina novaehollandiae*	LC		0	0	0
Bird	*Corvus bennetti*	LC		0	0	0
Bird	*Corvus coronoides*	LC		0	0	0
Bird	*Corvus orru*	LC		0	0	0
Bird	*Cracticus nigrogularis*	LC		0	0	0
Bird	*Daphoenositta chrysoptera*	LC		0	0	0
Bird	*Dendrocygna eytoni*	LC		0	0	0
Bird	*Dicaeum hirundinaceum*	LC		0	0	0
Bird	*Elanus axillaris*	LC		0	0	0
Bird	*Elseyornis melanops*	LC		0	0	0
Bird	*Emblema pictum*	LC		0	0	0

Group	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	*Epthianura crocea*	EN\LC	VU\NL	1	0	1
Bird	*Epthianura tricolor*	LC		0	0	0
Bird	*Erythrogonys cinctus*	LC		0	0	0
Bird	*Falco berigora*	LC		0	0	0
Bird	*Falco cenchroides*	LC		0	0	0
Bird	*Falco longipennis*	LC		0	0	0
Bird	*Falco peregrinus*	LC		0	0	0
Bird	*Falco subniger*	LC		0	0	0
Bird	*Geopelia cuneata*	LC		0	0	0
Bird	*Geopelia placida*	LC		0	0	0
Bird	*Grallina cyanoleuca*	LC		0	0	0
Bird	*Grus rubicunda*	LC		0	0	0
Bird	*Gymnorhina tibicen*	LC		0	0	0
Bird	*Haliastur sphenurus*	LC		0	0	0
Bird	*Hamirostra melanosternon*	LC		0	0	0
Bird	*Hieraaetus morphnoides*	LC		0	0	0
Bird	*Himantopus himantopus*	LC		0	0	0
Bird	*Hirundo ariel*	LC		0	0	0
Bird	*Hirundo nigricans*	LC		0	0	0
Bird	*Lalage sueurii*	LC		0	0	0
Bird	*Lichenostomus keartlandi*	LC		0	0	0
Bird	*Lichenostomus penicillatus*	LC		0	0	0
Bird	*Lichenostomus plumulus*	LC		0	0	0
Bird	*Lichenostomus virescens*	LC		0	0	0
Bird	*Lichmera indistincta*	LC		0	0	0
Bird	*Lophoictinia isura*	NT		1	0	0
Bird	*Malurus lamberti*	LC		0	0	0
Bird	*Malurus leucopterus*	LC		0	0	0
Bird	*Malurus melanocephalus*	LC		0	0	0
Bird	*Manorina flavigula*	LC		0	0	0
Bird	*Melanodryas cucullata picata/westralensis*	LC		0	0	0
Bird	*Melithreptus gularis*	LC		0	0	0
Bird	*Melopsittacus undulatus*	LC		0	0	0
Bird	*Merops ornatus*	LC		1	0	0
Bird	*Milvus migrans*	LC		0	0	0
Bird	*Mirafra javanica*	LC		0	0	0
Bird	*Neopsephotus bourkii*	LC		0	0	0
Bird	*Nymphicus hollandicus*	LC		0	0	0
Bird	*Ocyphaps lophotes*	LC		0	0	0
Bird	*Pachycephala rufiventris*	LC		0	0	0
Bird	*Pardalotus rubricatus*	LC		0	0	0
Bird	*Passer domesticus*	INT		0	1	0
Bird	*Pelecanus conspicillatus*	LC		0	0	0
Bird	*Phalacrocorax melanoleucos*	LC		0	0	0
Bird	*Phalacrocorax sulcirostris*	LC		0	0	0
Bird	*Phalacrocorax varius*	LC		0	0	0
Bird	*Phaps histrionica*	NT		1	0	0
Bird	*Plegadis falcinellus*	LC		1	0	0
Bird	*Rhipidura leucophrys*	LC		0	0	0
Bird	*Smicrornis brevirostris*	LC		0	0	0

Group	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Bird	*Stiltia isabella*	LC		0	0	0
Bird	*Taeniopygia guttata*	LC		0	0	0
Bird	*Todiramphus pyrrhopygia*	LC		0	0	0
Bird	*Tringa nebularia*	LC		1	0	0
Bird	*Turnix pyrrhothorax*	LC		0	0	0
Bird	*Turnix velox*	LC		0	0	0
Bird	*Vanellus tricolor*	LC		0	0	0
Frog	*Cyclorana australis*	DD		1	0	0
Frog	*Notaden nichollsi*	LC		0	0	0
Frog	*Uperoleia trachyderma*	LC		0	0	0
Mammal	*Bos taurus*	INT		0	1	0
Mammal	*Canis lupus*	LC		0	1	0
Mammal	*Dasycercus cristicauda*	VU	VU	1	0	1
Mammal	*Lagorchestes conspicillatus*	NT		1	0	0
Mammal	*Leggadina forresti*	LC		0	0	0
Mammal	*Macropus rufus*	LC		0	0	0
Mammal	*Macrotis lagotis*	VU	VU	1	0	1
Mammal	*Notomys alexis*	LC		0	0	0
Mammal	*Oryctolagus cuniculus*	INT		0	0	0
Mammal	*Planigale ingrami*	LC		0	0	0
Mammal	*Pseudomys desertor*	LC		0	0	0
Mammal	*Pseudomys hermannsburgensis*	LC		0	0	0
Mammal	*Rattus villosissimus*	NT		1	0	0
Mammal	*Saccolaimus flaviventris*	LC		0	0	0
Mammal	*Sminthopsis macroura*	LC		0	0	0
Mammal	*Sminthopsis youngsoni*	LC		0	0	0
Reptile	*Antaresia stimsoni*	LC		0	0	0
Reptile	*Aspidites ramsayi*	NT		1	0	0
Reptile	*Carlia munda*	LC		0	0	0
Reptile	*Carlia triacantha*	LC		0	0	0
Reptile	*Cryptoblepharus plagiocephalus*	LC		0	0	0
Reptile	*Ctenophorus isolepis*	LC		0	0	0
Reptile	*Ctenophorus nuchalis*	LC		0	0	0
Reptile	*Ctenotus grandis*	LC		0	0	0
Reptile	*Ctenotus greeri*	LC		0	0	0
Reptile	*Ctenotus helenae*	LC		0	0	0
Reptile	*Ctenotus joanae*	LC		0	0	0
Reptile	*Ctenotus leonhardii*	LC		0	0	0
Reptile	*Ctenotus pantherinus*	LC		0	0	0
Reptile	*Ctenotus robustus*	LC		0	0	0
Reptile	*Delma tincta*	LC		0	0	0
Reptile	*Diplodactylus conspicillatus*	LC		0	0	0
Reptile	*Diplodactylus stenodactylus*	LC		0	0	0
Reptile	*Diplodactylus tessellatus*	LC		0	0	0
Reptile	*Diporiphora lalliae*	LC		0	0	0
Reptile	*Diporiphora winneckei*	LC		0	0	0
Reptile	*Egernia stokesii*	LC		0	0	0
Reptile	*Eremiascincus richardsonii*	LC		0	0	0
Reptile	*Gehyra minuta*	LC		0	0	0
Reptile	*Gehyra montium*	LC		0	0	0
Reptile	*Gehyra variegata*	LC		0	0	0

Group	Species Name	TPWC	EPBC	Significant	Exotic	Threatened
Reptile	*Heteronotia binoei*	LC		0	0	0
Reptile	*Lerista bipes*	LC		0	0	0
Reptile	*Lerista xanthura*	LC		0	0	0
Reptile	*Lophognathus longirostris*	LC		0	0	0
Reptile	*Menetia greyii*	LC		0	0	0
Reptile	*Menetia maini*	LC		0	0	0
Reptile	*Moloch horridus*	LC		0	0	0
Reptile	*Morethia ruficauda*	LC		0	0	0
Reptile	*Oedura marmorata*	LC		0	0	0
Reptile	*Pogona vitticeps*	LC		0	0	0
Reptile	*Proablepharus kinghorni*	LC		0	0	0
Reptile	*Pseudechis australis*	LC		0	0	0
Reptile	*Pseudonaja ingrami*	LC		0	0	0
Reptile	*Pseudonaja modesta*	LC		0	0	0
Reptile	*Pseudonaja nuchalis*	LC		0	0	0
Reptile	*Ramphotyphlops diversus*	LC		0	0	0
Reptile	*Rhynchoedura ornata*	LC		0	0	0
Reptile	*Strophurus ciliaris*	LC		0	0	0
Reptile	*Tiliqua multifasciata*	LC		0	0	0
Reptile	*Tympanocryptis lineata*	LC		0	0	0
Reptile	*Varanus acanthurus*	LC		0	0	0
Reptile	*Varanus gilleni*	LC		0	0	0
Reptile	*Varanus gouldii*	LC		0	0	0
Reptile	*Varanus spenceri*	DD		1	0	0
Reptile	*Varanus tristis*	LC		0	0	0

9.17 Appendix Seventeen: Northern Territory Parks and Wildlife Fauna Atlas (2007) records of conservation significance (Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and/or Territory Parks and Wildlife Conservation Act (2000) (TPWC)) within the Wonarah prospect and surrounding region (50km) over Landsat 5 image. The keys to conservation codes and species status are provided in Appendix Eleven and Sixteen respectively.



9.18 **Appendix Eighteen:** Coordinates for fauna species of conservation significance (as defined by the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004) and Territory Parks and Wildlife Conservation Act (2000) (TPWC) recorded in LES field surveys and Northern Territory Parks and Wildlife Fauna Atlas (2007) records within the Wonarah Phosphate Project area and surrounding 50 km buffer area. A key to conservation codes is provided in Appendix Sixteen.

Group	Long	Lat	Species Name	TPWC	EPBC	Significant	Threatened
Bird	136.42	-19.92	*Ardeotis australis*	VU		1	1
Bird	136.1667	-19.85	*Ardeotis australis*	VU		1	1
Bird	136.45436	-20.00894	*Ardeotis australis*	VU		1	1
Bird	136.47036	-20.0094	*Ardeotis australis*	VU		1	1
Bird	136.50196	-20.00864	*Ardeotis australis*	VU		1	1
Bird	136.33611	-20.11534	*Ardeotis australis*	VU		1	1
Bird	136.36247	-20.09689	*Ardeotis australis*	VU		1	1
Bird	136.7442	-19.765	*Epthianura crocea*	EN\LC	VU\NL	1	1
Bird	136.92	-19.92	*Lophoictinia isura*	NT		1	0
Bird	136.58	-19.92	*Lophoictinia isura*	NT		1	0
Bird	136.7147	-19.7932	*Phaps histrionica*	NT		1	0
Bird	136.7882	-19.7713	*Phaps histrionica*	NT		1	0
Bird	136.7442	-19.765	*Phaps histrionica*	NT		1	0
Bird	136.7199	-19.7896	*Phaps histrionica*	NT		1	0
Frog	136.05	-19.87	*Cyclorana australis*	DD		1	0
Mammal	136.0333	-20.1833	*Dasycercus cristicauda*	VU	VU	1	1
Mammal	136.2167	-20.3667	*Lagorchestes conspicillatus*	NT		1	0
Mammal	136.2167	-20.3667	*Lagorchestes conspicillatus*	NT		1	0
Mammal	136.1746	-20.4223	*Macrotis lagotis*	VU	VU	1	1
Mammal	136.32523	-20.13156	*Macrotis lagotis*	VU	VU	1	1
Mammal	136.67	-20.05	*Rattus villosissimus*	NT		1	0
Mammal	136	-20.1667	*Rattus villosissimus*	NT		1	0
Mammal	136.0333	-20.1833	*Rattus villosissimus*	NT		1	0
Mammal	136	-20.1667	*Rattus villosissimus*	NT		1	0
Mammal	136.0333	-20.1833	*Rattus villosissimus*	NT		1	0
Mammal	136.2167	-20.3667	*Rattus villosissimus*	NT		1	0
Mammal	136.2167	-20.3833	*Rattus villosissimus*	NT		1	0
Mammal	136.35	-20.0833	*Rattus villosissimus*	NT		1	0
Mammal	136.35	-20.1333	*Rattus villosissimus*	NT		1	0
Reptile	136.48	-19.95	*Aspidites ramsayi*	NT		1	0
Reptile	136.7652	-19.7747	*Varanus spenceri*	DD		1	0

Appendix Ninteen: Site Description Summaries: **Survey 1 2008:** Trap Site 1.

Site No.: Trap Site 1	**Survey:** Wonarah Trap Site 1	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 1 (see Appendix Three).

Alluvial Low Lying Sand Plain / open woodland dominated by *Hakea divaricata* with scattered *Acacia* shrubs

Photo References:

Land unit: Alluvial Sand Plain	**Run:** Off	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 5	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 1 **Species -** Camel
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	70 %	30 %

Pebbles (<0.6cm):	0	**Rock Types and Description**
Small stones (0.6-2cm):	0	
Stones (2-6cm):	0	
Small rocks (6-20cm):	0	
Rocks (20-60cm):	0	
Big rocks (60cm-2m):	0	
Boulders (>2m):	0	
Outcrop / slab:	0	

Soil texture: red sand

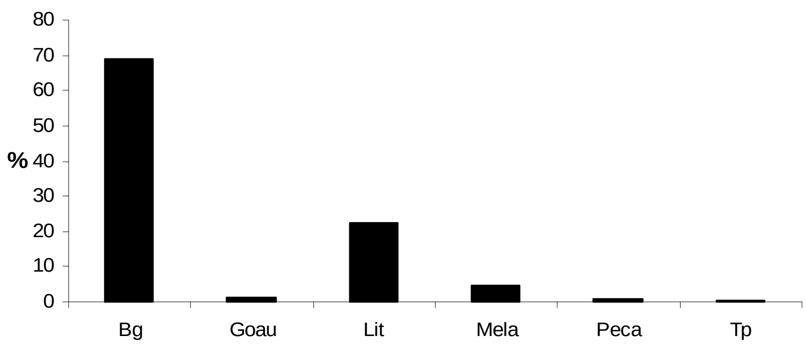
Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure

Termite mounds (no.): 10	**Max. ht. (m):** 1	**Profile:** dome
Number of fallen logs >15cm diameter in the quadrat: 20		

Strata	**Dominant species**	**Average ht. (m) of strata**	**Cover (%) of strata (% cover classes) <10 10-30 30-70 >70**
Emergent tree layer:	*Acacia ancistrocarpa*	5-8	<10
	Carissa lanceolata	5-8	<10
	Corymbia opaca	5-8	<10
	Eucalyptus leucophloia	5-8	<10
	Hakea macrocarpa	5-8	<10
	Melaleuca lasiandra	4	<10
Upper shrub layer:	*Acacia stipuligera*	0.2	10-30
	Eucalyptus leucophloia	1	<10
	Melaleuca lasiandra	2	<10
	Petalostylis cassioides	0.5	10-30
Lower shrub layer:	*Carissa lanceolata*	0.3	<10
	Gossypium australe	0.3	<10
	Melaleuca lasiandra (re-sprouting)	0.4	<10
	Petalostylis cassioides	0.3	<10
Ground layer:	*Triodia pungens*	0.2	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Bg = Bare Ground, Goau = *Gossypium australe,* Lit = Litter, Mela = *Melaleuca lasiandra,* Peca = *Petalostylis cassioides*, and Tp = *Triodia pungens.*



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 11 (5.5 %)

Fauna List	**Evidence**
Mammals	
Camelus dromedarius (camel)	Tracks
Notomys alexis (spinifex hopping mouse)	Tracks, Trapped (6)
Birds	
Rhipidura leucophrys (willie wagtail)	Observed

Site No.: Trap Site 2	**Survey:** Wonarah Trap Site 2	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 2 (see Appendix Three).

Deep Sand Plain / open woodland dominated by *Eucalyptus, Atalaya, and Acacia* spp.

Photo References:

Land unit: Deep Sand Plain	**Run:** On	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 5	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 1 **Species -** Camel
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	65 %	35 %

Pebbles (<0.6cm):	0	**Rock Types and Description**
Small stones (0.6-2cm):	0	
Stones (2-6cm):	0	
Small rocks (6-20cm):	0	
Rocks (20-60cm):	0	
Big rocks (60cm-2m):	0	
Boulders (>2m):	0	
Outcrop / slab:	0	

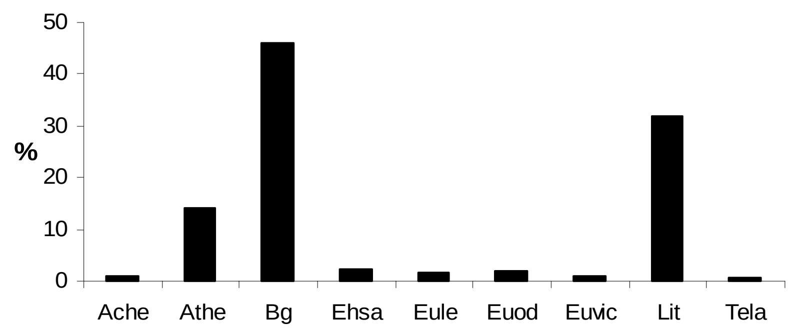
Soil texture: red sand

Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 3	**Max. ht. (m):** 0.2	**Profile:** dome
Number of fallen logs >15cm diameter in the quadrat: 1		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Atalaya hemiglauca*	6	<10
	Acacia hemignosta	6	<10
	Acacia sericophylla	5-8	<10
	Eucalyptus odontocarpa	5-8	<10
	Eucalyptus victrix	5-8	<10
	Ventilago viminalis	5-8	<10
Upper shrub layer:	*Atalaya hemiglauca* (re- sprouting)	1	<10
	Ehretia saligna	1	<10
Lower shrub layer:	*Eucalyptus leucophloia*	0.5	<10
	Tephrosia lasiochlaena	0.5	<10
Ground layer:	*Aristida contorta*	0.1	<10
	Abutilon otocarpum	0.1	<10
	Astrebla pectinata	0.1	<10
	Gossypium sturtianum	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Ache = *Acacia hemignosta,* Athe = *Atalaya hemiglauca*, Bg = bare ground, Ehsa = *Ehretia saligna*, Eule = *Eucalyptus leucophloia,* Euod = *Eucalyptus odontocarpa*, Euvic = *Eucalyptus victrix,* Lit = Litter and Tela = *Tephrosia lasiochlaena.*



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 22 (11 %)

Fauna List	Evidence
Mammals	
Camelus dromedarius (camel)	Tracks
Macropus robustus (euro)	Tracks
Notomys alexis (spinifex hopping mouse)	Tracks, Trapped (6)
Pseudomys hermannsburgensis (sandy inland mouse)	Trapped (3)

Appendix Twenty-one: Site Description Summaries: Survey 1 2008: Trap Site 3

Site No.: Trap Site 3	**Survey:** Wonarah Trap Site 3	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 3 (see Appendix Three)

Shallow Sand Plain / Calcareous Plain / open scattered woodland dominated by *Atalaya hemiglauca* over *Aristida inaequiglumis* and *Triodia pungens*.

Photo References:

Land unit: Shallow Sand Plain / Calcareous Plain	**Run:** On	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 1	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 1 **Species -** Camel
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop: 5 %	**Loose Rock/stones:** 15 %	**Bare soil/sand:** 80 % =100%	**Bare Ground** 20 % **Veg Cover** 80 %

Pebbles (<0.6cm):	0	**Rock Types and Description**
Small stones (0.6-2cm):	0	**Siltstone**
Stones (2-6cm):	>90 %	
Small rocks (6-20cm):	0	
Rocks (20-60cm):	0	
Big rocks (60cm-2m):	0	
Boulders (>2m):	0	
Outcrop / slab:	0	

Soil texture: red sand

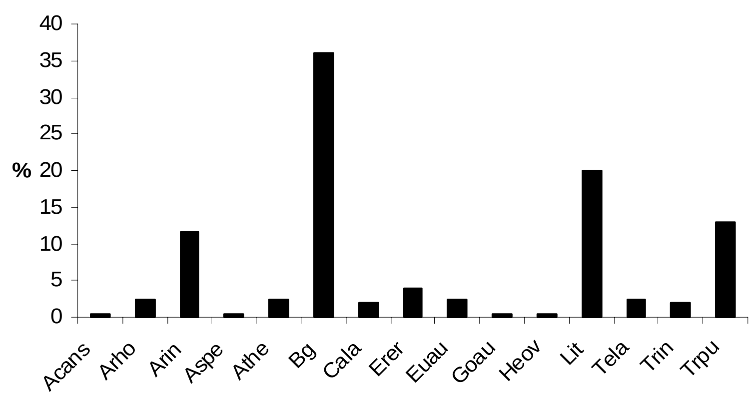
Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure

Termite mounds (no.): 0	Max. ht. (m): N/A	Profile:
Number of fallen logs >15cm diameter in the quadrat: 4		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Atalaya hemiglauca*	6	<10
Upper shrub layer:	*Atalaya hemiglauca*	1	<10
Lower shrub layer:	*Atalaya hemiglauca*	1	<10
Ground layer:	*Aristida holathera*	0.1	<10
	Aristida inaequiglumis	0.1	<10
	Astrebla pectinata	0.1	10-30
	Triodia pungens	0.1	<10
	Triodia intermedia	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Acans = *Acacia ancistrocarpa,* Arho = *Aristida holathera,* Arin = *Aristida inaequiglumis,* Aspe = *Astrebla pectinata,* Athe = *Atalaya hemiglauca,* Bg = bare ground, Cala = *Carissa lanceolata,* Erer = *Eragrostis eriopoda,* Euau = *Eulalia aurea,* Goau = *Gossypium australe,* Heov = *Heliotropium ovalifolium,* Lit = Litter, Tela = *Tephrosia lasiochlaena,* Trin = *Triodia intermedia,* Trpu = *Triodia pungens.*



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 16 (11 %)

Fauna List	Evidence
Mammals	
Camelus dromedarius (camel)	Tracks
Canis lupis (dingo)	Tracks
Macropus robustus (euro)	Tracks, Scats
Macropus rufus (red kangaroo)	Tracks
Notomys alexis (spinifex hopping mouse)	Tracks, Trapped (15)
Pseudomys hermannsburgensis (sandy inland mouse)	Trapped (3)
Pseudomys desertor (desert mouse)	Trapped (2)
Sminthopsis crassicaudata (fat tailed dunnart)	Trapped (1)
Reptiles	
Goanna (unknown)	Diggings

Appendix Twenty-two: Site Description Summaries**:** **Survey 1 2008:** Trap Site 4

Site No.: Trap Site 4	**Survey:** Wonarah Trap Site 4	**Quadrat size:** 200 x 200

Site description & location details: Main Zone – Trap Site 4 (see Appendix Three)

Alluvial Low Lying Sand Plain with minor Deep Sand Plain and Silcrete Rocky Rises dominated by *Acacia stipuligera* and *Grevillea wichkamii* with scattered *Eucalyptus victrix* over *Triodia pungens.*

Photo References:

Land unit: Alluvial Low Lying Sand Plain / Deep Sand Plain / Silcrete Rocky Rise	**Run:** Off	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 4	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 0 **Species:**
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
20 %	20 %	60 % =100%	40 %	60 %

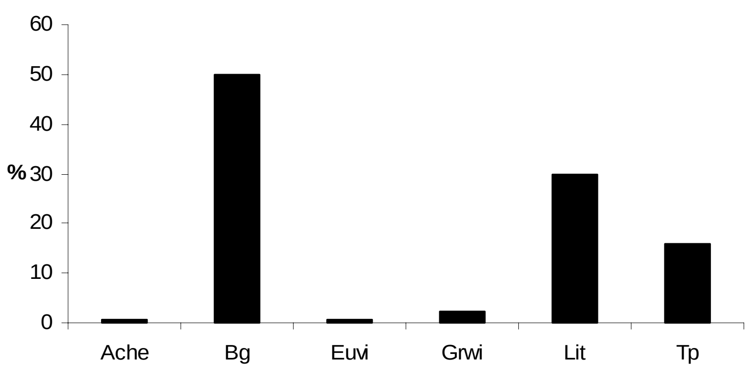
Pebbles (<0.6cm):	50-70 %	**Rock Types and Description**
Small stones (0.6-2cm):	50-70 %	**Siltstone**
Stones (2-6cm):	70-90 %	
Small rocks (6-20cm):	10-20 %	
Rocks (20-60cm):	10-20 %	
Big rocks (60cm-2m):	10-20 %	
Boulders (>2m):	<2 %	
Outcrop / slab:	0 %	

Soil texture: red sand

Soil depth (cm): 10-40		
Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 30	**Max. ht. (m):** 1	**Profile:** Dome
Number of fallen logs >15cm diameter in the quadrat: 4		

Strata	**Dominant species**	**Average ht. (m) of strata**	**Cover (%) of strata (% cover classes) <10 10-30 30-70 >70**
Emergent tree layer:	*Atalaya hemiglauca*	6	<10
	Eucalyptus victrix	6	<10
Upper shrub layer:	*Acacia stipuligera*	2	10-30
	Grevillia wichkamii	2	10-30
Lower shrub layer:	*Acacia hemignosta*	0.3	<10
Ground layer:	*Triodia pungens*	0.2	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Ache = *Atalaya hemiglauca*, Bg = bare ground, Euvi = *Eucalyptus victrix*, Grwi = *Grevillea wichkamii*, Lit = Litter, Tp = *Triodia pungens.*



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 33 (16.5 %)

Fauna List	**Evidence**
Mammals	
Canis lupis (dingo)	Tracks
Felis catus (feral cat)	Tracks
Macropus rufus (red kangaroo)	Tracks, Scats
Notomys alexis (spinifex hopping mouse)	Trapped (5)
Vulpes vulpes (fox)	Tracks
Birds	
Ardeotis australis (Australian bustard)	

Site No.: Trap Site 5	**Survey:** Wonarah Trap Site 5	**Quadrat size:** 200 x 200

Site description & location details: Main Zone – Trap Site 5 (see Appendix Three)

Ironstone / Silcrete Rocky Rise with Alluvial Low Lying Sand Plain

Photo References:

Land unit: Alluvial Low Lying Sand Plain / Silcrete Rocky Rise	**Run:** On / Off	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 5	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 0 **Species:**
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
50 %	10 %	40 % =100%	90 %	10 %

		Rock Types and Description
Pebbles (<0.6cm):	0 %	Silcrete Outcrop
Small stones (0.6-2cm):	2-10 %	
Stones (2-6cm):	10-20 %	
Small rocks (6-20cm):	10-20 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

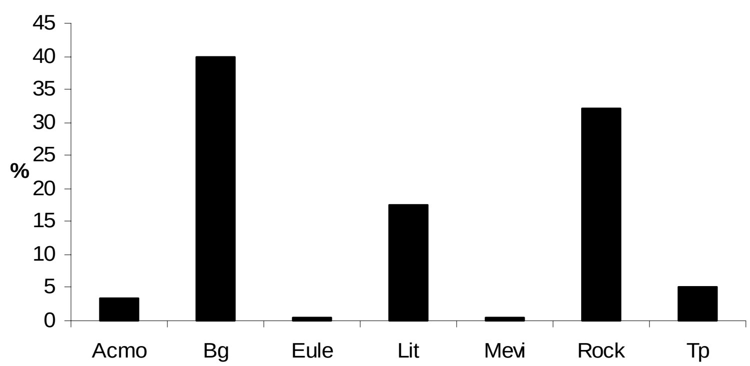
Soil texture: red sand, deep in sand plain

Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 50	**Max. ht. (m):** 2.5	**Profile:** Dome
Number of fallen logs >15cm diameter in the quadrat: 20		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Acacia monticola* *Hakea macrocarpa*	2 2	<10 <10
Upper shrub layer:	*Acacia monticola*	2	<10
Lower shrub layer:	*Eucalyptus leucophloia* (re-sprouting)	0.3	<10
Ground layer:	*Triodia pungens*	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Acmo = *Acacia monticola,* Bg = bare ground, Eule = *Eucalyptus leucophloia,* Lit = Litter, Mevi = *Melaleuca viridiflora*, Rock = Rock, Tp = *Triodia pungens.*



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 10 (5 %)

Fauna List	Evidence
Mammals	
Canis lupis (dingo)	Tracks
Notomys alexis (spinifex hopping mouse)	Tracks, Trapped (5)

Appendix Twenty-four: Site Description Summaries: **Survey 1 2008:** Site 6

Site No.: Site 6	**Survey:** Wonarah Site 6	**Quadrat size:** 200 x 200

Site description & location details: End Aruwurra Road – Site 6 (see Appendix Three)

Alluvial Low Lying Sand Plain adjacent to lateritic rise with *Eucalyptus odontocarpa* and *Hakea macrocarpa* over *Grevillea spp*. and *Triodia pungens*

Photo References:

Land unit: Alluvial Low Lying Sand Plain	**Run:** On / Off	**Topographic position:** Flat
Closest Ecotone - 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 3	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 1 **Species:** Camel
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
5 %	0 %	95 % =100%	70 %	30 %

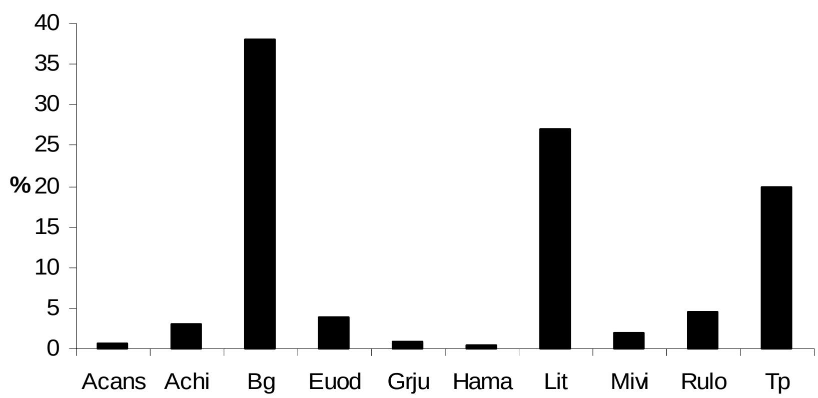
Pebbles (<0.6cm):	0 %	**Rock Types and Description**
Small stones (0.6-2cm):	<2 %	Silcrete Outcrop
Stones (2-6cm):	<2 %	
Small rocks (6-20cm):	<2 %	
Rocks (20-60cm):	<2 %	
Big rocks (60cm-2m):	2 - 10 %	
Boulders (>2m):	2 - 10 %	
Outcrop / slab:	2 - 10 %	

Soil texture: red sand	
Soil depth (cm): 10-40	

Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 0	**Max. ht. (m):** 0	**Profile:**
Number of fallen logs >15cm diameter in the quadrat: 0		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Acacia ancistrocarpa*	2	<10
	Acacia sericophylla	2	<10
	Eucalyptus odontocarpa	2	<10
	Hakea macrocarpa	2	<10
Upper shrub layer:	*Grevillea juncifolia*	2	<10
	Grevillea refracta	2	<10
Lower shrub layer:	*Acacia hilliana*	0.3	<10
	Dodonaea coriacea	0.3	<10
	Scaevola parvifolia	0.3	<10
	Scaevola amblyanthera	0.3	<10
Ground layer:	*Aristida holothera*	0.2	<10
	Triodia pungens	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Acans = *Acacia ancistrocarpa,* Achi = *Acacia hilliana*, Bg = bare ground, Euod = *Eucalyptus odontocarpa*, Grju = *Grevillea juncifolia*, Hama = *Hakea macrocarpa*, Lit = Litter, Mivi = *Mirbelia viminalis*, Rulo = *Rulingia loxophylla*, Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 25 (12.5 %)

Fauna List	Evidence
Mammals	
Canis lupis (dingo)	Tracks
Goanna (unknown)	Tracks

Site No.: Site 7	**Survey:** Wonarah Site 7	**Quadrat size:** 200 x 200

Site description & location details: Main Prospect – Site 7 (see Appendix Three)

Alluvial Low Lying Sand Plain with minor Deep Sand Plain / Open *Eucalyptus* woodland over *Triodia pungens*

Photo References:

Land unit: Alluvial Low Lying Sand Plain / Deep Sand Plain	**Run:** On	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 3	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 1 **Species:** Camel
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	40 %	60 %

Pebbles (<0.6cm):	0 %	**Rock Types and Description**
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

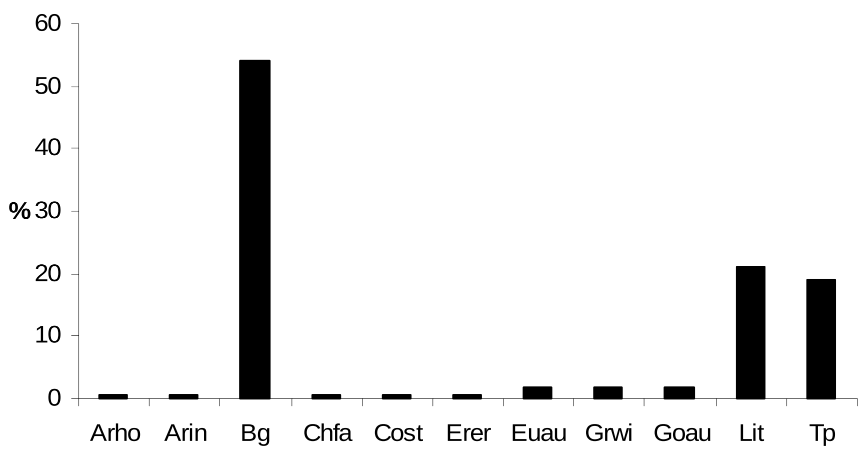
Soil texture: red sand

Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 50	**Max. ht. (m):** 1	**Profile:** Tower
Number of fallen logs >15cm diameter in the quadrat: 0		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Eucalyptus victrix*	> 5	<10
Upper shrub layer:	*Grevillea wichkamii*	2	<10
Lower shrub layer:	*Eucalyptus victrix* (re-sprouting)	0.2	0.2
Ground layer:	*Eulalia aurea*	0.1	<10
	Triodia pungens	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho = *Aristida holathera*, Arin = *Aristida inaequiglumis*, Bg = bare ground, Chfa = *Chrysopogon fallax*, Cost = *Sclerolaena costata*, Erer = *Eragrostis eriopoda*, Euau = *Eulalia aurea*, Grwi = *Grevillea wichkamii*, Goau = *Gossypium australe*, Lit = Litter, Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 25 (12.5 %)

Fauna List	Evidence
Mammals	
Canis lupis (dingo)	Tracks
Goanna sp (unknown)	Tracks
Birds	
Ardeotis australis (Australian bustard)	Tracks

Appendix Twenty-six: Site Description Summaries: Survey 1 2008: Site 8

Site No.: Site 8	**Survey:** Wonarah Site 8	**Quadrat size:** 200 x 200

Site description & location details: Main Prospect – Site 8 (see Appendix Three)

Ironstone Rocky Rise / Deep Sand Plain.

Photo References:

Land unit: Ironstone Rocky Rise / Deep Sand Plain	**Run:** On	**Topographic position:** Flat
Closest Ecotone- 200 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: 0		**Current water:** 0
Climate (1-4): 2 = Dry, no plant stress		

Disturbance type-	
Fire impact (0-5): 4	**Last fire:** This year
Rabbit damage (0-5): 0	**Introduced herbivores (0-5):** 0 **Species:**
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
20 %	5 %	75 % =100%	90 %	10 %

Pebbles (<0.6cm):	<2 %	**Rock Types and Description**
Small stones (0.6-2cm):	2-10 %	
Stones (2-6cm):	2-10 %	
Small rocks (6-20cm):	2- %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

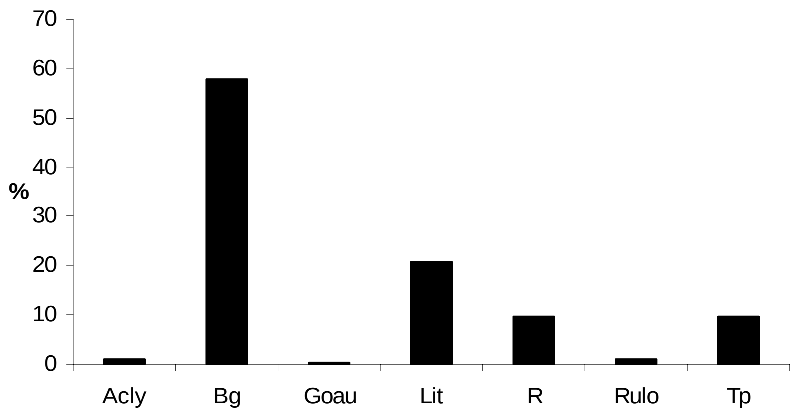
Soil texture: red sand

Soil depth (cm): 10-40

Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 50	**Max. ht. (m):** 1	**Profile:** Tower
Number of fallen logs >15cm diameter in the quadrat: 0		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:			
Upper shrub layer:	*Acacia lysiphloia*	2	<10
Lower shrub layer:			
Ground layer:	*Triodia pungens*	0.1	<10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Acly = *Acacia lysiphloia,* Bg = Bare ground, Goau = *Gossypium australe*, Lit = Litter, R = Rock, Rulo = *Rulingia loxophylla*, Tp = *Triodia pungens*.



Number of intervals with more than 1 height class (i.e. multiple vegetation layers) = 10 (5 %)

Fauna List	Evidence
Mammals	
Canis lupis (dingo)	Tracks
Birds	
Ardeotis australis (Australian bustard)	Tracks

Site No.: Trap Site 1	**Survey:** Wonarah Survey 2 2009: Trap Site 1	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 1.

Shallow Sand Plain with low lying (seasonally wet) areas / Eucalypt open woodland dominated by scattered Coolibah upperstorey, Senna sp. lower shrub layer and dense *Inidgofera colutea* and *Aristida holathera* ground cover.

Photo References:

Land unit: Shallow Sand Plain	**Run:** On	**Topographic position:** Lower Slope
Closest Ecotone: 100 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: >5 km		**Current water:** 0.5 – 5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 1	**Last fire:** Last year
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 1	**Weed Species:** Buffel Grass (*Cenchrus ciliaris*)

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	40 %	60 %

		Rock Types and Description:
Pebbles (<0.6cm):	0 %	
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil Classification: Kandosol – KA, AA, AB, E, M, V. Site also borders Vertosols.

Surface: Fine Sand

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.01	A1	Sandy Loam (SL) (A) (F) (K)	5.5	10R3/4
0.01 – 0.05	B2	Sandy Clay Loam (SCL) (M) (E)	5.5	10R3/4
0.05 – 0.40	B21	Sandy Clay Loam (SCL) (M) (E)	5.5	10R4/6

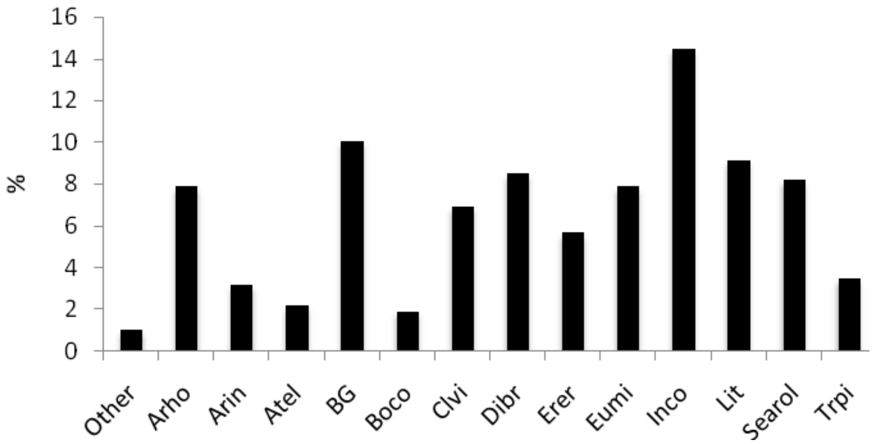
Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure		
Crust Present: Yes (minor)	**Crust soil cover:** 2%	**Crust Composition:** Biological
Termite mounds (no.): none	**Max. ht. (m):** n/a	**Profile:** n/a
Number of fallen logs >15cm diameter in the quadrat: 3		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Eucalyptus microtheca*	3	< 10
Upper shrub layer:	*Atalaya hemiglauca* *Acacia ancistrocarpa*	1.5 1.5	< 10 < 10
Lower shrub layer:	*Senna artemisioides ssp. oligophylla*	1	< 10

Ground layer:	*Inidgofera colutea*	0.3	10 – 30
	Aristida holathera	0.3	10 – 30
	Digitaria brownii	0.2	< 10
	Cleome viscosa	0.7	< 10
	Eragrostis eriopoda	0.4	< 10
	Aristida inaequiglumis	0.7	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho=*Aristida holathera,* Arin=*Aristida inaequiglumis,* Atel=*Atriplex elachophylla,* BG=Bare ground, Boco=*Boerhavia coccinea,* Clvi=*Cleome viscosa,* Dibr=*Digitaria brownii,* Erer=*Eragrostis eriopoda,* Eumi=*Eucalyptus microtheca,* Inco=*Inidgofera colutea,* Lit=Litter, Searol=*Senna artemisioides ssp. oligophylla* and Trpi=*Trianthema pilosa.* **Other** = species < 2 % cover (*Capparis umbonata, Eremophila latrobei, Ptilotus polystachyus, Tephrosia brachyodon, Acacia ancistrocarpa, Carrisa lanceolata, Chrysopogon fallax, Scaevola ovalifolia, Tephrosia benthamii, Dactyloctenium radulans, Eremophila longifolia, Portulaca oleracea, Psydrax latifolia, Enneapogon polyphyllus* and *Indigofera linifolia).*



No. of intervals with > 1 height class (i.e. multiple veg layers) = 98 (49 %); **> 2 height classes =** 20 (10 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 30.

Incidentals (within survey quadrat but not on transect): *Abutilon otocarpum, Atalaya hemiglauca, Cenchrus ciliaris* and *Crotolaria medicaginea.*

Fauna List	**Evidence**
Mammal	
Macropus rufus (Red Kangaroo)	Scats
Onychogalea unguifera (Northern Nailtail Wallaby)	Scats
Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)	Trapped (1)
Reptile	
*Ctenotus leonhardii (*Ctenotus Skink)	Trapped (1)
Eremiascincus richardsonii (Broad-banded Sand-swimmer)	Trapped (1)
Lerista bipes (Two-toed Lerista)	Trapped (2)
Varanus eremius (Pygmy Desert Monitor)	Trapped (1)
*Varanus gilleni (*Pygmy Mulga Monitor)	Trapped (1)
Varanus gouldii (Sand Goanna)	Digs
Birds	
Budgerigar (*Melopsittacus undulatus*)	Sighting
Dove, Diamond (*Geopelia cuneata*)	Sighting
Finch, Zebra(*Taeniopygia guttata*)	Sighting
Pardalote, Red-browed(*Pardalotus rubricatus*)	Call
Triller, White-winged(*Lalage sueurii*)	Sighting
Woodswallow, Blackfaced(*Artamus cinereus*)	Sighting
Woodswallow, Masked(*Artamus personatus*)	Sighting

Appendix Twenty-eight: Site Description Summaries: **Survey 2 2009:** Trap Site 2.

Site No.: Trap Site 2	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 2.

Alluvial Low-lying Sand Plain / Acacia open woodland dominated by scattered Dogwood (*Acacia sericophylla*), occasional Bloodwood and Coolibah emergent trees and dense *Aristida holathera, Yakirra australiensis* and *Whiteochloa airoides* ground cover.

Photo References:

Land unit: Alluvial Low-lying Sand Plain	**Run:** Plain	**Topographic position:** Flat sand plain
Closest Ecotone: 1 km		**Road Type in Vicinity:** Exploration track
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 0	**Last fire:** Last year.
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground** / **Veg Cover**
0 %	0 %	100 % =100%	50 % 50 %

		Rock Types and Description:
Pebbles (<0.6cm):	0 %	
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil Classification: Kandosol - KA, AA, AB, A, E, M, X.

Surface: Fine Sand

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.02	A1	Sandy Loam (SL) (A) (F) (K)	6	10R3/4-2/2
0.02 – 0.10	B2	Sandy Clay Loam (SCL) (M)	6	10R4/6
0.10 – 0.40	B21	Sandy Clay Loam (SCL) / Clay Loam (CL) (M) (X)	6	10R4/6


Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure

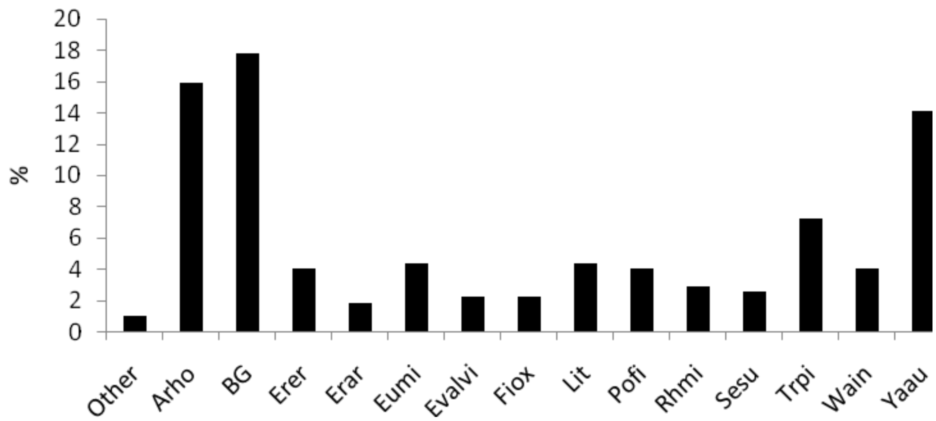
Crust Present: No	**Crust soil cover:** N/A	**Crust Composition:** N/A
Termite mounds (no.): 1	**Max. ht. (m):** 0.2	**Profile:** Dome

Number of fallen logs >15cm diameter in the quadrat: 1

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Eucalyptus microtheca* *Corymbia opaca*	5 4	< 10 < 10
Upper shrub layer:	*Acacia sericophylla* *Capparis umbonata*	3 2	< 10 < 10

Lower shrub layer:	*Acacia sericophylla*	0.7	< 10
	Eucalyptus microtheca	0.7	< 10
	Ehrtia saligna	1	< 10
	Gossypium australe	0.6	< 10
Ground layer:	*Aristida holathera*	0.3	10 – 30
	Yakirra australiensis	0.2	10 – 30
	Whiteochloa airoides	1.2	10 – 30
	Trianthema pilosa	0.3	10 – 30
	Eragrostis eriopoda	0.3	< 10
	Eriachne aristida	0.2	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho=*Aristida holathera,* BG=Bare Ground, Erer=*Eragrostis eriopoda,* Erar=*Eriachne aristida,* Eumi=*Eucalyptus microtheca,* Evalvi=*Evolvulus alsinoides var. villosicalyx,* Fiox=*Fimbristylus oxystachya,* Lit=Litter, Pofi=*Portulaca filifolia,* Rhmi=*Rhynchosia minima,* Sesu=*Setaria surgens,* Trpi=*Trianthema pilosa,* Wain=*Waltheria indica* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % cover (*Boerhavia coccinea, Corymbia opaca, Ehretia saligna, Euphorbia comans, Gomphrena lanata, Scaevola parvifolia, Schizachyrium fragile, Trianthema triquetra, Whiteochloa airoides, Acacia sericophylla, Triodia schinzii, Ptilotus polystachyus, Tephrosia benthamii, Melaleuca lasiandra, Spermacoce dolichosperma, Tribulopis angustifolia and Zornia albiflora*).



No. of intervals with > 1 height class (i.e. multiple veg layers) = 64 (32 %); **> 2 height classes =** 10 (5 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 40.

Incidentals (within survey quadrat but not on transect): *Acacia ancistrocarpa, Acacia stipuligera, Capparis umbonata, Carrisa lanceolata, Crotalaria novae-hollandiae, Eragrostis cumingii, Eremophila latrobei, Eriachne mucronata, Fimbristylis ammobia, Gossypium australe* and *Keraudrenia integrifolia.*

Fauna List	**Evidence**
Mammal	
Felis catus (Feral Cat)	Tracks
Macropus rufus (Red Kangaroo)	Tracks
Mouse (unknown)	Tracks
Reptile	
Goanna (unknown)	Tracks
Varanus gouldii (Sand Goanna)	Trapped (1)
Lerista bipes (Two-toed Lerista)	Trapped (3)
Legless lizard (unknown)	Tracks
Small lizard (unknown)	Tracks
Birds	
Babbler, Grey-crowned (*Pomatostomus temporalis*	Sighting/Call
Budgerigar (*Melopsittacus undulatus*)	Sighting
Bustard, Australian (*Ardeotis australis*)	Tracks
Button-Quail, Little (*Turnix pyrrhothorax*)	Tracks
Chat, Crimson (*Epthianura tricolor*)	Sighting
Finch, Zebra (*Taeniopygia guttata*)	Sighting
Owl, Barn (*Tyto alba*)	Feather
Woodswallow, Blackfaced (*Artamus cinereus*)	Sighting
Woodswallow, Masked (*Artamus personatus*)	Sighting

9.19

Appendix Twenty-nine: Site Description Summaries: Survey 2 2009: Trap Site 3.

Site No.: Trap Site 3	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 3.

Calcrete rise surrounded by Floodplain / Eucalypt open woodland dominated by scattered Coolibah and Bloodwood on floodplain and scattered Supplejack on calcrete rises, over *Aristida holathera, Tribulus eichlerianus* and*Cleome viscosa* grassland ground cover.

Photo References:

Land unit: Calcareous Plain	**Run:** Off	**Topographic position:** Hill / Plain
Closest Ecotone: 100 m		**Road Type in Vicinity:** Exploration Track.
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 0	**Last fire:** Last year.
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 1	**Weed Species:** Buffel Grass (*Cenchrus ciliaris*)

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
5 %	5 %	90 % =100%	10 %	90 %

Pebbles (<0.6cm):	2-10 %	**Rock Types and Description:** Calcrete pedogenic nodules in rises – deep sandy loams.
Small stones (0.6-2cm):	2-10 %	
Stones (2-6cm):	2-10 %	
Small rocks (6-20cm):	2-10 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil Classification: Calcarosol - CA, AB, BC, U.

Surface / Comment: Calcrete pedogenic nodules in rises with sandy loams.

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.02	A1	Sandy Clay Loam (SCL) (M)	6.5	10R3/4-46
0.02 – 0.1	B2	Sandy Clay Loam (SCL) (M) (U)	8.5	10R3/4
0.1 – 0.6 +	B21	Sandy Clay Loam (SCL) (M) (U)	9.5	10R3/4

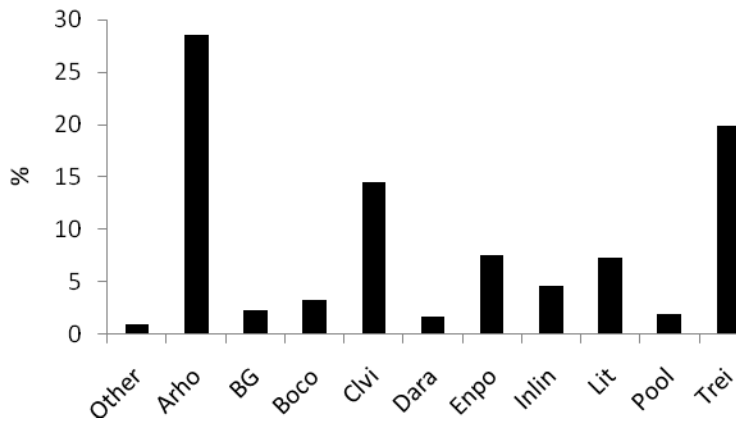
Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure		
Crust Present: Minor	**Crust soil cover:** <1 %	**Crust Composition:** Biological
Termite mounds (no.): 0	**Max. ht. (m):** N/A	**Profile:** N/A
Number of fallen logs >15cm diameter in the quadrat: 2		

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Corymbia opaca*	8	< 10
	Eucalyptus microtheca	8	< 10
	Ventilago viminalis	6	< 10
Upper shrub layer:	*Capparis umbonata*	2	< 10
	Ventilago viminalis	3	< 10
Lower shrub layer:	*Gossypium australe*	0.8	< 10
	Corymbia opaca	0.8	< 10
	Eucalyptus microtheca	0.8	< 10

Ground layer:	*Aristida holathera*	0.5	30 – 70
	Tribulus eichlerianus	0.3	30 – 70
	Cleome viscosa	0.7	30 – 70
	Indigofera linifolia	0.2	10 – 30
	Enneapogon polyphyllus	0.4	< 10
	Dactyloctenium radulans	0.2	< 10
	Crotolaria medicaginea	0.3	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho=*Aristida holathera,* BG=Bare Ground, Boco=*Boerhavia coccinea,* Clvi=*Cleome viscosa,* Dara=*Dactyloctenium radulans,* Enpo=*Enneapogon polyphyllus,* Inlin=*Indigofera linifolia,* Lit=Litter, Pool=*Portulaca oleracea* and Trei=*Tribulus eichlerianus.* **Other** = species < 2 % cover (*Acacia hemignosta, Eragrostis eriopoda, Portulaca filifolia, Salsola tragus, Corymbia opaca, Crotolaria medicaginea, Eulalia aurea, Gossypium australe* and *Ventilago viminalis.*



No. of intervals with > 1 height class (i.e. multiple veg layers) = 95 (48 %); **> 2 height classes =** 13 (7 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 25

Incidentals (within survey quadrat but not on transect): *Aristida contorta, Atalaya hemiglauca, Capparis umbonata, Cenchrus ciliaris, Eucalyptus microtheca, Cucumis maderaspatanus, Swainsonia sp.* and*Triraphis mollis.*

Fauna List	**Evidence**
Mammal	
Macropus rufus (Red Kangaroo)	Tracks/Scats/Lay-down areas
Reptile	
Goanna (unknown)	Digs
*Ctenotus leonhardii (*Ctenotus Skink)	Trapped (1)
Ctenotus schomburgkii (Ctenotus skink)	Trapped (1)
Birds	
Budgerigar (*Melopsittacus undulatus*)	Sighting
Bustard, Australian (*Ardeotis australis*)	Feather
Button-Quail, Little (*Turnix pyrrhothorax*)	Sighting
Dove, Diamond (*Geopelia cuneata*)	Sighting
Finch, Zebra (*Taeniopygia guttata*)	Sighting
Kite, Black (*Milvus migrans*)	Sighting
Songlark, Brown (*Cincloramphus cruralis*)	Sighting
Triller, White-winged(*Lalage sueurii*)	Sighting
Woodswallow, Blackfaced (*Artamus cinereus*)	Sighting
Woodswallow, Masked (*Artamus personatus*)	Sighting

Appendix Thirty: Site Description Summaries: Survey 2 2009: Trap Site 4.

Site No.: Trap Site 4	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 4.

Shallow Sand Plain below Silcrete Rocky Rise / Acacia and Mallee shrubland with hummock grassland dominated by E*ucalyptus odontocarpa, E. pachyphylla* and *Acacia hilliana* over soft Spinifex.

Photo References:

Land unit: Silcrete Rocky Rise	**Run:** Off	**Topographic position:** Mid Slope.
Closest Ecotone: 0.5 km		**Road Type in Vicinity:** Exploration Track
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 4	**Last fire:** Last year.
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	5 %	95 % =100%	70 %	30 %

		Rock Types and Description:
Pebbles (<0.6cm):	0 %	Silcrete alluvial / colluvial wash from ridge to north.
Small stones (0.6-2cm):	2-10 %	
Stones (2-6cm):	< 2 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil Classification: Rudosol – RU, AA, AB, A, E, K, X

Surface / Comment: Fine sand grains minor silcrete rock outcrops

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.002	A1	Sand (S) (A) (E) (K)	6	10R 3/4
0.002 – 0.14	B	Sand (S) (K)	5.8	10R 3/6
0.14 – 0.6 +	B	Loamy Sand (LS) (M) (X)	5.8	10R 3/2


Soil depth (cm): > 40

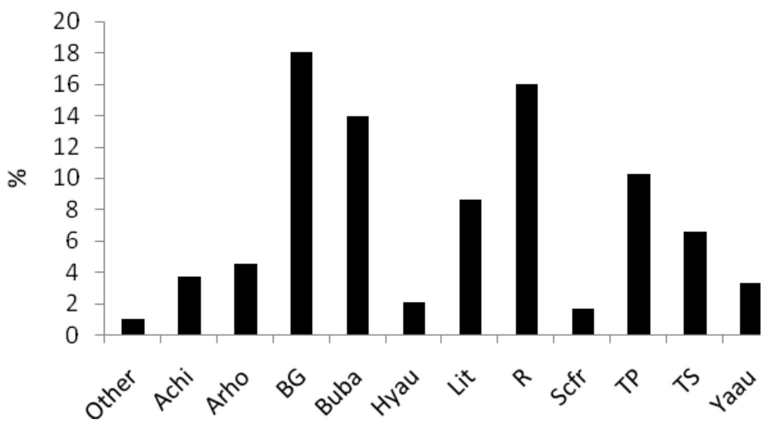
Soil crust, termites, log habitat and vegetation strata structure		
Crust Present: Yes	**Crust soil cover:** 10 %	**Crust Composition:** Biological
Termite mounds (no.): > 50	**Max. ht. (m):** 0.8	**Profile:** Tower.

Number of fallen logs >15cm diameter in the quadrat: 0

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Corymbia opaca*	4	< 10
	Hakea lorea	3	< 10
	Eucalyptus setosa	4	< 10
Upper shrub layer:	*Hakea lorea*	2	< 10
	Grevillea refracta	1.5	< 10

Lower shrub layer:	*Acacia hilliana*	0.6	< 10
	Eucalyptus odontocarpa	0.6	< 10
	Eucalyptus pachyphylla	0.6	< 10
	Gossypium australe	0.5	< 10
	Acacia adoxa	0.5	< 10
Ground layer:	*Triodia pungens*	0.3	10 – 30
	Triodia schinzii	0.3	10 – 30
	Aristida holathera	0.3	10 – 30
	Yakirra australiensis	0.2	10 – 30
	Bulbostylis barbata	0.1	10 – 30
	Hybanthus aurantiacus	0.3	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Achi=*Acacia hilliana,* Arho=*Aristida holathera,* BG=Bare Ground, Buba=*Bulbostylis barbata,* Hyau=*Hybanthus aurantiacus,* Lit=Litter, R=Rock, Scfr=*Schizachyrium fragile,* TP=*Triodia pungens,* TS=*Triodia schinzii* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % (*Amphipogon caricinus, Eucalyptus odontocarpa, Eucalyptus pachyphylla, Corymbia setosa, Fimbristylis simulans, Goodenia armitiana, Grevillea refracta, Petalostylis cassioides, Polycarpaea spirostylis, Ptilotus calostachyus, Ptilotus polystachyus, Spermacoce dolichosperma, Goodenia ramelii, Gossypium australe, Paraneurachne muelleri, Ptilotus fusiformis, Urochloa sp., Acacia adoxa* and *Setaria surgens*).



No. of intervals with > 1 height class (i.e. multiple veg layers) = 42 (21 %); **> 2 height classes =** 1 (0.5 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 34.

Incidentals (within survey quadrat but not on transect): *Brunonia australis, Cassytha capillaries, Corchorus sidoides, Corymbia opaca, Eragrostis cumingii, Eucalyptus setosa, Hakea lorea* and *Sida filiformis.*

Fauna List	**Evidence**
Mammal	
Mouse (unknown)	Tracks
Reptile	
Ctenophorus isolepis (Military Dragon)	Trapped (2)
Diplodactylus conspicillatus (Fat-tailed Gecko)	Trapped (1)
Gecko (unknown)	Tracks
Legless lizard (unknown)	Tracks
Lerista bipes (Two-toed Lerista)	Trapped (5)
Small lizard (unknown)	Trapped (1)
Strophurus ciliaris (Spiny-tailed Gecko)	Tracks
Varanus gouldii (Sand Goanna)	Diggings / Holes
Birds	
Budgerigar (*Melopsittacus undulatus*)	Sightings
Button-Quail, Little (*Turnix pyrrhothorax*)	Tracks
Chat, Crimson (*Epthianura tricolor*)	Sightings
Dove, Diamond (*Geopelia cuneata*)	Sightings
Finch, Zebra(*Taeniopygia guttata*)	Sightings
Woodswallow, Masked *(Artamus personatus*)	Sightings

Appendix Thirty-one: Site Description Summaries: Survey 2 2009: Trap Site 5.

Site No.: Trap Site 5	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 5 .

Alluvial Low-lying Sand Plain / open Eucalypt woodland with hummock grassland dominated by Coolibah and Bloodwood upper-storey over Spinifex ground-cover.

Photo References:

Land unit: Alluvial Low-lying Sand Plain	**Run:** Plain	**Topographic position:** Lower Slope Floodpalin

Closest Ecotone: 0.5 km	**Road Type in Vicinity:** Exploration track
Perm. Water: >5 km	**Current water:** >5 km

Climate (1-4): 4 = Recent rain, noticeable vegetation response.

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 4	**Last fire:** Last year.
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	70 %	30 %

Pebbles (<0.6cm):	0 %	**Rock Types and Description:** Aeolian sand grains to 2 mm. Mostly fine sands with iron staining.
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	
	0 %	

Soil Classification: Rudosol – RU, AA, AB, A, E, K, W

Surface / Comment: Fine sand grains minor outcrops

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.002	A	Sand (S) (A) (E)	5.7	10R 5/4
0.002 – 0.05	B	Sand (S) (K)	5.75	10R 3/4
0.05 – 0.22	B	Sand (S) (K)	5.75	10R 3/4
0.22 – 0.6	B	Sand (S) (K)	5.75	10R 4/6- 3/4

Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure

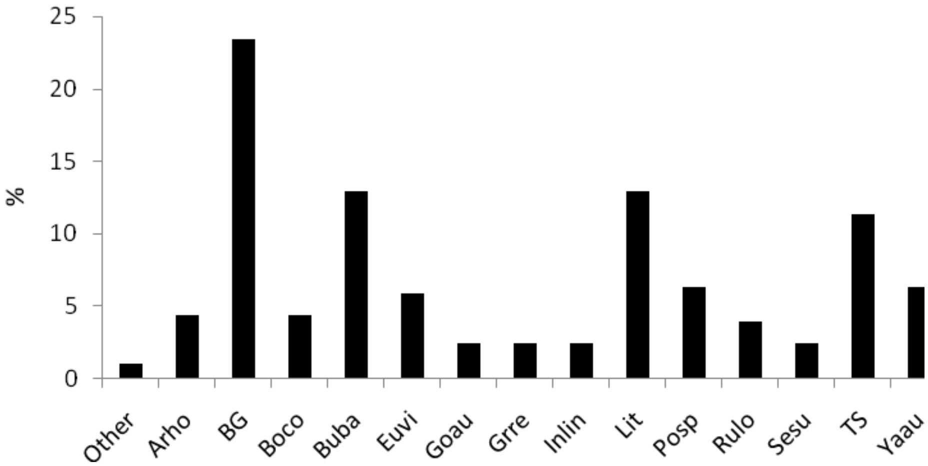
Crust Present: Yes	**Crust soil cover:** 5 %	**Crust Composition:** Biological
Termite mounds (no.): 30	**Max. ht. (m):** 1	**Profile:** Tower & Dome.

Number of fallen logs >15cm diameter in the quadrat: 0

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Eucalyptus victrix* *Hakea macrocarpa*	15 5	< 10 < 10
Upper shrub layer:	*Eucalyptus odontocarpa* *Grevillea refracta*	1.5 1.5	< 10 < 10
Lower shrub layer:	*Gossypium australe*	1	< 10

Ground layer:	*Triodia schinzii*	0.3	10 – 30
	Bulbostylis barbata	0.1	10 – 30
	Aristida holathera	0.3	10 – 30
	Rulingia loxophylla	0.3	10 – 30
	Boerhavia coccinea	0.2	10 – 30
	Yakirra australiensis	0.2	10 – 30
	Indigofera linifolia	0.3	10 - 30

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho=*Aristida holathera,* BG=Bare Ground, Boco=*Boerhavia coccinea,* Buba=*Bulbostylis barbata,* Euvi=*Eucalyptus victrix,* Goau=*Gossypium australe,* Grre=*Grevillea refracta,* Inlin=*Indigofera linifolia,* Lit=Litter, Posp=*Polycarpaea spirostylis,* Rulo=*Rulingia loxophylla,* Sesu=*Setaria surgens,* TS=*Triodia schinzii* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % (*Aristida inaequiglumis, Cleome viscosa, Eulalia aurea, Ptilotus fusiformis, Sebastiana chamaelea* and *Eragrostis eriopoda*).



No. of intervals with > 1 height class (i.e. multiple veg layers) = 58 (29 %); **> 2 height classes =** 8 (4 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 29.

Incidentals (within survey quadrat but not on transect): *Clerodendrum floribundum, Crotalaria novae-hollandiae, Eucalyptus odontocarpa, Euphorbia tannensis, Fimbristylis oxystachya, Grevillea wickhamii, Hakea macrocarpa, Heliotropium glanduliferum, Paraneurachne muelleri* and *Spermacoce dolichosperma.*

Fauna List	**Evidence**
Mammal	
Mouse (unknown)	Tracks
Notomys alexis (Spinifex Hopping Mouse)	Tracks
Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)	Trapped (1)
Reptile	
Ctenophorus isolepis (Military Dragon)	Trapped (1)
*Ctenotus leonhardii (*Ctenotus Skink)	Sighted (1)
Diplodactylus conspicillatus (Fat-tailed Gecko)	Trapped (1)
Gehyra variegata (Variegated Gecko)	Trapped (1)
Small lizard (unknown)	Tracks
Snake (unknown)	Tracks
Varanus gouldii (Sand Goanna)	Tracks
Birds	
Budgerigar (*Melopsittacus undulatus*)	Sightings
Cockatiel (*Nymphicus hollandicus*)	Sightings
Galah (*Cacatua roseicapilla*)	Sightings
Hobby, Australian (*Falco longipennis*)	Sightings
Kite, Black (*Milvus migrans*)	Sightings
Kite, Whistling (*Haliastur sphenurus*)	Sightings
Magpie, Black-backed (*Gymnorhina tibicen*)	Sightings
Miner, Yellow-throated (*Manorina flavigula*)	Sightings
Wagtail, Willie (*Rhipidura leucophrys*)	Sightings

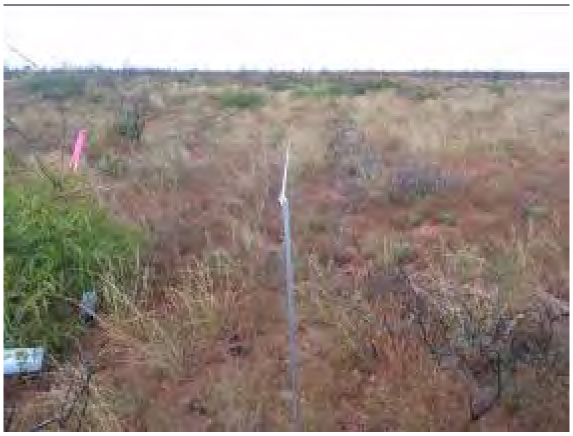
Appendix Thirty-two: Site Description Summaries: Survey 2 2009: Trap Site 6.

Site No.: Trap Site 6	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 6 (same as Site TS5 2008 survey)

Ironstone Rocky Rise surrounded by drainage depression / Acacia and Mallee shrubland dominated by *A. stipuligera, A. hilliana* and *Eucalyptus odontocarpa* over sedges and perennial grasses.

Photo References:



Land unit: Ironstone Rocky Rise	**Run:** Off	**Topographic position:** Slope (Upper & Lower)
Closest Ecotone: 100m		**Road Type in Vicinity:** Exploration Track
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 2	**Last fire:** Last year
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop: 10 %	**Loose Rock/stones:** 10 %	**Bare soil/sand:** 80 % =100%	**Bare Ground** 30 % **Veg Cover** 60 % **Rock Types and Description:** Silcrete

Pebbles (<0.6cm):	0 %	**Rock Types and Description:**
Small stones (0.6-2cm):	0 %	Silcrete
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	
	0 %	

Soil Classification: Rudosol – RU, AA, AB, A, E, K, U

Surface / Comment: Fine sand grains minor silcrete outcrops

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.005	A	Sand (S) (A) (E)	5.75	10R 3/4
0.005 – 0.1	B	Sand (S) (K)	5.75	10Y 4/6
0.1 – 0.16	B	Sand (S) (K)	5.75	10R 3/4 - 4/6
0.16 – 0.6	B	Sand (S) (K)	5.75	10R 3/4 - 4/6

Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure

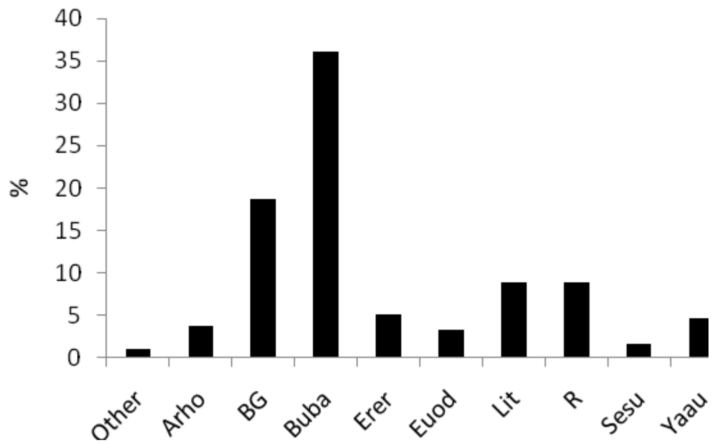
Crust Present: No	**Crust soil cover:** N/A	**Crust Composition:** N/A
Termite mounds (no.): In sand plain outside of quadrat	**Max. ht. (m):** 2	**Profile:** Tower

Number of fallen logs >15cm diameter in the quadrat: 0

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	None	-	-
Upper shrub layer:	Litter (Dead *Acacia stipuligera*)	2	< 10
Lower shrub layer:	*Eucalyptus odontocarpa* Litter (Dead *Acacia hilliana*)	1 0.7	< 10 < 10

Ground layer:	*Bulbostylis barbata*	0.2	30 – 70
	Eragrostis eriopoda	0.3	10 – 30
	Yakirra australiensis	0.1	10 – 30
	Aristida holathera	0.3	10 – 30
	Grevillea wickhamii	0.1	< 10
	Grevillea refracta	0.1	< 10
	Schizachyrium fragile	0.1	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Arho=*Aristida holathera,* BG=Bare Ground, Buba=*Bulbostylis barbata,* Erer=*Eragrostis eriopoda,* Euod=*Eucalyptus odontocarpa,* Lit=Litter, R=Rock, Sesu=*Setaria surgens* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % cover (*Acacia adoxa, Acacia stipuligera, Cucumis maderaspatanus, Goodenia ramelii, Gossypium australe, Hybanthus aurantiacus, Indigofera linifolia, Rulingia loxophylla, Schizachyrium fragile, Sida arenicola, Urochloa sp., Eragrostis cumingii, Euphorbia comans, Grevillea refracta, Grevillea wickhamii* and *Heliotropium glanduliferum*).



No. of intervals with > 1 height class (i.e. multiple veg layers) = 52 (26 %); **> 2 height classes =** 4 (2 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 37.

Incidentals (within survey quadrat but not on transect): *Cleome viscosa, Corchorus sidoides, Dicrastylis gilesii, Heliotropium pulvinum, Ipomoea costata, Keraudrenia integrifolia, Cucumis maderaspatana, Portulaca filifolia, Portulaca oleracea, Ptilotus fusiformis, Senna notables, Sida fibulifera, Sida filiformis* and *Spermacoce dolichosperma.*

Fauna List	**Evidence**
Mammal	
Felis catus (Feral Cat)	Tracks
Mouse (unknown)	Tracks
Notomys alexis (Spinifex Hopping Mouse)	Tracks
Tachyglossus aculeatus (Short-beaked Echidna)	Digs
Reptile	
Ctenophorus isolepis (Military Dragon)	Trapped (1)
Diporiphora lalliae (Dragon)	Trapped (1)
Legless lizard (unknown)	Tracks
Small lizard (unknown)	Tracks
Snake (unknown)	Tracks
Varanus gouldii (Sand Goanna)	Trapped (3), Tracks
Birds	
Bellbird, Crested (*Oreoica gutturalis*)	Sightings
Budgerigar (*Melopsittacus undulatus*)	Sightings
Button-Quail, Little (*Turnix pyrrhothorax*)	Sightings
Chat, Crimson (*Epthianura tricolor*)	Sightings
Dove, Diamond (*Geopelia cuneata*)	Sightings
Fairy-wren, Variegated (*Malurus lamberti*)	Sightings
Finch, Zebra(*Taeniopygia guttata*)	Sightings
Honeyeater, Grey headed (*Lichenostomus keartlandii*)	Sightings
Honeyeater, Spiny-cheeked (*Acanthagenys rufogularis*)	Sightings
Kite, Black (*Milvus migrans*)	Sightings
Woodswallow, Blackfaced *(Artamus cinereus*)	Sightings
Woodswallow, Masked *(Artamus personatus*)	Sightings

Appendix Thirty-three: Site Description Summaries: Survey 2 2009: Trap Site 7.

Site No.: Trap Site 7	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Arruwurra Prospect – Trap Site 7

Deep Sand Plain / open Eucalyptus woodland over hummock grassland dominated by *Eucalyptus victrix, E. pachyphylla* and *Acacia sericophylla* over soft Spinifex.

Photo References:

Land unit: Deep Sand Plain	**Run:** Plain	**Topographic position:** Bottom
Closest Ecotone: > 5 km		**Road Type in Vicinity:** Exploration Track
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 4	**Last fire:** Last year
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	80 %	20 %

		Rock Types and Description:
Pebbles (<0.6cm):	0 %	
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil Classification: Kandosol - KA, AA, AB, A, E, K, X.

Surface / Comment: Fine aeolian sand

Depth (m)	Horizon	Texture	pH	Colour
0 - 0.002	A1	Sand (S) (A) (E) (K)	6	10R 3/2
0.002 – 0.05	B2	Sand (S) (K)	5.8	10R 3/2
0.05 – 0.12	B21	Sand (S) (K)	6	10R 3/3
0.12 – 0.6	B21	Sand (S) (K) (X)	6	10R 3/6.

Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure

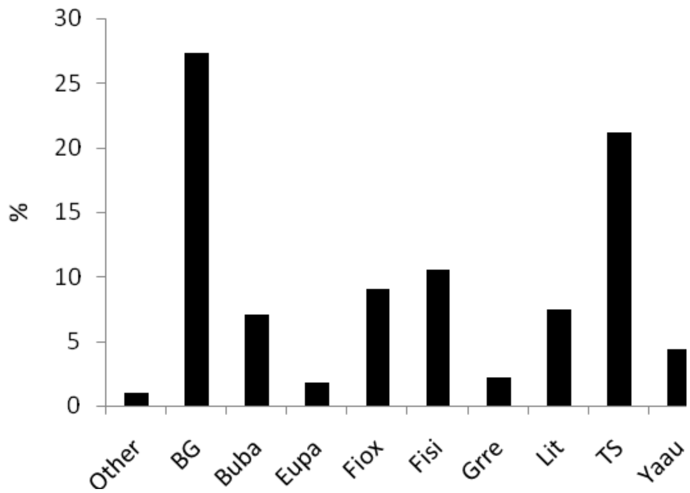
Crust Present: Yes	**Crust soil cover:** 10 %	**Crust Composition:** Biological
Termite mounds (no.): 5	**Max. ht. (m):** 0.5	**Profile:** Dome

Number of fallen logs >15cm diameter in the quadrat: 5

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Acacia sericophylla* *Eucalyptus victrix*	4 5	< 10 < 10
Upper shrub layer:	*Grevillea refracta*	2	< 10
Lower shrub layer:	*Eucalyptus pachyphylla*	1	< 10

Ground layer:	*Triodia schinzii*	0.2	10 – 30
	Fimbristylis simulans	0.2	10 – 30
	Fimbristylis oxystachya	0.2	10 – 30
	Bulbostylis barbata	0.1	< 10
	Senna notablis	0.3	< 10
	Yakirra australiensis	0.2	< 10
	Paraneurachne muelleri	0.3	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: BG=Bare Ground, Buba=*Bulbostylis barbata,* Eupa=*Eucalyptus pachyphylla,* Fiox = *Fimbristylis oxystachya,* Fisi=*Fimbristylis simulans,* Grre=*Grevillea refracta,* Lit=Litter, TS=*Triodia schinzii* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % cover (*Amphipogon caricinus, Eragrostis eriopoda, Paraneurachne muelleri, Scaevola parvifolia, Schizachyrium fragile, Spermacoce dolichosperma, Urochloa sp., Acacia sericophylla, Aristida holathera, Setaria surgens, Stackhousia 'Mt Leibig', Polycarpaea spirostylis* and *Tribulopis angustifolia*).



No. of intervals with > 1 height class (i.e. multiple veg layers) = 28 (14 %); **> 2 height classes =** 1 (0.5 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 27.

Incidentals (within survey quadrat but not on transect): *Gossypium australe, Heliotropium glanduliferum, Ptilotus fusiformis, Ptilotus polystachyus, Senna notables* and *Ventilago viminalis.*

Fauna List	Evidence
Mammal	
Felis catus (Feral Cat)	Tracks
Macropus rufus (Red Kangaroo)	Tracks
Mouse (unknown)	Tracks
Notomys alexis (Spinifex Hopping Mouse)	Tracks
Sminthopsis youngsoni (Lesser Hairy-footed Dunnart)	Trapped (1)
Reptile	
Ctenophorus isolepis (Military Dragon)	Trapped (2)
*Ctenotus leonhardii (*Ctenotus Skink)	Trapped (1)
Diplodactylus conspicillatus (Fat-tailed Gecko)	Trapped (1)
*Varanus gilleni (*Pygmy Mulga Monitor)	Trapped (1)
Varanus gouldii (Sand Goanna)	Tracks
Legless lizard (unknown)	Tracks
Small lizard (unknown)	Tracks
Snake (unknown)	Tracks
Birds	
Bellbird, Crested (*Oreoica gutturalis*)	Sightings
Budgerigar (*Melopsittacus undulatus*)	Sightings
Button-Quail, Little (*Turnix pyrrhothorax*)	Sightings
Chat, Crimson (*Epthianura tricolor*)	Sightings
Dove, Diamond (*Geopelia cuneata*)	Sightings
Finch, Zebra (*Taeniopygia guttata*)	Sightings
Honeyeater, Grey headed (*Lichenostomus keartlandii*)	Sightings
Honeyeater, Singing (*Lichenostomus virescens*)	Sightings
Jacky Winter (*Microeca fascinans*)	Sightings
Kingfisher, Sacred (*Todiramphus sanctus*)	Sightings
Kite, Black (*Milvus migrans*)	Sightings
Pardalote, Red-browed (*Pardalotus rubricatus*)	Sightings
Triller, White-winged *(Lalage sueurii*)	Sightings
Woodswallow, Masked *(Artamus personatus*)	Sightings

Appendix Thirty-four: Site Description Summaries: Survey 2 2009: Trap Site 8.

Site No.: Trap Site 8	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** 200 x 200

Site description & location details: Aruwurra Prospect – Trap Site 8.

Deep Sand Plain / Eucalypt and Acacia low open woodland over hummock grassland with *Melaleuca lasiandra* in drainages, dominated by *Acacia sericophylla, A. stipuligera* and *Triodia schinzii* and *Aristida holathera* groundcover.

Photo References:

Land unit: Deep Sand Plain	**Run:** Plain	**Topographic position:** Flat Plain
Closest Ecotone: 100 m		**Road Type in Vicinity:** Exploration Track
Perm. Water: >5 km		**Current water:** >5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:

0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 3	**Last fire:** Last year.
Rabbit damage: 0	**Introduced herbivores :** 0 **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

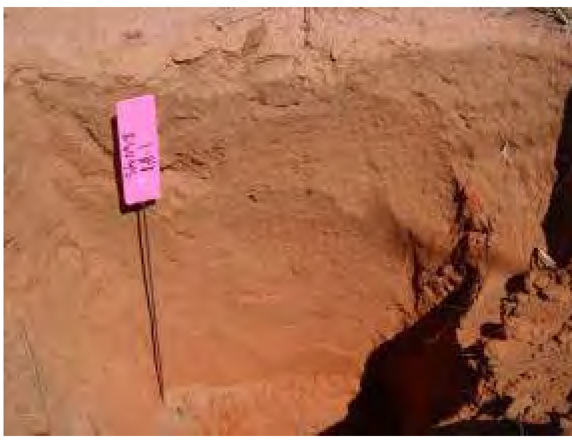
Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground**	**Veg Cover**
0 %	0 %	100 % =100%	80 %	20 %

Pebbles (<0.6cm):	0 %	**Rock Types and Description:** Deep sands.
Small stones (0.6-2cm):	0 %	
Stones (2-6cm):	0 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	
	0 %	

Soil Classification: Kandosol - KA, AA, AB, A, E, K, X.

Surface / Comment: Fine aeolian sand

Depth (m)	Horizon	Texture	pH	Colour
0 – 0.002	A1	Clayey Sand (CS)	5.5	10R 2/4
0.002 – 0.12	B2	Sand (S)	5.8	10R 3/4
0.12 – 0.6+	B21	Sand (S)	5.5	10R 4/6



Soil depth (cm): > 40

Soil crust, termites, log habitat and vegetation strata structure

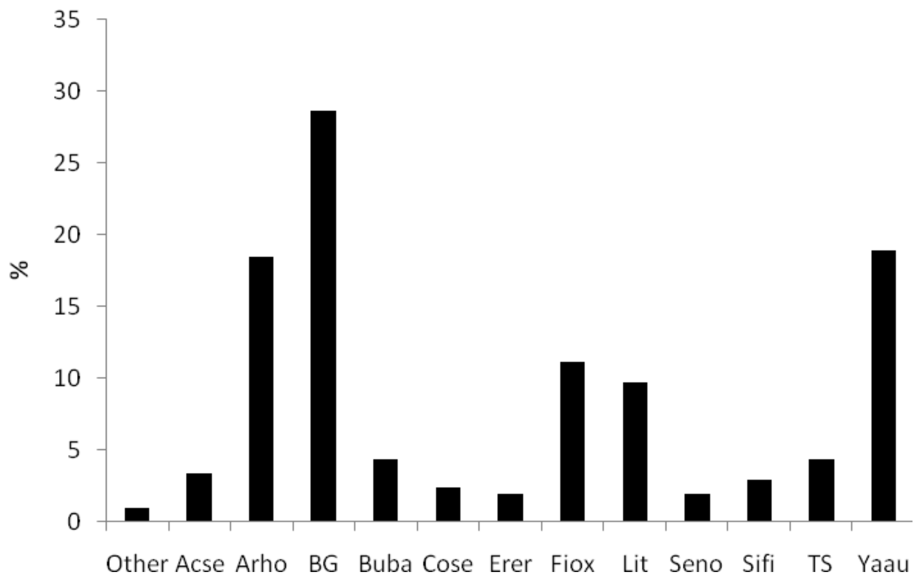
Crust Present: Yes	**Crust soil cover:** 10 %	**Crust Composition:** Biological / Pedological **Comment:** Clay cryptogam.
Termite mounds (no.): 0	**Max. ht. (m):** N/A	**Profile:** N/A

Number of fallen logs >15cm diameter in the quadrat: 5

Strata	Dominant species	Average ht. (m) of strata	Cover (%) of strata (% cover classes) <10 10-30 30-70 >70
Emergent tree layer:	*Acacia sericophylla*	4	< 10
	Eucalyptus setosa	3	< 10
Upper shrub layer:	*Acacia stipuligera*	2	< 10
	Melaleuca lasiandra	2	< 10
Lower shrub layer:	*Gossypium australe*	1	< 10

Ground layer:	*Triodia schinzii*	0.3	10 – 30
	Yakirra australiensis	0.2	10 – 30
	Aristida holathera	0.3	10 – 30
	Sida filiformis	0.2	< 10
	Bulbostylis barbata	0.1	< 10
	Eragrostis eriopoda	0.3	< 10

Percentage Ground Cover (counts at 1 m intervals over 200 m transect). Where: Acse =*Acacia sericophylla,* Arho=*Aristida holathera,* BG=Bare Ground, Buba=*Bulbostylis barbata,* Erer=*Eragrostis eriopoda,* Cose=*Corymbia setosa,* Fiox=*Fimbristylis oxystachya,* Lit=Litter, Seno=*Senna notabilis,* Sifi=*Sida filiformis,* TS=*Triodia schinzii* and Yaau=*Yakirra australiensis.* **Other** = species < 2 % cover (*Schizachyrium fragile, Tephrosia* sp Barrow Creek , *Trichodesma zeylanicum, Amphipogon caricinus, Eriachne aristidea, Evolvulus alsinoides var. decumbens, Melaleuca lasiandra, Urochloa sp., Eucalyptus odontocarpa, Setaria surgens* and *Triumfetta centralis.*



No. of intervals with > 1 height class (i.e. multiple veg layers) = 47 (24 %); **> 2 height classes =** 1 (0.5 %); **> 3 height classes =** 0.

Species Richness (total species) including incidental species = 27.

Incidentals (within survey quadrat but not on transect): *Acacia stipuligera, Corchorus sidoides, Gossypium australe, Heliotropium glanduliferum, Ptilotus fusiformis* and *Spermacoce dolichosperma.*

Fauna List	Evidence
Mammal	
Dunnart (unknown)	Tracks
Macropus rufus (Red Kangaroo)	Tracks / Scats
Notomys alexis (Spinifex Hopping Mouse)	Tracks
Reptile	
*Ctenotus leonhardii (*Ctenotus Skink)	Trapped (2)
Legless lizard (unknown)	Tracks
Lerista bipes (Two-toed Lerista)	Trapped (1)
Small lizard (unknown)	Tracks
Snake (unknown)	Tracks
Varanus gouldii (Sand Goanna)	Tracks / Hole
Birds	
Bellbird, Crested (*Oreoica gutturalis*)	Sightings
Budgerigar (*Melopsittacus undulatus*)	Sightings
Button-Quail, Little (*Turnix pyrrhothorax*)	Sightings / Tracks
Chat, Crimson (*Epthianura tricolor*)	Sightings
Dove, Diamond (*Geopelia cuneata*)	Sightings
Finch, Zebra (*Taeniopygia guttata*)	Sightings
Honeyeater, Grey headed (*Lichenostomus keartlandii*)	Sightings
Honeyeater, Singing (*Lichenostomus virescens*)	Sightings
Wedgebill, Chiming (*Psophodes occidentalis*)	Sightings
Woodswallow, Masked *(Artamus personatus*)	Sightings

Appendix Thirty-five: Site Description Summaries: Survey 2 2009: Ephemeral Lake.

Site No.: 9 - Ephemeral Lake	**Survey:** Wonarah Survey 2 2009	**Quadrat size:** Drive over

Site description & location details: Ephemeral lake within CLC exclusion zone. *E. microtheca* (Coolibah) low-open woodland with low grassland and clay depressions with sedges.
(Visit supervised by Traditional Owners with prior agreement from CLC).

Photo References:




Land unit: Ephemeral Lake	**Run:** On	**Topographic position:** Bottom slope
Closest Ecotone: 300m		**Road Type in Vicinity:** None
Perm. Water: >5km		**Current water:** 0.5 – 5 km
Climate (1-4): 4 = Recent rain, noticeable vegetation response.		

Disturbance:
0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Disturbance type-

Fire impact: 0	**Last fire:** Long unburnt

Rabbit damage: None	**Introduced herbivores :** none **Species:** N/A
Weeds (0-5): 0	**Weed Species:** N/A

Outcrop:	**Loose Rock/stones:**	**Bare soil/sand:**	**Bare Ground / Veg Cover**
0 %	20 %	80- % =100%	60 % / 40 %

		Rock Types and Description:
Pebbles (<0.6cm):	0 %	Colluvial & alluvial silcrete stone outwash from adjacent hills.
Small stones (0.6-2cm):	50 - 70 %	
Stones (2-6cm):	2-10 %	
Small rocks (6-20cm):	0 %	
Rocks (20-60cm):	0 %	
Big rocks (60cm-2m):	0 %	
Boulders (>2m):	0 %	
Outcrop / slab:	0 %	

Soil texture:		
Soil depth (cm): 10-40		
Soil crust, termites, log habitat and vegetation strata structure		
Termite mounds (no.): 0	**Max. ht. (m):** N/A	**Profile: N/A**
Number of fallen logs >15cm diameter in the quadrat: 3		

Strata	**Flora species list**		
Emergent tree layer:	*Eucalyptus victrix*		
Upper shrub layer:	*Capparis umbonata* *Psydrax latifolia*		
Lower shrub layer:	*Eremophila latrobei* *Eremophila longifolia*		
Ground layer:	*Aeschynomene indica* *Ammannia multiflora* *Aristida contorta* *Aristida holathera* *Aristida inaequiglumis* *Bergia barklyana* *Cleome viscosa* *Dactyloctenium radulans*	*Enneapogon polyphyllus* *Eragrostis falcata* *Eucalyptus victrix* *Fimbristylus dichotoma* *Gossypium australe* *Indigofera linnaei* *Leptoclada fusca* *Neptunia gracilis*	*Paspalidium rarum* *Portulaca filifolia* *Portulaca oleracea* *Solanum coactiliferum* *Teucrium integrifolium* *Trianthema pilosa* *Trianthema triquetra* *Whiteochloa airoides*

A vegetation transect was not conducted.

No trapping or tracking data collected, although bird observations were made during drive through.

Birds	
Budgerigar (*Melopsittacus undulatus*)	Sightings
Cockatiel (*Nymphicus hollandicus*)	Sightings

Appendix Thirty-six: Flora recorded during on site investigations by LES within the Wonarah prospect.

Status is given under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White et al. (2000). See Appendix Sixteen for conservation code descriptions. Indigenous use of species was determined from discussions with traditional owners during field surveys and supplemented with searches through the literature.

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Abutilon otocarpum	Keeled Lantern-bush, Desert Chinese Lantern, Desert Lantern					TS2	1	Seeds edible	Utilitarian
Acacia adoxa							4,6		
Acacia ancistrocarpa	Fitzroy Wattle, Pirraru					TS1, TS3, S6	1,2		
Acacia hemignosta	Club-leaf Wattle			bioregional	BRT (southern range limit)	TS2, TS4	3	Seeds edible	Utilitarian
Acacia hilliana	Flying-saucer Bush			bioregional	CR (southern range limit)	S6	4, Inc. (Ironstone/chert rise S19.97287 E136.45370).		
Acacia lysiphloia	Turpentine, Turpentine Bush, Turpentine Wattle			bioregional	GSD (disjunct and southern range limit)	S8		Medicinal - pain relief, cold relief. Mothers and babies 'smoked' after birth.	Cultural, Utilitarian
Acacia monticola	Hill Turpentine			bioregional	CR (southern range limit)	TS5			
Acacia sericophylla	Dogwood, Wirewood					TS2, S6	2,7,8	Seeds edible	Utilitarian
Acacia stipuligera	Scrub Wattle, Kurapuka					TS1, TS4	2,6,8	Seeds edible	Utilitarian
Aerva javanica	Kapok Bush, Snow Bush	Int.					Inc. (along road near Arruwurra prospect)		
Aeschynomene indica	Budda Pea, Kath Sola						9		
Ammannia multiflora	Jerry Jerry						9		
Amphipogon caricinus	Grey-beard Grass, Long Grey-beard Grass						4,7,8		
Aristida contorta	Bunched Kerosene Grass, Mulga Grass					TS2	3,9		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass					TS3, S6, S7	1,2,3,4,5,6,7,8,9		
Aristida inaequiglumis	Curly Wiregrass, Fire Grass, Unequal Three-awn					TS3, S7	1,5,9	Medicinal - tea for immune boost	Utilitarian
Astrebla pectinata	Barley Mitchell Grass					TS2, TS3			
Atalaya hemiglauca	Whitewood					TS2, TS3, TS4	1,3	Flowering an indicator for crocodile egg laying	Cultural
Atriplex elachophylla	Annual Saltbush, Saltbush						1		
Bergia barklyana		nt		national	3R		9		
Boerhavia coccinea	Tar Vine						1,2,3,5		
Brunonia australis	Pincushion, Blue Pincushion						4		
Bulbostylis barbata	Short-leaved Rush						4,5,6,7,8		
Capparis umbonata	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate			bioregional	MGD (southern range limit)		1,2,3,9	Fruit edible	Utilitarian
Carissa lanceolata	Conkerberry, Conkle Berry, Kungsberry Bush					TS1, TS3	1,2	Medicinal - pain relief, antiseptic. Sick children 'smoked'	Cultural, Utilitarian
Cassytha capillaris	Hairless Dodder-laurel, Snotty Gobble						4		
Cenchrus ciliaris	Buffel Grass	Int.					1,3		
Chrysopogon fallax	Golden Beard Grass, Ribbon Grass, Weeping Grass, Spear Grass					S7	1		
Cleome viscosa	Tickweed, Mustard Bush						1,3,5,6,9	Medicinal - treat sores, ulcers and wounds, headache, rheumatism and diarrhoea	Utilitarian
Clerodendrum floribundum	Smooth Clerodendrum, Smooth Spiderbush, Lollybrush, Lolly Bush						5	Medicinal.	Utilitarian

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Corchorus sidoides	Flannel Weed						4,6,8		
Corymbia opaca	Bloodwood					TS1	2,3,4		
Corymbia setosa	Rough-leaved Bloodwood						4,8		
Crotalaria medicaginea	Clover-leaf Rattlepod, Trefoil Rattlepod						1,3		
Crotalaria novae-hollandiae	New Holland Rattlepod						2,5		
Cucumis maderaspatanus	Head-ache Vine						3,6		
Dactyloctenium radulans	Button Grass, Finger Grass, Toothbrush Grass						1,3,9		
Dicrastylis gilesii							6		
Digitaria brownii	Cotton Panic Grass						1		
Dodonaea coriacea	Hopbush					S6			
Ehretia saligna	Coonta, False Cedar, Peachwood, Peachbush					TS2	2		
Enneapogon polyphyllus	Woolly Oat-grass, Oat-grass, Leafy Nine-awn						1,3,9		
Eragrostis cumingii	Fairy Grass, Cumings Lovegrass						2,4,6		
Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail					TS3, S7	1,2,3,5,6,7,8		
Eragrostis falcata	Sickle Lovegrass						9		
Eremophila latrobei	Native Fuchsia, Latrobes Desert Fuchsia, Georgina Poison Bush						1,2,9	Medicinal. Ceremonially increase mothers milk supply	Cultural, Utilitarian
Eremophila longifolia	Emu Bush, Weeping Emu Bush, Long-leaved Desert Fuchsia						1,9	Medicinal. 'Smoking' of candidates in rites of passage	Cultural, Utilitarian
Eriachne aristidea	Three-awn Wanderrie						2,8		
Eriachne mucronata	Mountain Wanderrie						2		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites 2008	Survey Sites 2009	Indigenous Use	Category
Eucalyptus gamophylla	Blue Mallee, Twin-leaved Mallee, Blue-leaved Mallee			bioregional	TAN (northern range limit)		Inc. (Emphemeral lakes) Inc. (Shallow sand plain S19.97053 E136.45397).		
Eucalyptus leucophloia	Snappy Gum, Migum					TS1, TS2, TS5			
Eucalyptus microtheca	Coolibah						1,2,3	Coolamon carved out of bark.	Utilitarian
Eucalyptus odontocarpa	Sturt Creek Mallee			bioregional	GSD (southern range limit)	TS2, S6	4,5,6,8		
Eucalyptus pachyphylla	Red-bud Mallee			bioregional	DMR (northern range limit)		4,7		
Eucalyptus pruinosa	Silver Box, Silver-leaf Box, Apple Box, Smoke Tree						Inc. (Silcrete rocky rise associated with Site 5)		
Eucalyptus victrix	Smooth-barked Coolibah, Ghost Gum Coolibah, Gum-barked Coolibah			bioregional	MGD (eastern range limit)	TS2, TS4, S7	5,7,9		
Eulalia aurea	Silky Browntop, Sugar Grass					TS3, S7	3,5		
Euphorbia comans							2,6		
Euphorbia tannensis	Caustic Bush, Desert Spurge						5		
Evolvulus alsinoides var. decumbens	Blue Periwinkle, Tropical Speedwell						8		
Evolvulus alsinoides var. villosicalyx	Blue Periwinkle, Tropical Speedwell						2		
Fimbristylis ammobia				bioregional	MGD (eastern range limit)		2		
Fimbristylis dichotoma	Eight Day Grass, Common Fringe-rush						9		
Fimbristylis oxystachya	Lukarrara						2,5,7,8		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Fimbristylis simulans				bioregional	DMR (eastern range limits)		4,7		
Gomphrena lanata							2		
Goodenia armitiana	Narrow-leaved Goodenia						4		
Goodenia ramelii							4,6		
Gossypium australe	Native Cotton, Tall Desert Rose					TS1, TS3, S7, S8	2,3,4,5,6,7,8,9		
Gossypium sturtianum	Sturts Desert Rose					TS2			
Grevillea juncifolia	Desert Grevillea, Honey Grevillea, Honeysuckle Grevillea					S6		Flowers edible and steeped	Utilitarian
Grevillea refracta	Silver-leaf Grevillea					S6	4,5,6,7		
Grevillea wickhamii	Holly-leaf Grevillea					TS4, S7	5,6		
Hakea lorea	Long-leaf Corkwood, Corkbark Tree						4		
Hakea macrocarpa	Flat-leaved Hakea			bioregional	SSD (southern range limit)	TS1, TS5, S6	5	Flowers steeped	Utilitarian
Heliotropium glanduliferum							5,6,7,8		
Heliotropium ovalifolium						TS3			
Heliotropium pulvinum		dd		Northern Territory	3K		6		
Hibiscus brachychlaenus		nt		Northern Territory	3r		6		
Hybanthus aurantiacus	Orange Spade Flower						4,6		
Indigofera colutea	Sticky Indigo						1		
Indigofera linifolia	Native Indigo						1,3,5,6		
Indigofera linnaei	Birdsville Indigo, Nine-leaved Indigo						9		
Ipomoea costata	Bush Potato, Potato Vine, Desert Yam						6, Inc. (deep sand plain)	Tubers edible	Utilitarian
Jacquemontia browniana	Snake Stem						2		
Keraudrenia integrifolia							2,6		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Leptochloa fusca	Beetle Grass						9		
Marsdenia australis	Bush Banana, Lungkwa, Doubah						2		
Melaleuca lasiandra	Sandhill Tea-tree					TS1	2,8		
Melaleuca viridiflora	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark					TS5			
Mirbelia viminalis	Yellow Broom					S6			
Neptunia gracilis	Native sensitive grass						9		
Pandorea doratoxylon	Spearwood, Wonga Vine, Spearbush						Inc. (Deep sand plain associated with TS2)	Spear-making	Utilitarian
Paraneurachne muelleri	Spinifex Couch, Northern Mulga Grass						4,5,7		
Paspalidium rarum	Bunch Paspalidium						9		
Petalostylis cassioides	Butterfly Bush, Petalostylis					TS1	4	Medicinal - skin treatment	Utilitarian
Polycarpaea spirostylis	Copper Plant						4,5,7		
Portulaca filifolia	Slender Pigweed						2,3,6,9		
Portulaca oleracea	Pigweed, Common Purslane, Munyeroo						1,3,6,9	Whole plant edible	Utilitarian
Psydrax latifolia	Native Currant, Orange Bush						1,9		
Ptilotus calostachyus	Weeping Mulla Mulla						4		
Ptilotus fusiformis	Skeleton plant						4,5,6,7,8		
Ptilotus polystachyus	Long Pussy-tails						1,2,4,7		
Rhynchosia minima	Native Pea, Rhynchosia						2		
Rulingia loxophylla	Desert Fire Weed					S6, S8	5,6		
Salsola tragus	Buckbush, Rolypoly, Tumbleweed						3		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Santalum lanceolatum	Plumbush, Wild Plum						Inc. (Deep sand plain associated with TS2)	Fruits and seeds edible. Medicinal - skin treatment, cold and cough relief. Babies 'smoked' to ensure good health	Cultural, Utilitarian
Scaevola amblyanthera						S6			
Scaevola ovalifolia	Bushy Fanflower			bioregional	GSD (western range limit)		1		
Scaevola parvifolia	Fanflower					S6	2,7		
Sclerolaena costata				bioregional	CHC (eastern range limit)	S7			
Schizachyrium fragile	Firegrass, Red Spathe Grass, Small Red-leaf						2,4,6,7,8		
Sebastiania chamaelea							5		
Senna artemisioides subsp. oligophylla	Oval-leaf Cassia						1	Medicinal - bathe patient for skin treatment, cold & cough relief.	Utilitarian
Senna notablis	Cockroach Bush						6,7,8		
Senna venusa	Graceful Cassia						Inc. (Silcrete rocky rise associate with Site 5)		
Setaria surgens	Brown Pigeon Grass			bioregional	GSD (southern range limit)		2,4,5,6,7,8		
Sida arenicola							6		
Sida fibulifera	Silver Sida, Pin Sida						6		
Sida filiformis	Fire Sida, Fine Sida						4,6,8		
Solanum coactiliferum	Western Nightshade						9		
Spermacoce dolichosperma							2,4,5,6,7,8		
Stackhousia 'Mt Leibig'							7		

Full Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	Survey Sites		Indigenous Use	Category
						2008	2009		
Swainsonia sp.							3		
Tephrosia benthamii							1,2,8		
Tephrosia brachyodon	Red Pea-bush						1		
Tephrosia lasiochlaena				bioregional	MAC (southern range limit)	TS2, TS2			
Teucrium integrifolium	Green Germander			bioregional	TAN (disjunct and western range limit)		9		
Trianthema pilosa							1,2,9		
Trianthema triquetra	Red Spinach						2,9		
Tribulopis angustifolia							2,7		
Tribulus eichlerianus	Bindieye						3		
Trichodesma zeylanicum	Cattle Bush, Camel Bush						8		
Triodia intermedia	Winged Spinifex			bioregional	DMR (disjunct and eastern range limit), BRT (disjunct and southern range limit)	TS3			
Triodia pungens	Soft Spinifex, Gummy Spinifex					TS1, TS3, TS4, TS5, S6, S7, S8	4		
Triodia schinzii	Feathertop Spinifex						2,4,5,7,8		
Triraphis mollis	Purple Plumegrass, Purple Heads, Needle Grass						3		
Triumfetta centralis				bioregional	SSD (eastern range limit)		8		
Urochloa sp.							4,6,7,8		
Ventilago viminalis	Supplejack, Vine Tree					TS2	3,7		
Waltheria indica							2		
Whiteochloa airoides							2,9		
Yakirra australiensis	Desert Flinders Grass						2,4,5,6,7,8		
Zornia albiflora				bioregional	GSD (southern range limit)		2		

Appendix Thirty-seven: Significant flora recorded within the Wonarah project area during on-site investigations including LES field surveys and NT Flora Atlas (2007) records.

__Note:__ "LES Survey" indicates species recorded during LES surveys (Dry Season 2008 & Wet Season 2009 surveys). All other species were recorded in the NT Flora Atlas (2007).

See Appendix Sixteen for conservation code descriptions.

__**Land unit codes:**__

ASP: Alluvial low-lying sand plain
DSP: Deep sand plain
IRR: Ironstone rocky rise
SRR: Silcrete rocky rise
EL: Ephemeral lake
CP: Calcareous plain

Species Name	TPWC	EPBC	SSOBS level	SSOBS Code	LES Survey	Land unit
Bonamia alatisemina	DD		National	3K		**DSP**
Distichostemon barklyanus	DD		Northern Territory	3k		**DSP**
Heliotropium ballii	DD		Northern Territory	3k		**IRR**
Heliotropium pulvinum	DD		Northern Territory	3K	*	**IRR, SRR**
Sporobolus latzii	DD		National	1K		**EL**
Triumfetta deserticola	DD		Northern Territory	3k		**ASP**
Bergia barklyana	nt		National	3R	*	**EL**
Hibiscus brachychlaenus	nt		Northern Territory	3r	*	**IRR**

Appendix Thirty-eight: Significant fauna species recorded within the Wonarah Phosphate Project area during on-site investigations including LES field surveys and NT Flora Atlas (2007) records.

<u>**Note:**</u> "Inside" column refers to species recorded inside the Wonarah Phosphate Project area. All other species were recorded outside the Wonarah Phosphate Project area but within a 50 km buffer.

"LES Survey" indicates species recorded during LES surveys (Dry Season 2008 & Wet Season 2009 surveys). All other species were recorded in the NT Flora Atlas (2007).

See Appendix Sixteen for conservation code descriptions.

Species Name	Common Name	TPWC	EPBC	Inside	LES Survey
Ardeotis australis	Australian Bustard	VU		*	*
Epthianura crocea	Yellow Chat	EN\LC	VU\NL		
Lophoictinia isura	Square-tailed kite	NT			
Phaps histrionica	Flock Bronzwing	NT			
Cyclorana australis	Northern Snapping Frog or Giant Frog	DD			
Dasycercus cristicauda or *D. blythi*	Crest-tail or Brush-tail Mulgara	VU	VU		
Lagorchestes conspicillatus	Spectacled Hare Wallaby	NT			
Macrotis lagotis	Bilby	VU	VU		
Onychogalea unguifera	Northern Nailtail Wallaby	NT		*	*
Rattus villosissimus	Long-haired rat	NT		*	
Aspidites ramsayi	Woma	NT		*	
Varanus spenceri	Spencers Goanna	DD			

Appendix Thirty-nine: Fauna recorded during LES field surveys (Dry Season 2008 & Wet Season 2009 surveys) within the Wonarah Phosphate Project area.

Status is given under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), and the Territory Parks and Wildlife Conservation Act (2000) (TPWC). See Appendix Sixteen for conservation code descriptions.

Note: Location details of incidental records are provided in the "Inc. Locations" column.

Common Name	Scientific	Evidence	Conservation Status		Survey Sites		
Mammals			**EPBC**	**TPWC**	**2008**	**2009**	**Inc. Locations**
Camel	*Camelus dromedarius*			Int.	TS1, TS2, TS3		
Cat, Feral	*Felis catus*	Tracks	-	Int.	TS4	2,6,7, Inc.	Drill Sump S20.12903 E136.32635
Cow	*Bos taurus*	Tracks	-	Int.		Inc.	Drill Sump S20.12903 E136.32635
Dingo	*Canis lupis*	Tracks	-	LC	TS3, TS4, TS5, S6, S7, S8		
Donkey, Feral	*Equus asinus*	Tracks	-	Int.		Inc.	Drill Sump S20.12903 E136.32635
Dunnart, Fat-tailed	*Sminthopsis crassicaudata*			LC	TS3		
Dunnart, Lesser hairy-footed	*Sminthopsis youngsoni*	Trapped	-	LC		1,5,7	
Dunnart (unidentified)		Tracks	-	-		8	
Echidna, Short-beaked	*Tachyglossus aculeatus*	Tracks/Digs	-	LC		6, Inc.	Within Arruwurra prospect along road
Euro	*Macropus robustus*			LC	TS2, TS3		
Fox, Red	*Vulpes vulpes*	Tracks	-	Int.	TS4		
Kangaroo, Red	*Macropus rufus*	Tracks/Scats	-	LC	TS3, TS4	1,2,3,7,8	
Mouse, Sandy inland	*Pseudomys hermannsburgensis*			LC	TS2		
Mouse, Desert	*Pseudomys desertor*			LC	TS3		
Mouse, Spinifex Hopping	*Notomys alexis*			LC	TS1, TS2, TS3, TS4, TS5	5,6,7,8	
Mouse (unidentified)						2,4,5,6,7	
Wallaby, Northern Nailtail	*Onychogalea unguifera*	Scats	-	NT		1	
Reptiles			**EPBC**	**TPWC**	**2008**	**2009**	**Inc. Locations**
Blue-tongue, Centralian	*Tiliqua multifasciata*	Track	-	LC		Inc.	Alluvial Low-lying Sand Plain associated with Site 2.
Dragon	*Diporiphora lalliae*	Trapped	-	LC		6	
Dragon, Military	*Ctenophorus isolepis*	Trapped	-	LC		4,5,6,7	
Gecko, Fat-tailed	*Diplodactylus conspicillatus*	Trapped	-	LC		4,5,7	

Common Name	Scientific	Evidence	Conservation Status		Survey Sites		
Gecko, Spiny-tailed	*Strophurus ciliaris*	Trapped	-	LC		4	
Gecko, Varigated	*Gehyra variegata*					5	
Gecko (unidentified)		Track	-	-		4	
Goanna, Sand	*Varanus gouldii*	Trapped/Sighting/Digs	-	LC		1,2,4,5,6,7,8, Inc.	Silcrete Rise
Goanna (unidentified)		Track/Digs	-	-	TS3, S6, S7	2,3	
Legless lizard (unidentified)		Track	-	-		2,4,6,7,8	
Lerista, Two-toed	*Lerista bipes*	Trapped	-	LC		1,2,4,8	
Monitor, Pygmy Desert	*Varanus eremius*	Trapped	-	LC		1	
Monitor, Pygmy Mulga	*Varanus gilleni*	Trapped	-	LC		1,7	
Thorny Devil	*Moloch horridus*	Track	-	LC		Inc.	Calcareous plain associated with Site 3
Sand-swimmer, Broad-banded	*Eremiascincus richardsonii*	Trapped	-	LC		1	
Skink, Ctenotus	*Ctenotus leonhardii*	Trapped	-	LC		1,3,5,7,8	
Skink, Ctenotus	*Ctenotus schomburgkii*	Trapped	-	LC		3	
Small lizard (unidentified)						2,4,5,6,7,8	
Snake (unidentified)		Track	-	-		5,6,7,8	
Birds			**EPBC**	**TPWC**	**2008**	**2009**	**Inc. Locations**
Babbler, Grey-crowned	*Pomatostomus temporalis*	Call	-	LC		2	
Bellbird, Crested	*Oreoica gutturalis*	Call	-	LC		6,7,8	
Budgerigar	*Melopsittacus undulatus*	Sighting	-	LC		1,2,3,4,5,6,7, 8,9	
Bustard, Australian	*Ardeotis australis*	Tracks/Feather	-	VU	TS4, S7, S8	2,3	
Button-Quail, Little	*Turnix pyrrhothorax*	Sighting/Tracks	-	LC		2,3,4,6,7,8	
Chat, Crimson	*Epthianura tricolor*	Sighting	-	LC		2,4,6,7,8	
Cockatiel	*Nymphicus hollandicus*	Sighting	-	LC		5,9	
Dove, Diamond	*Geopelia cuneata*	Sighting	-	LC		1,3,4,6,7,8	
Fairy-wren, Variegated	*Malurus lamberti*	Sighting	-	LC		6	
Falcon, Brown	*Falco berigora*	Sighting	-	LC		Inc.	Deep sand plain at Nth cross track & Ironstone Rocky Rise associated with Site 6
Finch, Zebra	*Taeniopygia guttata*	Sighting	-	LC		1,2,3,4,6,7,8	
Galah	*Cacatua roseicapilla*	Sighting	-	LC		5	
Hobby, Australian	*Falco longipennis*	Sighting	-	LC		5	
Honeyeater, Grey headed	*Lichenostomus keartlandi*	Sighting	-	LC		6,7,8	
Honeyeater, Singing	*Lichenostomus virescens*	Sighting	-	LC		7,8	
Honeyeater, Spiny-	*Acanthagenys*	Sighting	-	LC		6	

Common Name	Scientific	Evidence	Conservation Status		Survey Sites		
cheeked	*rufogularis*						
Jacky Winter	*Microeca fascinans*	Sighting	-	LC		7	
Kingfisher, Sacred	*Todiramphus sanctus*	Sighting	-	LC		7, Inc.	Alluvial low-lying sand plain associated with S6 (2008 site)
Kite, Black	*Milvus migrans*	Sighting	-	LC		3,5,6,7	
Kite, Whistling	*Haliastur sphenurus*	Sighting	-	LC		5	
Magpie, Black-backed	*Gymnorhina tibicen*	Sighting	-	LC		5	
Miner, Yellow-throated	*Manorina flavigula*	Sighting	-	LC		5	
Owl, Barn	*Tyto alba*	Feather	-	LC		2	
Pardalote, Red-browed	*Pardalotus rubricatus*	Sighting	-	LC		1,7	
Parrot, Australian Ringneck	*Barnardius zonarius*	Sighting	-	LC		Inc.	Deep sand plain associated with Site 7
Pratincole, Australian	*Stiltia isabella*	Sighting	-	LC		Inc.	Camp
Quail-thrush Cinnamon	*Cinclosoma cinnamomeum*	Sighting	-	LC		Inc.	Deep sand plain associated with Site 8
Songlark, Brown	*Cincloramphus cruralis*	Sighting	-	LC		3	
Triller, White-winged	*Lalage sueurii*	Sighting	-	LC		1,3,7	
Wagtail, Willie	*Rhipidura leucophrys*	Sighting	-	LC	TS1	5	
Wedgebill, Chiming	*Psophodes occidentalis*	Call	-	LC		8	
Woodswallow, Blackfaced	*Artamus cinereus*	Sighting	-	LC		1,2,3,6	
Woodswallow, Masked	*Artamus personatus*	Sighting	-	LC		1,2,3,4,6,7,8	

Appendix Forty: The preferred habitat, distribution, threatening process and beneficial fire characteristics for significant species that may potentially occur within the Wonarah Project Area.

See Appendix Sixteen for conservation code descriptions.

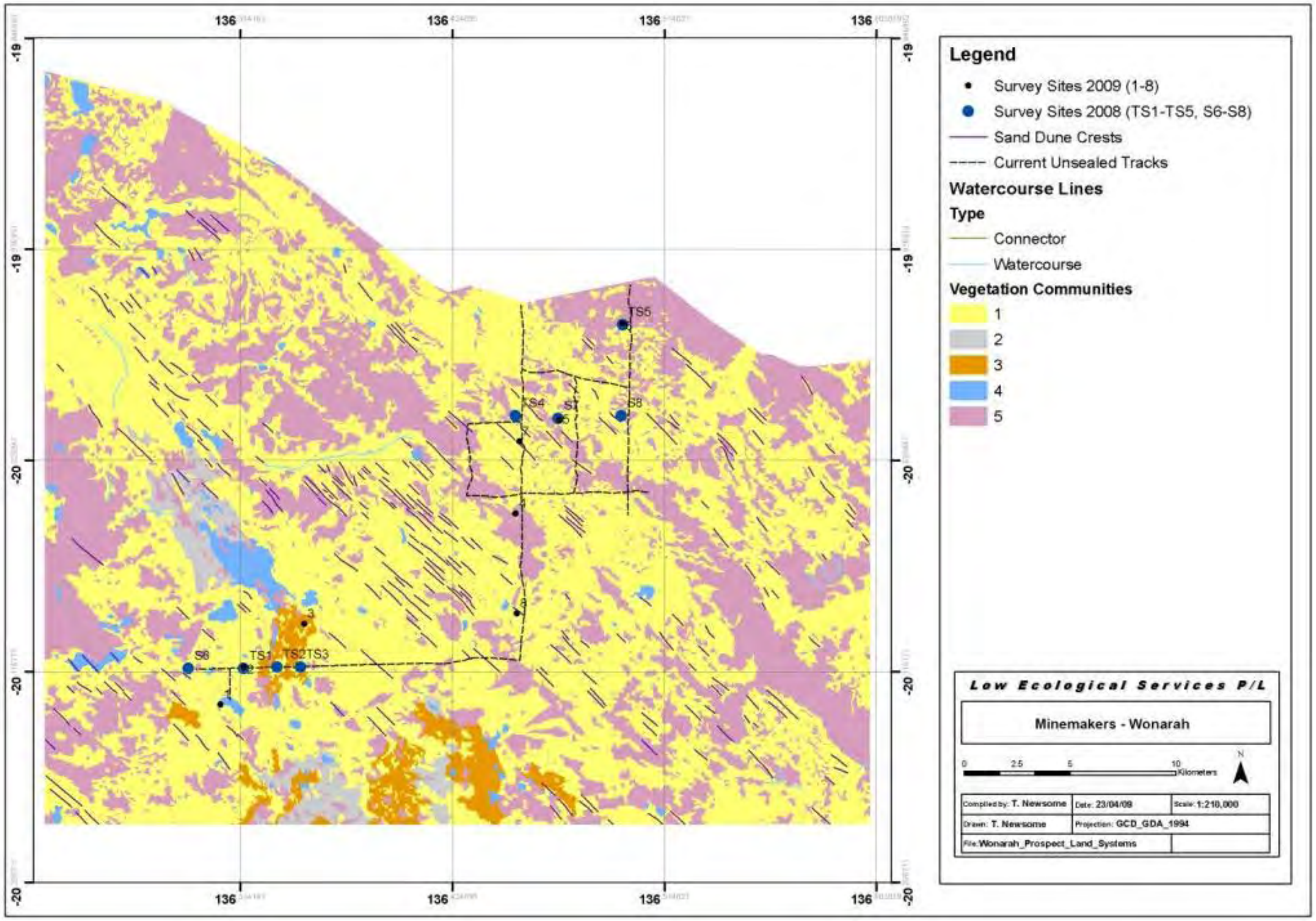
Species	EPBC	TPWC	Preferred Habitat	Threatening processes	Distribution	Fire requirements
Bird						
Ardeotis australis (Australian bustard)		VU	Open grasslands, low shrublands, grassy woodlands and other similar artificial habitats such as crop lands and airfields (Ziembicki 2006)	Predation, altered fire regimes, hunting, disturbance, habitat alteration, pesticides and grazing (Ziembicki 2006)	Away from settlements in part of east inland, inland, northern Aust and W.A. Nomadic, dispersive in response to rainfall; regular movements south in summer & to northern Aust in winter (Pizzey & Knight, 2001).	Often found in recently burnt country. Respond readily to fire which is conducive to their opportunistic diet and reproductive behaviours (Ziembicki 2006)
Epthianura crocea (Yellow chat)	VU\NL	EN\LC	Chenopod shrublands and grasslands around water sources in semi-arid areas		From Roebuck Plains, near Broome (W.A), to Barkly Tablelands (N.T)-Gulf lowlands (Qld), east to approx. Hughenden. Rare. Sedentary; nomadic (Pizzey & Knight, 2001).	
Rostratula australis (Australian painted snipe)	VU	VU	Shallow, vegetated, freshwater swamps, claypans, inundated grassland and temporary wetlands (Taylor *et al*, 2006)	Predominately wetland drainage although habitat degradation by cattle is also possible (Taylor *et al*, 2006)	Mostly south-east Aust, south of Brisbane-Adelaide; scarce & erratic over much of inland, northern Qld, N.T. & coastal W.A.; vagrant Tas.	
Lophoictinia isura (Square-tailed kite)		NT	Heathlands, woodlands, forests; tropical & sub-tropical rainforest; timbered watercourses; hills & gorges (Pizzey & Knight, 2001).		Mostly a non-breeding visitor to coastal & sub-coastal northern Aust but in eastern Qld widely scattered breeding occurs. Sedentary; part-migratory. Rare. (Pizzey & Knight, 2001).	

Species	EPBC	TPWC	Preferred Habitat	Threatening processes	Distribution	Fire requirements
Mammal						
Macrotis lagotis (Bilby)	VU	VU	Sandy soils dominated by hummock grasslands covered predominately by spinifex and an overstorey of low shrub cover dominated by *Acacia* and *Melaleuca*. Often comprises rocky outcrops, lateritic rises and low-lying drainage depressions (Pavey, 2007)	Predation by carnivores (especially European fox), competition with rabbits and grazing by cattle (Pavey 2007). Unsuitable fire regimes may restrict breeding and impede dispersal and colonisation of unoccupied areas. High intensity, uncontrolled wildfires are of particular concern (Pavey 2006)	2 separate geographic areas; 1st extending from the western deserts region of N.T. & W.A. into the Pilbara & Kimberley regions, 2nd into the Channel country of SW Qld. (Pavey, 2007)	Seed promoted by fire is an important dietary requirement. A mosaic of fire ages will increase the chance that a crop of fire promoted plants will occur each year. Bilbies occupy the full spectrum of seral states from recently burnt to long unburnt. (Pavey 2006)
Lagorchestes conspicillatus (Spectacled hare wallaby)		NT	Open forests, open woodland, tall shrublands, tussock grasslands and hummock grasslands. Particularly favours *Acacia shirleyi* /*Macropteranthes kekwickii* thickets with an open understorey (Ingleby and Westoby 1992)	Introduced predators and competitors, pastoralism and alteration to fire regimes (Ingleby 1991)	Extremely patchy. Qld - widespread from Weipa to Dajarra and south to Rolleston, WA - extremely rare, few isolated populations in the Pilbara and Kimberley, NT - Widespread, as far north as 12°S, common in suitable habitat between 16-18°S, rarely occurring south of 21°S (Ingleby 1991)	Frequently feeds in areas regenerating after fire (Ingleby and Westoby 1992)
Onychogalea unguifera (Northern nailtail wallaby)		NT	Open long-grass woodlands, grasslands & shrubby savannah, usually near water.		Northern Australia coast and the 500mm rainfall isohyet. Extends several hundred kilometres inland into North-western Australia although tends to avoid higher rainfall in Arnhemland and the Kimberleys.	
Rattus villosissimus (Long-haired rat)		NT	Mesic, densely vegetated sites (Dickman 1993)	Overgrazing, degradation of vegetation and soil by rabbits and livestock and predation (Dickman 1993)		
Dasycercus cristicauda or *D. blythi* (Crest-tailed mulgara or Brush-tailed mulgara)	EN/VU	VU/VU	Arid and semi arid sandy regions particularly mature hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens* (Masters *et al*. 2003).	Cause of decline unknown. Changes to fire regimes, grazing by introduced herbivores and predation by introduced predators are all likely threatening processes (Pavey *et al*. 2006)	*D. cristicauda* occurs predominately in the Simpson desert & nthn S.A. *D. blythi* occurs from Western & Simpson deserts, with confirmed records in N.T. from Haast Bluff, Uluru, Papunya, Tanami Desert, Illamurta, Charlotte Waters and Crown Point (Woolley, 2005).	

Species	EPBC	TPWC	Preferred Habitat	Threatening processes	Distribution	Fire requirements
Reptile						
Apsidites ramsayi (Woma)		NT	Subhumid to arid interior. Woodlands, heaths and shrublands, often with spinifex, sheltering in abandoned monitor and mammal burrows and soil cracks (Wilson & Swan 2003).	Land-clearing & possible predation by feral animals (Wilson & Swan, 2003).	Northwest coast W.A to Moonie & Tara districts, nthn S.A. & sthn Qld.	
Varanus spenceri (Spencer's monitor)		DD	Treeless, deeply cracking clay plains vegetated with Mitchell grass, sheltering in soil cracks (Wilson & Swan, 2003).	None. Limited data prevents classification of species.	Limited distribution, Barkly Tablelands N.T. into inland S.E. Qld.	

Appendix Forty-one: Vegetation Communities within the Wonarah Project Area

See table below for descriptions



Appendix Forty-one (cont): Vegetation community classifications against land unit boundaries utilising floristic data collected during the Wet Season 2009 LES field survey and species presence data in the NT Flora Atlas (2007).

Veg No.	Land Unit	Veg. Community Name	Dominant flora species
1	Sand Plain (Alluvial Low-lying, Shallow & Deep Sand Plains)	Eucalypt (Coolabah, Mallee & Bloodwood) and Acacia (Dogwood) low open-woodland with Senna sp. low shrublands over hummock grassland.	**Emergent Trees:** *Eucalyptus microtheca, E. victrix, E. setosa, Corymbia opaca* and *Acacia sericophylla.* **Lower Shrub Layer:** *Senna artesmisioides subsp. oligophylla, Gossypium australe* and *A. stipuligera.* **Ground cover:** *Triodia pungens, T. schinzii, Aristida holathera and Yakirra australiensis.*
2	Black soil & Clay plains	Coolabah low-open woodland with Silky browntop (*Eulalia aurea*) and *Aristida* sp. grasslands.	Further surveys conducted due to inaccessibility; however these sites are outside the proposed impact areas.
3	Calcareous Plain	Supplejack low open woodland with open-grassland understorey.	**Emergent Trees:** *Ventilago viminalis* and *Eucalyptus microtheca.* **Ground cover:** *Digitaria brownii* and *Cleome viscosa.*
4	Ephemeral Lake	*E. victrix* (Coolabah) low open-woodland with open-grassland understorey.	**Emergent Trees:** *Eucalyptus victrix.* **Ground cover:** *Whiteochloa airoides*
5	Rocky Rises (Silcrete & Ironstone Rocky Rises & Limestone & Mud Stone Outcrops)	Acacia & mallee shrubland over hummock grassland.	**Emergent Trees:** *Eucalyptus microtheca, E. victrix, Corymbia opaca* and *Acacia sericophylla.* **Upper Shrub Layer:** *E. odontocarpa, E. pachyphylla* **Lower Shrub Layer:** *Acacia hilliana, Grevillea refracta, G. wickhamii* **Ground cover:** *Triodia pungens, T. schinzii, Aristida holathera* and *Yakirra australiensis*

Appendix Forty-two: Flora species list within Land Units and suitable species for rehabilitation

(See also Appendix Four). Based on the NT Flora Atlas (2007) and LES surveys herein. Status is given under the Commonwealth Environment Protection and Biodiversity Act (1999) (EPBC) (amended 2004), Territory Parks and Wildlife Conservation Act (2000) (TPWC) and conservation codes defined by White et al. (2000). See Appendix Eleven for conservation code descriptions.

<u>**Note:**</u> Flora species recorded in each land unit by LES are denoted with an asterisk in the "LES Survey" column. All other species were recorded in the NT Flora Atlas (2007) and were not verified by LES as occurring in the given land unit. There is some discrepancies in the true location of these species and possibly the land units they occur in due to the accuracy of recording location in historic studies as well as the accuracy in transferring between mapping datum's used in the NT Flora Atlas (2007) spatial database.

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
Alluvial Low Lying Sand Plain	*Acacia adoxa var. adoxa*		LC		bioregio nal	TAN (eastern range limit)		good	
	Acacia ancistrocarpa	Fitzroy Wattle, Pirraru	LC				*	good	
Regolith Unit	*Acacia hemignosta*	Club-leaf Wattle	LC		bioregio nal	BRT (souther n range limit)	*		
Active Colluvium / Colluvium over Mudstone	*Acacia hilliana*	Flying-saucer Bush	LC		bioregio nal	CR (souther n range limit)	*	good	
	Acacia melleodora	Waxy Wattle	LC						
	Acacia monticola	Hill Turpentine	LC		bioregio nal	CR (souther n range limit)			
	Acacia sericophylla	Dogwood, Wirewood	LC				*	good	
	Acacia stipuligera	Scrub Wattle, Kurapuka	LC				*	good	
	Amphipogon caricinus var. caricinus	Grey-beard Grass, Long Grey-beard Grass	LC					mod	
	Aristida holathera		LC				*	good	
	Aristida inaequiglumis	Curly Wiregrass, Fire Grass, Unequal Three-awn	LC				*		
	Atalaya hemiglauca	Whitewood	LC				*	good	
	Boerhavia coccinea	Tar Vine	LC				*	good	
	Bonamia media var. media		LC					good	
	Bulbostylis barbata	Short-leaved Rush	LC				*	good	
	Capparis umbonata	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate	LC		bioregio nal	MGD (souther n range limit)	*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Alluvial Low Lying Sand Plain	*Carissa lanceolata*	Conkerberry, Conkle Berry, Kungsberry Bush	LC				*	good	
	Chrysopogon fallax	Golden Beard Grass, Ribbon Grass, Weeping Grass, Spear Grass	LC				*	good	periodically wet areas
	Cleome viscosa	Tickweed, Mustard Bush	LC				*		
	Clerodendrum floribundum	Smooth Clerodendrum, Smooth Spiderbush, Lollybrush, Lolly Bush	NE				*		
	Corymbia deserticola subsp. mesogeotica	Desert Bloodwood	LC		bioregional	MGD (eastern range limit), TAN (northern range limit), GSD (western and southern range limits)			
	Corymbia opaca	Bloodwood	LC				*		
	Crotalaria medicaginea var. neglecta	Clover-leaf Rattlepod, Trefoil Rattlepod	LC					good	
	Crotalaria novae-hollandiae		LC				*		
	Crotalaria novae-hollandiae subsp. lasiophylla	New Holland Rattlepod	LC						
	Cyperus bulbosus	Yalka, Nutgrass	LC					good	periodically wet areas
	Digitaria brownii	Cotton Panic Grass	LC					good	
	Dodonaea coriacea	Hopbush	LC				*	good	
	Ehretia saligna		LC				*	good	
	Eragrostis cumingii	Fairy Grass, Cumings Lovegrass	LC				*		
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*	good	
	Eremophila latrobei	Native Fuchsia, Latrobes Desert Fuchsia, Georgina Poison Bush	LC				*	good	
	Eriachne aristidea		LC				*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Alluvial Low Lying Sand Plain	*Eriachne mucronata*	Mountain Wanderrie	LC				*	good	
	Eucalyptus chlorophylla	Green-leaf Box	LC					good	
	Eucalyptus leucophloia	Snappy Gum, Migum	LC				*	good	
	Eucalyptus microtheca	Coolibah	LC				*	good	
	Eucalyptus odontocarpa	Sturt Creek Mallee	LC		bioregional	GSD (southern range limit)	*	good	
	Eucalyptus victrix	Smooth-barked Coolibah, Ghost Gum Coolibah, Gum-barked Coolibah	LC		bioregional	MGD (eastern range limit)	*	good	
	Eulalia aurea	Silky Browntop, Sugar Grass	LC				*	good	
	Euphorbia comans		LC				*		
	Euphorbia tannensis	Caustic Bush, Desert Spurge	LC				*		
	Evolvulus alsinoides var. villosicalyx		LC				*		
	Exocarpos sparteus	Slender Cherry, Broombush	LC		bioregional	DMR (northern range limit)			
	Fimbristylis ammobia		LC		bioregional	MGD (eastern range limit)	*	good	periodically wet areas
	Fimbristylis oxystachya	Lukarrara	LC				*	good	periodically wet areas
	Gomphrena lanata		LC				*	good	
	Goodenia armitiana	Narrow-leaved Goodenia	LC					good	
	Goodenia heterochila	Serrated Goodenia	LC					good	
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*	good	
	Grevillea juncifolia	Desert Grevillea, Honey Grevillea, Honeysuckle Grevillea	LC				*		
	Grevillea refracta	Silver-leaf Grevillea	LC				*	good	
	Grevillea refracta subsp. refracta	Silver-leaf Grevillea	LC					good	
	Grevillea wickhamii	Holly-leaf Grevillea	LC				*	good	
	Grevillea wickhamii subsp. aprica	Holly-leaf Grevillea	LC		bioregional	CR (southern range limit)			
	Hakea macrocarpa	Flat-leaved Hakea	LC		bioregional	SSD (souther	*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
						n range limit)			
Alluvial Low Lying Sand Plain	*Heliotropium glanduliferum*		LC				*		
	Hibiscus leptocladus	Variable-leaf Hibiscus	LC					good	
	Indigofera linifolia	Native Indigo	LC				*		
	Indigofera trita		LC		bioregio nal	BRT (disjunct)			
	Jacquemontia browniana		LC				*		
	Keraudrenia integrifolia		LC				*	good	
	Keraudrenia nephrosperma		LC					good	
	Lipocarpha microcephala	Button Rush	LC						
	Marsdenia australis		LC				*		
	Melaleuca lasiandra	Sandhill Tea-tree	LC				*	good	periodical ly wet areas
	Melaleuca viridiflora	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark	LC					good	periodical ly wet areas
	Melhania oblongifolia	Velvet Hibiscus	LC					good	
	Mirabilia viminalis		LC				*	good	
	Paraneurachne muelleri	Spinifex Couch, Northern Mulga Grass	LC				*	good	
	Petalostylis cassioides	Butterfly Bush, Petalostylis	LC				*	good	
	Polycarpaea spirostylis	Copper Plant	LC				*		
	Portulaca filifolia	Slender Pigweed	LC				*	good	
	Psydrax attenuata var. myrmecophila forma myrmecophila		LC					good	
	Ptilotus fusiformis	Skeleton plant	LC				*	good	
	Ptilotus polystachyus	Long Pussy-tails	LC				*	good	
	Rhynchosia minima	Native Pea, Rhynchosia	LC				*	good	
	Rulingia loxophylla	Desert Fire Weed	LC				*	good	
	Scaevola amblyanthera		LC				*		
	Scaevola ovalifolia	Bushy Fanflower	LC		bioregio nal	GSD (western range limit)			
	Scaevola parvifolia	Fanflower	LC				*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Alluvial Low Lying Sand Plain	*Schizachyrium fragile*	Firegrass, Red Spathe Grass, Small Red-leaf	LC				*	good	
	Sclerolaena costata		LC		bioregional	CHC (eastern range limit)	*	good	
	Sebastiania chamaelea		LC				*		
	Senna notabilis		LC					good	
	Setaria surgens	Brown Pigeon Grass	LC		bioregional	GSD (southern range limit)	*	good	
	Spermacoce dolichosperma		LC				*	good	
	Tephrosia sp Barrow Creek		LC				*		
	Tephrosia stuartii		LC		bioregional	DMR (eastern range limit)		good	
	Trianthema pilosa		LC				*	good	
	Trianthema triquetra	Red Spinach	LC				*	good	
	Tribulopis angustifolia		LC				*	good	
	Tribulus eichlerianus	Bindieye	LC					good	
	Triodia pungens	Soft Spinifex, Gummy Spinifex	LC				*	good	
	Triodia schinzii	Feathertop Spinifex	LC				*	good	
	Triumfetta deserticola		DD		Northern Territory	3k			
	Ventilago viminalis	Supplejack, Vine Tree	LC					good	
	Waltheria indica		LC				*	good	
	Whiteochloa airoides		LC				*	good	
	Yakirra australiensis	Desert Flinders Grass	LC				*	good	
	Zornia albiflora		LC		bioregional	GSD (southern range limit)	*	good	
Land Unit: Black Soil Plain **Regolith Unit** Black Soil	*Digitaria brownii*	Cotton Panic Grass	LC						Land unit occurs distal to proposed works
	Goodenia heterochila	Serrated Goodenia	LC						
	Ventilago viminalis	Supplejack, Vine Tree	LC						
	Zornia albiflora		LC		bioregional	GSD (southern range limit)			

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Land Unit: Calcareous Plain **Regolith Unit** Colluvium over Dolomite	*Acacia ancistrocarpa*		LC				*		
	Acacia hemignosta	Club-leaf Wattle	LC		bioregional	BRT (southern range limit)	*		
	Aristida contorta	Bunched Kerosene Grass, Mulga Grass	LC				*		
	Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*		
	Aristida inaequiglumis	Curly Wiregrass, Fire Grass, Unequal Three-awn	LC				*		
	Astrebla pectinata	Barley Mitchell Grass	LC				*		
	Atalaya hemiglauca	Whitewood	LC				*		
	Boerhavia coccinea	Tar Vine	LC				*		
	Capparis umbonata	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate	LC		bioregional	MGD (southern range limit)	*		
	Carissa lanceolata	Conkerberry, Conkle Berry, Kungsberry Bush	LC				*		
	Cenchrus ciliaris	Buffel Grass	INT				*		
	Cleome viscosa	Tickweed, Mustard Bush	LC				*		
	Corymbia opaca	Bloodwood	LC				*		
	Crotolaria medicaginea		LC				*		
	Cucumis maderaspatanus	Head-ache Vine	LC				*		
	Dactyloctenium radulans	Button Grass, Finger Grass, Toothbrush Grass	LC				*		
	Enneapogon polyphyllus	Woolly Oat-grass, Oat-grass, Leafy Nine-awn	LC				*		
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*		
	Eucalyptus microtheca	Coolibah	LC				*		
	Eulalia aurea	Silky Browntop, Sugar Grass	LC				*		
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*		
	Heliotropium ovalifolium		LC				*		
	Indigofera linifolia	Native Indigo	LC				*		
	Perotis rara	Comet Grass	LC						

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
Calcareous Plain	*Portulaca filifolia*	Slender Pigweed	LC				*		
	Portulaca oleracea	Pigweed, Common Purslane, Munyeroo	LC				*		
	Salsola tragus	Buckbush, Rolypoly, Tumbleweed	LC				*		
	Setaria surgens	Brown Pigeon Grass	LC		bioregio nal	GSD (souther n range limit)	*		
	Swainsonia sp.		LC				*		
	Tribulopis angustifolia		LC						
	Tribulus eichlerianus	Bindieye	LC				*		
	Triodia intermedia	Winged Spinifex	LC		bioregio nal	DMR (disjunct and eastern range limit), BRT (disjunct and souther n range limit)	*		
	Triodia pungens	Soft Spinifex, Gummy Spinifex	LC				*		
	Triraphis mollis	Purple Plumegrass, Purple Heads, Needle Grass	LC				*		
	Urochloa piligera	Hairy Armgrass, Hairy Summer Grass, Green Summer Grass	LC						
	Ventilago viminalis	Supplejack, Vine Tree	LC				*		
	Whiteochloa cymbiformis		LC						
Land Unit: Deep Sand Plain **Regolith Unit:** Deep Aeolian Sand Deposits	*Abutilon otocarpum*	Keeled Lantern-bush, Desert Chinese Lantern, Desert Lantern	LC				*	good	
	Acacia coriacea		LC						
	Acacia hemignosta	Club-leaf Wattle	LC		bioregio nal	BRT (souther n range limit)	*		
	Acacia lysiphloia	Turpentine, Turpentine Bush, Turpentine Wattle	LC		bioregio nal	GSD (disjunct and souther n range limit)		good	
	Acacia	Dogwood,	LC				*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
	sericophylla	Wirewood							
Deep Sand Plain	*Acacia stipuligera*	Scrub Wattle, Kurapuka	LC				*	good	
	Amphipogon caricinus	Grey-beard Grass, Long Grey-beard Grass	LC				*	good	
	Aristida contorta	Bunched Kerosene Grass, Mulga Grass	LC				*	good	
	Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*	good	
	Astrebla pectinata	Barley Mitchell Grass	LC				*		
	Atalaya hemiglauca	Whitewood	LC				*	good	
	Bonamia alatisemina		DD		national	3K			
	Bulbostylis barbata	Short-leaved Rush	LC				*	good	periodical ly wet areas
	Corchorus sidoides	Flannel Weed	LC				*	good	
	Corymbia setosa		LC				*		
	Distichostemon barklyanus		DD		Norther n Territor y	3k			
	Ehretia saligna s.lat.	Coonta, False Cedar, Peachwood, Peachbush	NE				*		
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*	good	
	Eriachne aristidea	Three-awn Wanderrie	LC				*	good	
	Eucalyptus leucophloia	Snappy Gum, Migum	LC				*	good	
	Eucalyptus odontocarpa	Sturt Creek Mallee	LC		bioregio nal	GSD (souther n range limit)	*	good	
	Eucalyptus pachyphylla	Red-bud Mallee	LC		bioregio nal	DMR (norther n range limit)	*	good	
	Eucalyptus victrix	Smooth-barked Coolibah, Ghost Gum Coolibah, Gum-barked Coolibah	LC		bioregio nal	MGD (eastern range limit)	*	good	
	Evolvulus alsinoides var. decumbens	Blue Periwinkle, Tropical Speedwell	LC				*		
	Fimbristylis ammobia		LC		bioregio nal	MGD (eastern range		good	periodical ly wet areas

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
						limit)			
Deep Sand Plain	*Fimbristylis oxystachya*	Lukarrara	LC				*	good	periodically wet areas
	Fimbristylis simulans		LC		bioregional	DMR (eastern range limits)	*	good	periodically wet areas
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*	good	
	Gossypium sturtianum	Sturts Desert Rose	LC				*	good	
	Grevillea refracta	Silver-leaf Grevillea	LC				*	good	
	Grevillia wickhamii	Northern Corkwood, Bootlace Tree, Bull Hakea, Whistling Tree	LC					good	
	Heliotropium glanduliferum		LC				*		
	Ipomoea costata	Bush Potato, Potato Vine, Desert Yam	LC				*	good	
	Melaleuca lasiandra	Sandhill Tea-tree	LC				*	good	
	Melaleuca viridiflora	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark	LC					good	
	Pandorea doratoxylon	Spearwood, Wonga Vine, Spearbush	LC				*	good	
	Paraneurachne muelleri	Spinifex Couch, Northern Mulga Grass	LC				*	good	
	Polycarpaea spirostylis	Copper Plant	LC				*		
	Ptilotus fusiformis	Skeleton plant	LC				*	good	
	Ptilotus polystachyus	Long Pussy-tails	LC				*	good	
	Santalum lanceolatum	Plumbush, Wild Plum					*	good	
	Scaevola parvifolia	Fanflower	LC				*	good	
	Schizachyrium fragile	Firegrass, Red Spathe Grass, Small Red-leaf	LC				*	good	
	Senna notablis	Cockroach Bush	LC				*	good	
	Setaria surgens	Brown Pigeon Grass	LC		bioregional	GSD (southern range limit)	*	good	
	Sida filiformis	Fire Sida, Fine Sida	LC				*	good	
	Spermacoce dolichosperma		LC				*		
	Stackhousia 'Mt Leibig'		LC				*		
	Swainsona burkei		LC		bioregio	TAN			

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
					nal	(western range limit)			
	Tephrosia lasiochlaena		LC				*		
Deep Sand Plain	*Tephrosia sp. Barrow Creek (G.M.Chippendale 921)*		LC		bioregional	GSD (southern range limit)	*		
	Tribulopis angustifolia		LC				*		
	Trichodesma zeylanicum	Cattle Bush, Camel Bush	LC				*		
	Triodia pungens	Soft Spinifex, Gummy Spinifex	LC					good	
	Triodia schinzii	Feathertop Spinifex	LC				*	good	
	Triumfetta centralis		LC		bioregional	SSD (eastern range limit)	*		
	Urochloa sp.		LC				*		
	Ventilago viminalis	Supplejack, Vine Tree	LC				*	good	
	Yakirra australiensis	Desert Flinders Grass	LC				*	good	
Land Unit:	*Acacia lysiphloia*	Turpentine, Turpentine Bush, Turpentine Wattle	LC		bioregional	GSD (disjunct and southern range limit)			no mining in these areas
Ephemeral Lakes	*Aeschynomene indica*	Budda Pea, Kath Sola					*		
Regolith Unit:	*Ammannia multiflora*	Jerry Jerry	LC				*		
Alluvium	*Aristida contorta*	Bunched Kerosene Grass, Mulga Grass	LC				*		
	Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*		
	Aristida inaequiglumis	Curly Wiregrass, Fire Grass, Unequal Three-awn	LC				*		
	Bergia ammannioides	Water-fire	LC		bioregional	BRT (apparently rare), SSD (disjunct)			
	Bergia barklyana		nt		national	3R	*		
	Bergia trimera	Small Water-fire	LC						
	Blumea tenella		LC						
	Boerhavia coccinea	Tar Vine	LC						
	Cajanus		LC						

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
	marmoratus								
Ephemeral Lakes	*Calandrinia pumila*	Tiny Purslane, Tiny Parakeelya	LC						
	Calotis porphyroglossa	Channel Burr-daisy	LC						
	Capparis umbonata	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate	LC		bioregional	MGD (southern range limit)	*		
	Cleome viscosa	Tickweed, Mustard Bush					*		
	Crotalaria medicaginea var. neglecta	Clover-leaf Rattlepod, Trefoil Rattlepod	LC						
	Cullen cinereum	Annual Verbine	LC						
	Cuscuta victoriana		LC						
	Cyperus bifax	Downs Nutgrass	LC		bioregional	MAC (disjunct)			
	Cyperus iria		LC						
	Dactyloctenium radulans	Button Grass, Finger Grass, Toothbrush Grass	LC				*		
	Enchylaena tomentosa	Ruby Saltbush, Sturts Saltbush, Plum Puddings, Berry Cottonbush	LC						
	Enneapogon pallidus	Conetop Nine-awn, Pale Bottlewasher	LC						
	Enneapogon polyphyllus	Woolly Oat-grass, Oat-grass, Leafy Nine-awn	LC				*		
	Eragrostis falcata	Sickle Lovegrass	LC				*		
	Eremophila latrobei	Native Fuchsia, Latrobes Desert Fuchsia, Georgina Poison Bush	LC				*		
	Eremophila longifolia	Emu Bush, Weeping Emu Bush, Long-leaved Desert Fuchsia	LC				*		
	Eucalyptus coolabah subsp. arida	Coolabah	LC		bioregional	TAN (tentative western range limit)			
	Eucalyptus microtheca	Coolibah	LC				*		
	Fimbristylis dichotoma	Eight Day Grass, Common Fringe-rush	LC				*		
	Fimbristylis microcarya		LC						
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*		

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Ephemeral Lakes	*Heliotropium ovalifolium*		LC						
	Indigofera linnaei	Birdsville Indigo, Nine-leaved Indigo	LC				*		
	Ipomoea coptica		LC						
	Isoetes muelleri	Quillwort	LC		bioregional	DMR (disjunct and apparently rare)			
	Leptochloa fusca	Beetle Grass	LC				*		
	Leptochloa fusca subsp. fusca	Small-flowered Beetle Grass	LC						
	Lysiana spathulata	Flat-leaved Mistletoe	LC						
	Neptunia dimorphantha	Sensitive Plant, Nervous Plant	LC						
	Neptunia gracilis	Native sensitive grass	LC				*		
	Paspalidium rarum	Bunch Paspalidium	LC				*		
	Portulaca filifolia	Slender Pigweed	LC				*		
	Portulaca oleracea	Pigweed, Common Purslane, Munyeroo	LC				*		
	Psydrax latifolia	Native Currant, Orange Bush	LC				*		
	Rothia indica subsp. australis		LC		southern NT	(disjunct and apparently rare)			
	Sida cunninghamii		LC						
	Solanum coactiliferum	Western Nightshade	LC				*		
	Solanum tumulicola	Black-soil Wild Tomato	LC						
	Sporobolus latzii		DD		national	1K			
	Streptoglossa adscendens		LC						
	Teucrium integrifolium	Green Germander	LC		bioregional	TAN (disjunct and western range limit)	*		
	Trianthema pilosa		LC						
	Trianthema triquetra	Red Spinach	LC				*		
	Whiteochloa airoides		LC				*		
Land Unit: Ironstone Rocky Rise	*Acacia adoxa*		LC				*	good	
	Acacia drepanocarpa subsp. latifolia		LC						
	Acacia hilliana		LC				*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Ironstone Rocky Rise	*Acacia lysiphloia*	Turpentine, Turpentine Bush, Turpentine Wattle	LC		bioregional	GSD (disjunct and southern range limit)	*	good	
Regolith Unit: Ferrugnous Duricrust	*Acacia monticola*	Hill Turpentine	LC		bioregional	CR (southern range limit)	*		
	Acacia stipuligera	Scrub Wattle, Kurapuka	LC				*	good	
	Amyema sanguinea var. sanguinea	Blood Mistletoe	LC						
	Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*	good	
	Bulbostylis barbata	Short-leaved Rush	LC				*	good	
	Cleome viscosa	Tickweed, Mustard Bush	LC				*		
	Corchorus sidoides	Flannel Weed	LC				*	good	
	Cucumis maderaspatanus	Head-ache Vine	LC				*		
	Dicrastylis gilesii		LC				*	good	
	Eragrostis cumingii	Fairy Grass, Cumings Lovegrass	LC				*	good	
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*	good	
	Eucalyptus leucophloia	Snappy Gum, Migum	LC				*	good	
	Eucalyptus odontocarpa	Sturt Creek Mallee	LC		bioregional	GSD (southern range limit)	*	good	
	Euphorbia comans		LC				*		
	Evolvulus alsinoides var. villosicalyx	Blue Periwinkle, Tropical Speedwell	LC						
	Goodenia ramelii		LC				*	good	
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*	good	
	Grevillea refracta	Silver-leaf Grevillea	LC				*	good	
	Grevillea refracta subsp. refracta	Silver-leaf Grevillea	LC					good	
	Grevillea wickhamii	Holly-leaf Grevillea	LC				*	good	
	Hakea macrocarpa	Flat-leaved Hakea	LC		bioregional	SSD (southern range limit)	*	good	
	Haloragis		LC					good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
	uncatipila								
Ironstone Rocky Rise	*Heliotropium ballii*		DD		Northern Territory	3k			
	Heliotropium glanduliferum		LC				*		
	Heliotropium pulvinum		DD		Northern Territory	3K	*		
	Hibiscus brachychlaenus		NT		Northern Territory	3R	*		
	Hybanthus aurantiacus		LC				*		
	Indigofera linifolia	Native Indigo	LC				*		
	Ipomoea costata	Bush Potato, Potato Vine, Desert Yam	LC				*	good	
	Keraudrenia integrifolia		LC				*	good	
	Melaleuca viridiflora	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark	LC					good	
	Mirbelia viminalis	Yellow Broom	LC					good	
	Portulaca filifolia	Slender Pigweed	LC				*	good	
	Portulaca oleracea	Pigweed, Common Purslane, Munyeroo	LC				*	good	
	Ptilotus calostachyus var. calostachyus	Weeping Mulla Mulla	LC					good	
	Ptilotus fusiformis	Skeleton Plant	LC				*	good	
	Rulingia loxophylla	Desert Fire Weed	LC				*	good	
	Schizachyrium fragile	Firegrass, Red Spathe Grass, Small Red-leaf	LC				*	good	
	Senna notablis	Cockroach Bush	LC				*	good	
	Setaria surgens	Brown Pigeon Grass	LC		bioregional	GSD (southern range limit)	*	good	
	Sida arenicola		LC				*	good	
	Sida fibulifera	Silver Sida, Pin Sida	LC				*	good	
	Sida filiformis	Fire Sida, Fine Sida	LC				*	good	
	Spermacoce dolichosperma		LC				*		
	Spermacoce hillii		LC						
	Themeda triandra	Kangaroo Grass	LC					good	
	Triodia pungens	Soft Spinifex,	LC				*	good	

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
		Gummy Spinifex							
Ironstone Rocky Rise	*Triumfetta centralis*		LC		bioregio nal	SSD (eastern range limit)			
	Urochloa sp.		LC				*		
	Yakirra australiensis	Desert Flinders Grass	LC				*	good	
Land Unit: Limestone Outcrop **Regolith Unit:** Oucropping Dolomitic Facies	No Survey Sites Present								
Land Unit: Mudstone Outcrop **Regolith Unit:** Outcropping Hangingwall Mudstone	No Survey Sites Present								
Land Unit:	*Abutilon otocarpum*		LC				*		
Shallow Sand Plain	*Acacia ancistrocarpa*	Fitzroy Wattle, Pirraru	LC				*	good	
	Aerva javanica	Kapok Bush, Snow Bush	Int.				*		
Regolith Unit:	*Aristida holathera*	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*	good	
Stabilised Aeolian Sand	*Aristida inaequiglumis*	Curly Wiregrass, Fire Grass, Unequal Three-awn	LC				*		
	Astrebla pectinata	Barley Mitchell Grass	LC						
	Atalaya hemiglauca	Whitewood	LC				*	good	
	Atriplex elachophylla		LC				*	good	
	Boerhavia coccinea	Tar Vine	LC				*	good	
	Capparis umbonata	Northern Wild Orange, Wild Orange, Bush Orange, Native Pomegranate	LC		bioregio nal	MGD (souther n range limit)	*	good	
	Carissa lanceolata	Conkerberry, Conkle Berry, Kungsberry Bush	LC				*	good	
	Cenchrus ciliaris	Buffel Grass	INT				*	introduced species and not recommend ed	
	Chrysopogon	Golden Beard	LC				*	good	

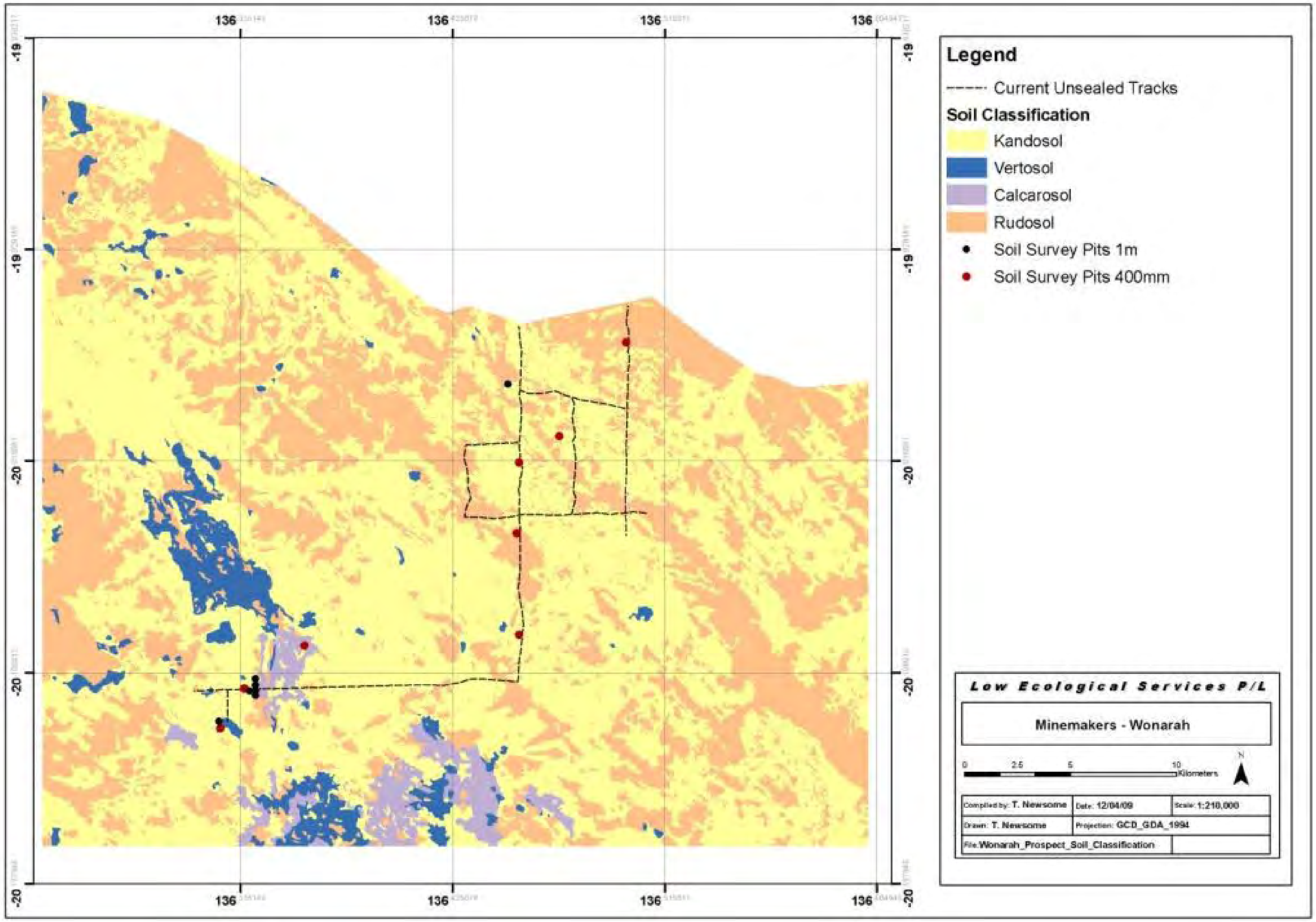
Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
	fallax	Grass, Ribbon Grass, Weeping Grass, Spear Grass							
Shallow Sand Plain	*Cleome viscosa*	Tickweed, Mustard Bush	LC				*		
	Crotalaria medicaginea		LC					good	
	Dactyloctenium radulans	Button Grass, Finger Grass, Toothbrush Grass	LC				*	good	
	Digitaria brownii		LC				*	good	
	Enneapogon polyphyllus	Woolly Oat-grass, Oat-grass, Leafy Nine-awn	LC				*	good	
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*	good	
	Eremophila latrobei	Native Fuchsia, Latrobes Desert Fuchsia, Georgina Poison Bush	LC				*	good	
	Eremophila longifolia	Emu Bush, Weeping Emu Bush, Long-leaved Desert Fuchsia	LC				*	good	
	Eucalyptus gamophylla	Blue Mallee, Twin-leaved Mallee, Blue-leaved Mallee	LC		bioregio nal	TAN (norther n range limit)	*	good	
	Eucalyptus microtheca	Coolibah	LC				*	good	
	Eulalia aurea	Silky Browntop, Sugar Grass	LC				*	good	
	Gossypium australe	Native Cotton, Tall Desert Rose	LC					good	
	Heliotropium ovalifolium		LC					good	
	Indigofera linifolia	Native Indigo	LC				*		
	Indigofera colutea		LC				*		
	Portulaca oleracea	Pigweed, Common Purslane, Munyeroo	LC				*	good	
	Psydrax latifolia	Native Currant, Orange Bush	LC				*	good	
	Ptilotus polystachyus	Long Pussy-tails	LC				*	good	
	Scaevola amblyanthera		LC				*	good	
	Scaevola ovalifolia	Bushy Fanflower	LC		bioregio nal	GSD (western range limit)		good	
	Senna artesmisioides ssp. oligophylla		LC				*	good	
	Tephrosia sp Barrow Creek		LC				*		

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
Shallow Sand Plain	*Tephrosia brachyodon*	Red Pea-bush	LC				*		
	Tephrosia lasiochlaena		LC		bioregional	MAC (southern range limit)			
	Trianthema pilosa		LC				*	good	
	Triodia intermedia	Winged Spinifex	LC		bioregional	DMR (disjunct and eastern range limit), BRT (disjunct and southern range limit)		good	well drained sites
Land Unit: Silcrete Rocky Rise **Regolith Unit:** Silcrete Breccia Duricrust	*Acacia adoxa*		LC				*	good	
	Acacia hilliana		LC				*	good	
	Acacia lysiphloia	Turpentine, Turpentine Bush, Turpentine Wattle	LC		bioregional	GSD (disjunct and southern range limit)		good	
	Acacia monticola	Hill Turpentine	LC		bioregional	CR (southern range limit)			
	Amphipogon caricinus	Grey-beard Grass, Long Grey-beard Grass	LC				*	good	
	Aristida holathera	Erect Kerosene Grass, White Grass, Arrow Grass	LC				*	good	
	Brunonia australis	Pincushion, Blue Pincushion	LC				*		
	Bulbostylis barbata	Short-leaved Rush	LC				*	good	
	Cassytha capillaris	Hairless Dodder-laurel, Snotty Gobble	LC				*		
	Corchorus sidoides	Flannel Weed	LC				*	good	
	Corymbia opaca	Bloodwood	LC				*	good	
	Corymbia setosa		LC				*		
	Eragrostis cumingii	Fairy Grass, Cumings Lovegrass	LC				*	good	
	Eragrostis eriopoda	Woollybutt Grass, Naked Woollybutt, Wire Wanderrie Grass, Never Fail	LC				*	good	
	Eragrostis eriopoda subsp.		LC						

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Requirements
	Sandy fireweed (P.K.Latz 12908)								
Silcrete Rocky Rise	*Eucalyptus odontocarpa*	Sturt Creek Mallee	LC		bioregional	GSD (southern range limit)	*	good	
	Eucalyptus pachyphylla	Red-bud Mallee	LC		bioregional	DMR (northern range limit)	*	good	
	Eucalyptus pruinosa	Silver Box, Silver-leaf Box, Apple Box, Smoke Tree	LC				*		
	Fimbristylis simulans		LC		bioregional	DMR (eastern range limits)	*	good	wet areas
	Goodenia armitiana	Narrow-leaved Goodenia	LC				*	good	
	Goodenia ramelii		LC				*	good	
	Goodenia strangfordii		LC		bioregional	MGD (southern range limit)		good	
	Gossypium australe	Native Cotton, Tall Desert Rose	LC				*	good	
	Grevillea dryandri subsp. dryandri	Dryanders Grevillea	LC					good	
	Grevillea refracta	Silver-leaf Grevillea	LC				*	good	
	Hakea lorea	Long-leaf Corkwood, Corkbark Tree	LC				*	good	
	Hakea macrocarpa	Flat-leaved Hakea	LC		bioregional	SSD (southern range limit)		good	
	Heliotropium pulvinum		DD		Northern Territory	3K			
	Hybanthus aurantiacus		LC				*		
	Melaleuca viridiflora	Green Paperbark, Broad-leaved Paperbark, Large-leaved Paperbark	LC					good	
	Paraneurachne muelleri	Spinifex Couch, Northern Mulga Grass	LC				*	good	
	Petalostylis cassioides	Butterfly Bush, Petalostylis	LC				*	good	
	Polycarpaea spirostylis	Copper Plant	LC				*		
	Ptilotus calostachyus	Weeping Mulla Mulla	LC				*		
	Ptilotus calostachyus var. calostachyus	Weeping Mulla Mulla	LC						
	Ptilotus fusiformis	Skeleton plant	LC				*		

Land Unit	Species Name	Common Name	TPWC	EPBC	SSOBS level	SSOBS code	LES Survey	Rehab potential	Special Require ments
Silcrete Rocky Rise	*Ptilotus polystachyus*	Long Pussy-tails	LC				*	good	
	Schizachyrium fragile	Firegrass, Red Spathe Grass, Small Red-leaf	LC				*	good	
	Senna notabilis	Cockroach Bush	LC					good	
	Senna venusa	Graceful Cassia	LC				*	good	
	Setaria surgens	Brown Pigeon Grass	LC		bioregio nal	GSD (souther n range limit)	*	good	
	Sida filiformis	Fire Sida, Fine Sida	LC				*	good	
	Solanum chippendalei	Bush Tomato, Ngaru	LC					good	
	Spermacoce dolichosperma		LC				*		
	Triodia pungens	Soft Spinifex, Gummy Spinifex	LC				*	good	
	Triodia schinzii	Feathertop Spinifex	LC				*	good	
	Urochloa sp.		LC				*		
	Yakirra australiensis	Desert Flinders Grass	LC				*	good	

Appendix Forty-three: Soil map for the Wonarah prospect area.



Appendix Forty-four: Road building techniques for arid Australia to mitigate soil degradation.

Soil Erosion Recommendations

The susceptibility of soils and topography to potential erosion is outlined in Section 5.7. To protect the project area techniques must be utilised to minimise the risk of erosion and subsequent sedimentation; topography, drainage, soil erosion risk and vegetation all need to be considered. With any change in land use it is important to understand the impact altered drainage may have on the surrounding environment. When planning the development it is essential to have an understanding of the existing natural drainage not only on the site, but also in the surrounding catchment. Operations such as road building and clearing for construction can cause localized erosion such as sheet wash or gullying even on very gentle slopes. Major constructed drainage or formalized drainage, such as table and mitre drains, should not be required if careful consideration is given to the following issues:

- Identify any natural waterways (eg. drainage lines, creeks and rivers).
- Ensure receiving waterways and habitats are protected from the impacts of runoff (e.g. using buffer zones, filter strips).
- Ensure crossfall drainage is incorporated into roads. It is important that water can move across the roads unimpeded. Allowing natural cross flow will reduce the likelihood of erosion, sedimentation, ponding and water starvation of downslope vegetation.
- Ensure that the surfaces of roads are never below natural ground level. Roads constructed below ground level intercept natural sheet flows and watercourses, concentrating them and directing flows away from their natural paths.
- Ensure windrows are not created. Windrows concentrate and divert natural overland water flows causing erosion and sedimentation.

Soil erosion risk

While some types of soils are more susceptible to erosion than others, all areas cleared of vegetation are at risk of either water or wind erosion. Wind erosion of disturbed areas is of particular concern in the arid areas of the NT. Wind erosion may lead to permanent degradation and initiate a cycle of increased erosion and instability.

It is therefore desirable that the amount of soil exposed should be minimised at any one time. If extensive clearing is unavoidable, all land which is not to be used before the onset of the wet season in the tropical regions, or summer in the arid and semiarid regions should be stabilised. This should be done in advance of the onset of rainfall.

No works should be undertaken during or shortly after a rainfall event. The use of machinery on wet soils causes compaction and rutting, ultimately leading to an increased possibility of initiating erosion. All works should be suspended until the work area has dried out.

Site management

Timing and duration of construction

When planning construction it is recommended that a timeline be developed which takes into consideration all of the activities that will be undertaken. This is to ensure that the proposed commencement and completion dates are achievable and that disturbed areas which are temporary or not for immediate use are rehabilitated, or at least stabilised in the interim, prior to October in the tropics, and as soon as possible in the arid and semi-arid regions where rain is more unpredictable. If the development is of a scale where works will not be completed prior to this time, consideration should be given to staging the proposed works. Staging can reduce the cleared, disturbed or modified area to a more manageable size. It is important to remember that the larger the disturbed area, the more management and maintenance will be required to ensure erosion and subsequent sedimentation is minimised.

Erosion and sediment controls

The main issue, for erosion and sediment control, is to minimise disturbance of soil, vegetation and drainage during construction, and to promote site restoration following disturbance. Some factors which need to be taken into account when designing drainage or erosion control works are:

- The slopes, soil types, rainfall regime and vegetation present.
- River and creek crossings.
- Presence of existing erosion.
- The estimated maximum flows from expected rainfall events.
- Inspection and maintenance of control structures until the area becomes stable.
- Identification and flagging riparian vegetation to be avoided.
- Maintenance of cross flow (to prevent down slope water starvation). Drainage and erosion control can be achieved using a number of different techniques. Selection of a technique and the design of control structures need to be carefully considered to ensure the site are protected from erosion.
- Diversion banks should be constructed based on the degree of slope and erosion risk.

- Runoff is to be dispersed onto stabilised areas.
- Areas of construction identified as high erosion risk may require additional measures.
- Cleared vegetation is not to be pushed into drainage lines.

Supplies and stockpiles

There are a few basic methods which can significantly reduce erosion of stockpiles and supplies and stop sediment entering waterways.

- Try to locate all stockpiles in a central area, on an open flat area and away from drainage lines and creeks.
- It is good practice for all stockpiles, no matter where they are located, to have controls such as sediment fencing installed a few metres from the base. This will minimise the risk of sediment leaving the stockpile area during rain events.
- All site debris and unused materials should be removed from the site.

Techniques for Erosion Control

Below are a number of structures and techniques which are commonly used to control erosion and sediment movement. Depending on the individual situation and the nature of the issue which requires control, only some of the measures may be suitable to a specific situation. Commonly used structures and techniques for erosion and sediment control are detailed below.

Temporary measures

Please note that some of the following temporary measures are only implemented in the tropical regions of the NT. In the arid and semi-arid regions only permanent measures are used.

- Diversion banks
- Sediment fence
- Coir logs

Permanent measures

- Diversion banks

Maintenance

Monitoring should be carried out on a regular basis. It is good practice to monitor the effectiveness of erosion and sediment controls regularly throughout the duration of the development, even in periods of dry weather. A standard monitoring schedule should include checks as follows:

- At weekly intervals.
- Following each rain event after the ground has dried out (in the arid and semi-arid regions).
- Following each storm event (in the tropical region).

Maintenance schedule

There are a number of actions that should be incorporated into a maintenance schedule during construction and throughout the life of the project. These include:

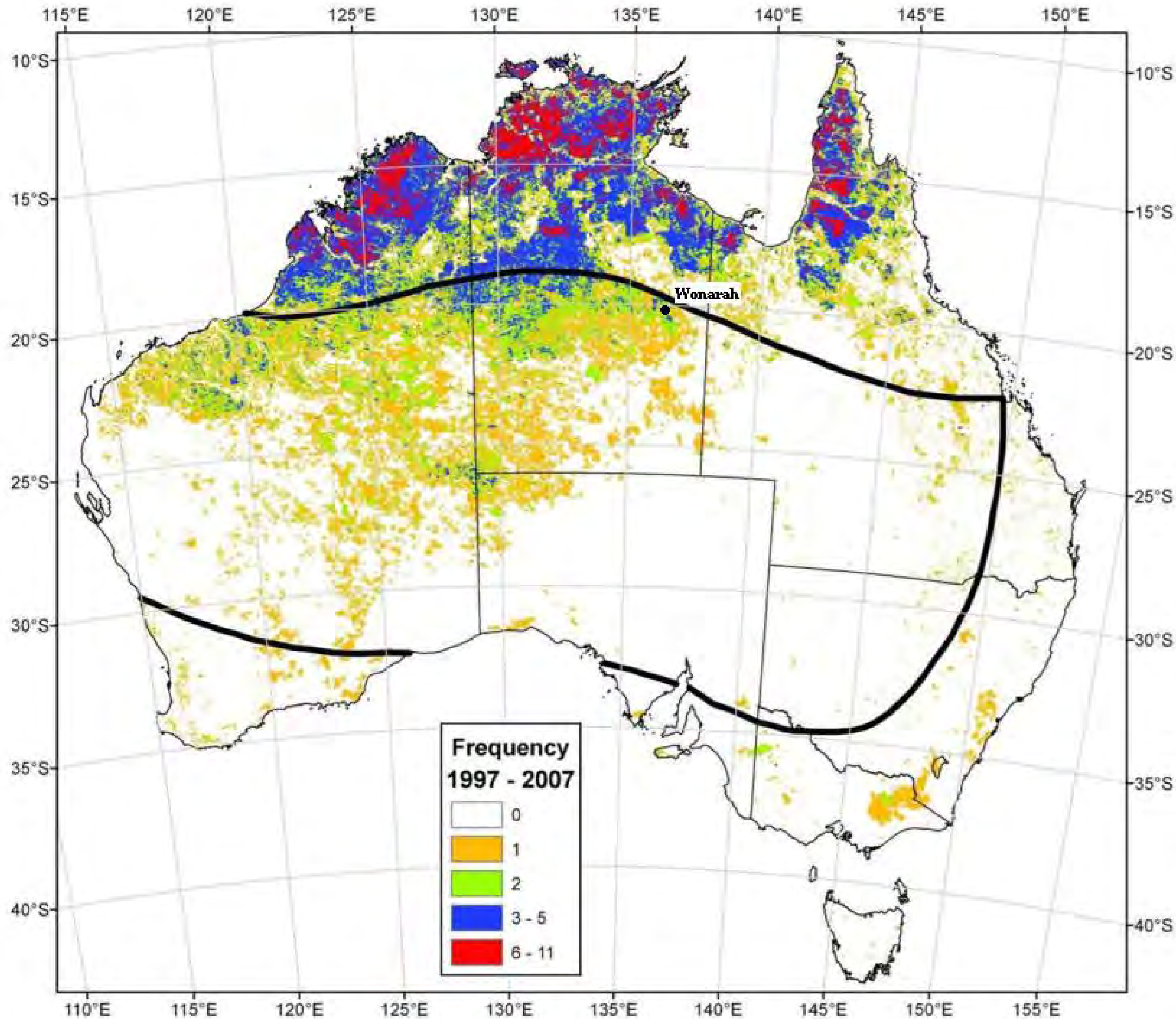
- Repair erosion control structures if and when necessary.
- Ensure that natural drainage is maintained down slope of disturbed areas by using whoa boy dispersion banks and off let drains to facilitate cross road drainage.

It is important to note that workers do NOT attempt to tidy up areas that are currently well vegetated or stable. This will unnecessarily leave new areas exposed.

Appendix Forty-five: Winrows located within the Wonarah Phosphate Project area.

Winrows were recorded during the Wet Season 2009 survey. These were located along the existing exploration track between the Main and Arruwurra prospects, within the Shallow Sand Plain land unit at coordinates (S20.11501 E136.38703). Winrows trap water and prevent natural drainage and their formation should be avoided. Whoah boy diversion banks and off let drains should be installed to facilitate cross road drainage.

Appendix Forty-six: Fire frequency within Australia between 1997 and 2007. Source: NT Bushfires Council.



Appendix Forty-seven: Rio Tinto's procedure for protecting Sporobolus latzii on the Wonarah tenements.

Background
Sporobolus latzii is potentially located on RTE-AR Wonarah tenements. The characteristics of this species are:

Significance
National 1K

Life Form
Erect perennial grass

Habitat
Known to occur in seasonal swamps with clay soils.

Distribution
May be endemic to the study region. Known only from a single location in the Wakaya Desert, in the east of the Tanami Bioregion.

Notes
Little known about this recently described species. Need to search areas of similar habitat to determine the conservation status of the species.

Issues
Due to the poor taxonomic recording of *Sporobolus latzii* the species is classed as having conservation significance. The only collected specimen was on a seasonal swamp clay area in the Wakaya Desert region, on the eastern portion of the Tanami Bioregion. The RTE-AR Wonarah tenement area is located in this region. Therefore, it is important that all RTE-AR activities conducted in this region do not disturb the habitat and communities of *Sporobolus latzii*.

Field Procedure
Habitat Identification
A ground survey will be conducted with maps to identify the potential habitats where the species are found. This will involve ground truthing the areas, identified on maps, located on the RTE-AR tenements as clay pan seasonal swamps habitat types. These areas will be clearly demarcated and recorded. Monitoring stations will be set up at these sites according to ENVT104 Site Monitoring.

Field Personnel Induction
It is fundamental that all personnel in the field are made aware of the situation. All personnel will be:
• Briefed on the conservation significance of *Sporobolus latzii*.
• Provided with a description of the plant
• Made familiar with the designated 'no-go areas' on the tenement

Appendix Forty-eight: Managing Dingoes within the proposed Wonarah Phosphate Project (WPP).

Minemakers Australia Pty Ltd (Minemakers) proposes to establish the Wonarah Phosphate Project (the project) to mine phosphate rock, in the Barkly region, Northern Territory. This will require establishment of a mine camp. Without appropriate strategic management, it is likely that the WPP will attract dingoes, affect these animals' natural behaviour and lead to negative human-dingo interactions. This is because dingoes are naturally inquisitive and opportunistic animals, and because many local dingoes conceivably already associate human activity with the provision of key resources.

The guiding principle for effective dingo management within the WPP should be:
No food, water or shelter for dingoes

Adherence to this principle by staff, contractors and visitors will significantly reduce the likelihood of negative interactions between humans and dingoes. To avoid likely problems developing in the future, this principle must be incorporated into the planning, construction and operational phases of the WPP. Proactive management of food, water and shelter availability will reduce future problems.

<u>Food Management</u>

No human-provided food should be available to dingoes.

Recommended Actions – WPP Planning Phase:

- Ensure supply of sufficient wildlife-proof bins to manage waste securely during the construction and operational phases.
- Ensure adequate waste removal and processing during the construction and operational phases.
- Provide staff time and resources to ensure that food management actions can be implemented during the construction and operational phases.
- Ensure agreements with staff and contractors include full compliance with food management actions during the construction and operational phases.

Recommended Actions – WPP Construction Phase:

- Make appropriate waste management a condition of working on and/or visiting the WPP site.

- Specifically, ensure that staff, contractors and visitors do not provide food directly, or indirectly, to dingoes or other wildlife.
- Install wildlife-proof bins on-site prior to the commencement of construction activity.
- Position bins appropriately relative to construction activity to increase likelihood of use.
- Ensure that all food/drink rubbish is immediately placed in the wildlife-proof bin.
- Remove food-drink rubbish to existing burn-tips on a schedule that prevents bins overflowing.
- Ensure staff and contractors perform a daily clean-up of their work areas to prevent dingoes from accessing food/drink rubbish.
- Minemakers should perform weekly inspections of construction areas to ensure staff, contractors and visitors comply with the waste management strategy.

Recommended Actions – WPP Operational Phase:

- Ensure staff, contractors and visitors do not provide food directly, or indirectly, to dingoes or other wildlife.
- Install wildlife-proof bins on-site prior to human habitation/operation. Provide areas where food and/or drink is likely to be consumed with additional wildlife-proof bins, e.g. outside dry mess, wet mess, BBQ areas etc.
- Actively encourage all staff, contractors and visitors to place food/drink rubbish in these bins.
- Remove all rubbish to landfills/processing areas daily, or more regularly if necessary, to prevent bins from overflowing.
- Schedule regular camp-wide clean-ups within the staff roster.
- Minemakers should regularly inspect the camp to ensure that personal items, such as boots, gloves, clothes etc. are not left outside rooms.
- Minemakers should constantly review compliance with the waste management strategy across the entire WPP site.

Water Management

Water management should focus on preventing water becoming available rather than preventing animals from accessing available water.

Recommended Actions – WPP Planning Phase:

- Provide staff and resources to ensure that water management actions can be implemented during the construction and operational phases.
- Ensure agreements with staff and contractors include full compliance with water management actions during the construction and operational phases.
- Ensure staff and contractors are aware of the requirement to seek approval from the Senior Environmental Officer to accumulate water in dams, ponds, open tanks etc.
- Ensure provision is made for dispersal of water resulting from leaking taps, cracked pipes, etc.

Recommended Actions – WPP Construction and Operational Phases:

- Ensure appropriate water management is made a condition of working on and/or visiting the WPP.
- Specifically, staff, contractors and visitors must not provide water directly, or indirectly, to dingoes or other wildlife.
- Ensure water is not accumulated (for example in dams, ponds, open tanks, troughs, or similar holdings) without prior approval from the Senior Environmental Officer. Such approval should be dependent upon both: i) necessity, and ii) a viable strategy for not attracting dingoes or other wildlife.
- Ensure leaks, e.g. dripping taps/pipes are fixed as a high priority.
- Ensure water that accumulates as a result of leaks (e.g. from dripping taps, cracked pipes etc.) is dispersed to facilitate rapid evaporation/infiltration.
- Ensure Minemakers regularly inspect the site to ensure staff, contractors and visitors comply with water management actions.

Shelter Management

Available shelter provides an incentive for dingoes to use an area, especially females seeking den sites. Minemakers should ensure that artificial shelter is not readily available to dingoes on the WPP site. Effective barriers will be important for preventing adult and juvenile dingoes from entering spaces underneath buildings. In designing and installing barriers, animal welfare must be a high priority, e.g. ensure there are no sharp edges or opportunities to become entangled or trapped.

Recommended Actions – WPP Planning Phase:

- Design the WPP to minimise opportunities for providing shelter to dingoes.

- In particular, provide staff time and resources to ensure that shelter management actions can be implemented during the construction and operational phases.
- Ensure agreements with staff and contractors include full compliance with shelter management actions during the construction and operational phases.

Recommended Actions – WPP Construction and Operational Phases:

- Ensure that (when it is practical to do so) building materials are stacked/stored so that shelter is not created for dingoes.
- Ensure building waste that could provide shelter to dingoes is removed regularly. In the interim any such waste should be stacked/arranged to limit its attractiveness to dingoes.
- Ensure that barriers preventing dingoes entering spaces underneath buildings are installed and regularly maintained.
- Hazing of dingoes (i.e. scaring dingoes to deter them from the area) should only undertaken by Minemakers with the approval of the Senior Environmental Officer.
- Minemakers regularly audit the site to ensure staff, contractors and visitors comply with the shelter management strategy.

APPENDIX F NT EPA PRE-REFERRAL SCREENING REPORT

Pre-Referral Screening Report

Wonarah Phosphate Project

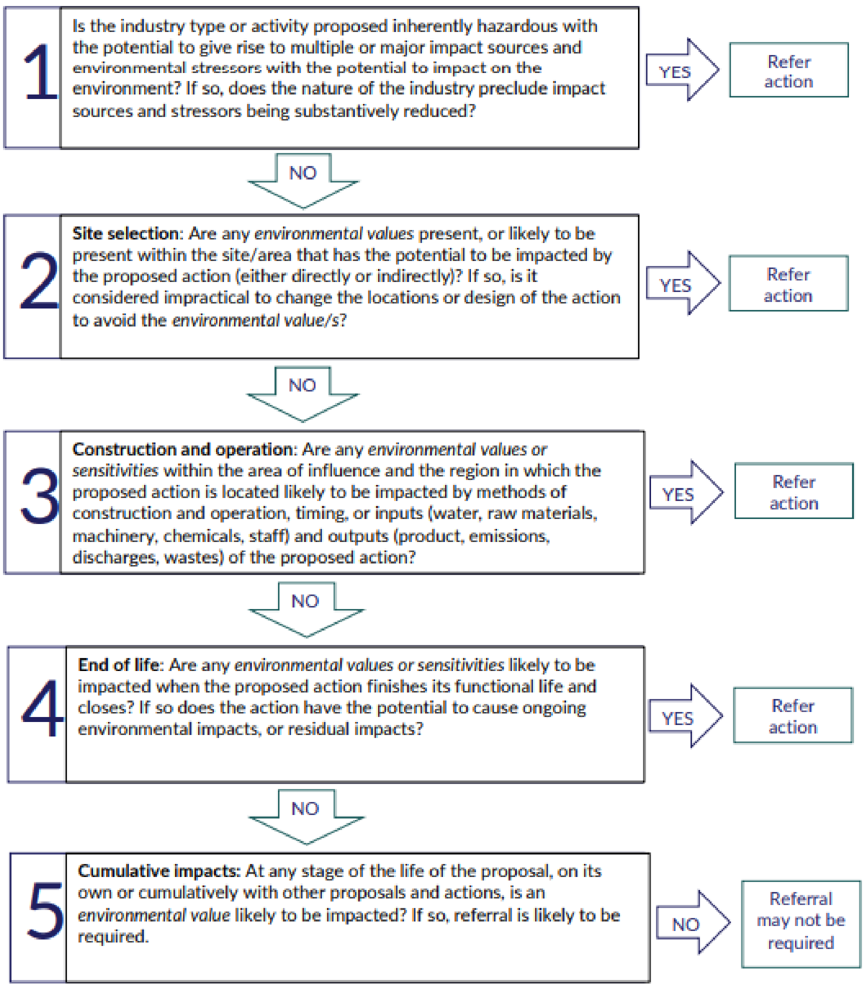
The NT EPA have developed a pre-referral screening tool to assist proponents determine whether their Proposal has potential to have a significant impact on the environment and therefore requires referral under the *Environment Protection Act* 2019. The tool is also used to identify the key environmental factors that are relevant to a Proposal that may require more detailed consideration during site selection and project planning. The tool has two parts:

- Part 1 – Screening Questions
- Part 2 – Answer Checklist

The tool is provided in the *Guideline – Referring a Proposal to the NT EPA* https://ntepa.nt.gov.au/publications-and-advice/environmental-management.

EcOz Environmental Consultants were engaged by Avenira Limited to undertake pre-referral screening of Wonarah Phosphate Project – Bulk test sample. The screening was undertaken with reference to the screening questions shown in Figure 1 and the results are documented in Table 1 below.

Figure 1. Pre-screening tool screening questions (Source: NT EPA 2021)



During 2010, Wonarah Phosphate Project underwent assessment under the *Environmental Assessment Act 1982* (redacted, now the *Environmental Protection Act 2019)*. The Wonarah Phosphate Project Environmental Impact Statement (WPP EIS), encompassed mining of the two deposits, known as 'Wonarah' and 'Arruwurra'.

Upon NT EPA review of the WPP EIS, Assessment Report 64 was issued, stating:

> *"Based on its review of the draft EIS, Supplement and responses submitted to the assessment process, the Environment Heritage and Arts Division of the Department of Natural Resources, Environment, the Arts and Sport considers that the project can be managed without unacceptable environmental impacts. This is provided that the project as proposed, including all proposed management mechanisms, environmental commitments and recommendations detailed in the draft EIS, the Supplement, this Assessment Report and in the final management plans, are implemented and managed under the Mining Management Plan for the Project, and are subject to regular reporting and compliance auditing to the Department of Resources."*

The proposed bulk test sample is stage 1.1 of a proposed longer term project pending bulk test sample success and future direct shipping ore mining management plan (MMP) approvals. The proposed bulk test sample, haul road realignment and grade control activities proposed in the Wonarah Phosphate Project Bulk Test Sample MMP are within the constraints of the approved WPP EIS, and no significant changes outside of this scope are identified.

Table 1. Pre-referral screening tool checklist prepared for Wonarah Phosphate Project – Bulk Test Sample Mining Management Plan

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions	Q1	Q2	Q3	Q4	Q5	Comments on whether or not referral required
				Yes No	☐ ☒					
Land	**Landforms** Objective: Conserve the variety and integrity of distinctive physical landforms.	• The Wonarah Phosphate Project is located on the undulating plains of the Barkly Tableland within the Davenport and Murchison Ranges Bioregion. Across the Barkly Tableland there is generally only a very gentle relief that varies less than 50 m in elevation from the highest to lowest point. The landscape of the project area has a general low relief, although small rocky outcrops are locally common. There are few natural features of note in the project area, other than the rocky outcrops and some termite mounds.	• No distinct natural landforms.	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • No distinct natural landforms are present in the proposal footprint area or area of influence.
Land	**Terrestrial Environmental Quality** Objective: Protect the quality and integrity of land and soils so that environmental values are supported and maintained.	• <100 ha of land and soils will be disturbed by land clearing and development for the bulk sample activities. • Semi-arid environment average rainfall 300-400mm/yr. No receiving drainage lines within the Project area. Runoff and sedimentation limited. • Soil types suitable for landuse – existing Arruwurra Pit from 2009 bulk test sample from previous operator (Minemakers). No obvious erosion or sedimentation issues presenting on satellite imagery beyond disturbance footprint of existing infrastructure. • Proposed disturbance footprint flat to <2% slope • One distinctive soil class within the project area: By4 - composed of undulating ridge and slope terrain on lateritic sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts (> 60%) of mixed and variable gravels or ironstone gravels, and also uniform coarse sands with some gravels on ridges and upper slopes generally. Kandosols and Rudosols dominate the sand plains within the project area. • Erodibility of soils was assessed through combining erosivity potentials of classified soils in accordance with descriptions of arid land soils and topography. Most soils were found to have low erodibility potentials, except deep soils (mostly Rudosols with loose rock aggregations) on slopes. • Waste rock storages will be vulnerable to erosion and sediment mobilisation in the short and long term by wind and seasonal rains • Vegetation sparce, already existing naturally exposed soils • Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit. • No acid sulfate soils present • The geochemistry assessment conducted by EGI (2009) demonstrated waste rock on site is non-acid forming and unlikely to result in AMD, however some elements occur at elevated concentrations. EGI recommended PO4, F and Be are included in site water monitoring programs.	• Waste rock storages will be vulnerable to erosion and sediment mobilisation in the short and long term by wind and seasonal rains.	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • Land clearing disturbance footprint is minimal (<100 ha) in comparison to the proposed disturbance footprint in the EIS (2326 ha), 4.3% of the proposed disturbance footprint for the proposed bulk test sample stage 1-1. Thus limited impacts from erosion and sedimentation • Hydrocarbon spill managed through Company procedures and implementing Australian standards. • Geochemical characterisation of waste and ore is non-acid forming and unlikely to result in AMD. Drainage will be monitored. • Waste dump designed to limit erosion and sedimentation (maximum height 20m) and final contoured 14-degree slope with berms every 10 vertical meters that are 3.7m wide.

	Terrestrial Ecosystems Objective: Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• Land clearing proposed disturbance footprint is <100 ha. • The main vegetation community of the project area is described as Eucalyptus opaca, (bloodwood) low open woodland with Triodia pungens (soft spinifex) hummock grassland understorey (Wilson et al. 1990). This particular vegetation community covers 28095.3 km2 in the Northern Territory (Wilson et al. 1990), of which the project area constitutes <0.004% of this area. FLORA: • No vegetation communities or flora species listed under the EPBC Act identified in the project area during field surveys or desktop assessment. • No vegetation communities listed under the TPWC Act were recorded in the project area. • Species of conservation significance communities listed under the TPWC Act that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas's) include flora species *Bonamia alatisemina, Distichostemon barklyanus, Heliotropium ballii, Heliotropium pulvinum, Sporobolus latzii, Triumfetta deserticola, Bergia barklyana* and *Hibiscus brachychlaenus.* • Project area lies within the 'Wonarah Beds' Site of Botanical Significance (SOBS). 6.7% of the Wonarah Beds SOBS is overlain by the MLs. Of this <0.07% will be within the proposed disturbance footprint if of the areas of the Wonarah Beds SOBS. • White et al. (2000) note that there is the potential for a number of species of conservation significance occurring within the Wonarah Beds SOBS. Land unit mapping derived suggested that *Sporobolus latzii* occurs within the ephemeral lakes land unit, the largest of which occurs to the north of the Arruwurra prospect. This area is currently within a cultural exclusion zone which prevents mining activities within the area, limiting the likelihood of works impacting upon this known record. Furthermore, proposed works are located away from the ephemeral lake land unit thus minimising impacts on this species potentially occurring elsewhere in this land unit (LES 2009). • Two environmental weed species, Cenchrus ciliaris (buffel grass) and Aerva javanica (kapok bush) were recorded during the LES 2009 survey. While these species are not listed under the Northern Territory's *Weeds Management Act*, buffel grass has led to a degradation of native habitats along drainage systems in central Australia. FAUNA: • No habitats of ecological significance were recorded during LES field surveys in the project area • Species of conservation significance that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas's) include fauna species, Australian bustard (*Ardeotis australis*), northern nailtail wallaby (*Onychogalea*	• Flora and fauna species of conservation significance under the TPWC Act identified within the project area. • Potential for a number of species of conservation significance occurring within the Wonarah Beds SOBS.	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger NT referral: • Eight flora species of significance (i.e. with near threatened or data deficient conservation codes) under the TPWC Act were recorded during LES field surveys and in the NT Flora Atlas. Of these species, the SOBS conservation codes, as defined by White et al. (2000), suggest that only *Sporobolus latzii* may be reliant on the project area for its continued persistence; however the known record is within a cultural exclusion zone associated with the ephemeral lake land unit which will not be disturbed by mining operations. • LES field surveys did not identify any flora species of high conservation value under the TPWC Act and most of the plants and associated vegetation communities are widespread throughout the region (Baker et al., 2005). • Fauna species of conservation significance recorded within the project area are mobile and not correlated to land units within the project area. Thus, the proposed, small, localised disturbance is not likely to affect the status of these species. • Mitigative measures outlined in LES (2009) to be implemented (fire management, feral animals, weeds, pre-clearance surveys, education of workforce for ID of threatened species, minimising clearing especially near drainage lines, progressive rehabilitation, monitoring programs). Does not trigger EPBC referral: • No protected migratory species have been identified within the project area or surrounding region in on-sight investigations including LES field surveys and the NT Fauna Atlas, though eight migratory bird species are listed by DEWHA in the EPBC Act as potentially occurring in the area. As there are no large drainage channels or drainage basins within the project area or surrounding region, there is not a significant amount of potential habitat for these species in the area, although ephemeral areas may be important in good seasons. Hence, migratory avifaunas are only likely to appear during significant wet seasons when rainfall is large enough to cause local flood events (LES 2009). • No fauna species listed under the EPBC Act were recorded within the Wonarah Phosphate Project area • No listed threatened ecological communities or flora were recorded within the Wonarah Phosphate Project area, • LES field surveys did not identify any flora species of high conservation value under the EPBC Act and most of the plants and associated vegetation communities are widespread throughout the region (Baker et al., 2005).

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions						Comments on whether or not referral required
					Q1	Q2	Q3	Q4	Q5	
				Yes No	☐ ☒					
		unguifera), long-haired rat (*Rattus villosissimus*) and woma (*Aspidites ramsayi*).								
Water	**Hydrological Processes** <u>Objective:</u> Protect the hydrological regimes of groundwater and surface water so that environmental including ecological health, land uses and the welfare and amenity of people are maintained.	Surface water • No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit. • No physical works proposed in any waterway • No surface water extraction proposed • Seasonally flooded swamps occur in the southwest of the project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding. Contributing factors to such extensive flooding include Arruwurra deposit located in a topographic low; within a large upstream catchment area of the watercourse and the lack of discernible channel. • There is no major water storage, diversion or supply infrastructure or current surface water licences within the vicinity of the Project area. Any water use is for stock watering, with groundwater resources providing the main water source in the region. Groundwater • Proposed bulk test pit depth is shallow (21 m) • Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated. Dewatering requirements are therefore likely to be negligible. Seepage rates will be low (0.02 to 0.2 L/s). • Water demand for the bulk test sample stage 1.1 is estimated a maximum of 8L/s. Groundwater extraction licence will be applied for under the Water Act. • Minor groundwater supplies found within in the vicinity of the Arruwurra deposit. • Good groundwater supplies were identified north of the Barkley Hwy with maximum bore yields of about 20 L/s. • The Wunara Community is the closest populated area to the project (approx.10 km to the east of ML33343 boundary), sourcing groundwater for use/potable supply. • A number of other bores are located along the Barkley Hwy for NTG use – roads. • North of the Barkley Hwy is pastoral land where bores are used for stock and domestic use.	• The Project is located within the Daly Roper Beetaloo Water Control District Declared Beneficial Use for Agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater. • Potential for seasonal flooding in the Arruwurra area	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: <u>Pit dewatering from groundwater</u> • The risk of pit inundation from groundwater inflow is low. A survey of groundwater levels in the vicinity of Arruwurra and the Main Zone have identified water table levels below the base of the ore, apart from a few isolated locations that show evidence of minor perched water bodies. <u>Pit dewatering from infiltrating and incident rainfall / flooding:</u> • Duration: Bulk test sample stage 1.1 is short term (~3mths). • Pit depth is shallow (21m). • Controlling strategies comprise installation of suitable flood management infrastructure (internal drainage system, sumps and sump pumps) and the maintenance of adequate ore stockpiles to provide sufficient time to dewater the pit(s) should this be necessary. • Waste dump and haul road positioned to protect pit and infrastructure from potential flooding. • Main flood mitigation works will be undertaken for larger scale operational DSO MMP. Proposed bulk test sample is slightly larger scale of already existing infrastructure (pit and waste dump) constructed in 2009 and has had no flooding issues experienced in this time. <u>Groundwater extraction:</u> • Will be managed through a groundwater extraction licence under the Water Act

Pre-Referral Screening Report

Wonarah Phosphate Project

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions						Comments on whether or not referral required
					Q1	Q2	Q3	Q4	Q5	
				Yes No	☐ ☒					
	Inland Water Environmental Quality Objective: Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	Surface water • No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit. • No physical works proposed in any waterway • No surface water extraction proposed • Seasonally flooded swamps occur in the southwest of the project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding. Contributing factors to such extensive flooding include Arruwurra deposit located in a topographic low; within a large upstream catchment area of the watercourse and the lack of discernible channel. • There is no major water storage, diversion or supply infrastructure or current surface water licences within the vicinity of the Project area. Any water use is for stock watering, with groundwater resources providing the main water source in the region. • Proposed ~20,000L bulk fuel storage onsite. • No magazine / explosives storage proposed for bulk test sample stage 1.1. • No wastewater discharges proposed. • ARD is not a concern for the project. However, there are some elements that occur at elevated concentrations in waste rock and non-DSO. Although their solubilities are expected to be low, phosphate, fluorine and beryllium will be included in site water quality monitoring programs. • Form of phosphate present in waste rock is insoluble, and eutrophication of water supplies as a result of rock phosphate entering surface water storages would be highly unlikely. Groundwater • Groundwater quality is fresh to brackish with elevated concentrations of iron and silica in the northern bores and at Arruwurra; boron was also high in the camp bore. • Groundwater monitoring program to be implemented.	• The Project is located within the Daly Roper Beetaloo Water Control District Declared Beneficial Use for Agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater. • Potential for seasonal flooding in the Arruwurra area	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • Land clearing disturbance footprint is minimal (<100 ha) in comparison to the proposed disturbance footprint in the EIS (2326 ha), 4.3% of the proposed disturbance footprint for the proposed bulk test sample stage 1-1. Thus limited impacts from erosion and sedimentation • Hydrocarbon spill managed through Company procedures and implementing Australian standards. • Geochemical characterisation of waste and ore is non-acid forming and unlikely to result in AMD. Drainage will be monitored.
	Aquatic Ecosystems Objective: Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit. • No physical works proposed in any waterway • No surface water extraction proposed	• No aquatic ecosystems present within or close to the project area	Yes No Uncertain N/A		☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	Does not trigger referral: • No aquatic ecosystems present within or close to the project area
Sea	**Coastal Processes** Objective: Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.	• Project located greater than 450km (direct) to nearest marine environment / estuary	• Not applicable	Yes No Uncertain N/A		☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	Does not trigger referral: • Project located greater than 450km (direct) to nearest marine environment / estuary
	Marine Environmental Quality Objective: Protect the quality and productivity of water, sediment and			Yes No		☐ ☐	☐ ☐	☐ ☐	☐ ☐	

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions						Comments on whether or not referral required
					Q1	Q2	Q3	Q4	Q5	
				Yes No	☐ ☒					
	biota so that environmental values are maintained.			Uncertain N/A		☐ ☒	☐ ☒	☐ ☒	☐ ☒	
	Marine Ecosystems Objective: Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.			Yes No Uncertain N/A		☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	☐ ☐ ☐ ☒	
Air	**Air Quality** <u>Objective:</u> Protect air quality and minimise emissions and their impact so that environmental values are maintained.	• Land clearing footprint is <100 ha – potential dust emissions • Operation of plant and equipment – GHG emissions	Sensitive receptors • Closest neighbour is the Wunara Community, approx.10 km to the east of ML33343 boundary and approx. 34 km to the northeast of the Arruwurra deposit. • The closest cultural sensitive receptor is outside of the project disturbance footprint. • The closest township is Tennant Creek, 240 km west of the project • The closest service area is the Barkley Homestead roadhouse is located ~75 km directly to the NW of the Project area.	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • Scale – land clearing disturbance footprint is minimal (<100 ha) in comparison to the proposed disturbance footprint in the EIS (2326 ha), 4.3% of the proposed disturbance footprint for the proposed bulk test sample stage 1-1. • Duration – project schedule is ~3 months • Extent – limited excavation of pit – from 2.8 ha existing disturbance to 1.1 Ha proposed additional disturbance and to 21m depth. Waste dump current extent is 2 ha, and proposed expansion of 8.1 ha. • Project area is a brown fields site - existing disturbance footprint is ~40 ha. Use of existing disturbance areas where possible to minimise additional disturbance. • Dust manageable through dust suppression activities with use of pit water and groundwater
	Atmospheric Processes <u>Objective:</u> Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.	• Operation of plant and equipment – GHG emissions	• Will not exceed Large Emitters thresholds	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • Limited GHG emissions due to limited clearing, short duration of the bulk test pit and limited plant and equipment in operations during this period.
People	**Communities and Economy** <u>Objective:</u> Enhance communities and the economy and foster resilience to a changing climate, for the welfare, amenity and benefit of current and future generations of Territorians.	• Use of local business and employment for duration of the Project • Local employment (approximately 46 employees total) proposed for stage 1.1. Pending success of bulk test sample and future DSO MMP approvals, the project is intended to be ongoing for a number of years and increase number of employees. • Use of existing on-site accommodation for workforce • Social and emergency services to be resourced from the area.	• The closest township is Tennant Creek, 240 km west of the project • The closest service area is the Barkley Homestead roadhouse is located ~75 km directly to the NW of the Project area. • The Wunara Community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 10 km to the east of ML33343 boundary and approx. 34 km to the northeast of the Arruwurra deposit. • Project located immediately south of the Barkly Highway • Project will create a small number of local jobs • Increased traffic on Barkly Highway – haulage from site to Tennant Creek / nearby railway siding	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • Impact negligible to local community due to short duration and small extent of the project • Limited impact to traffic from the Project area to the Port due to short duration (~3mts) • Creation of some local jobs and business opportunities that could extend in the future pending outcome of test batch and future DSO MMP approvals. • Limited impact to social and emergency services due to short duration of the Project.

Pre-Referral Screening Report

Wonarah Phosphate Project

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions						Comments on whether or not referral required
					Q1	Q2	Q3	Q4	Q5	
				Yes No	☐ ☒					
	Culture and Heritage Objective: Protect sacred sites, culture and heritage	• Direct disturbance - Land clearing footprint is <100 ha (maximum) • Project located on Aboriginal land (NT enhanced freehold) Arruwurra Aboriginal Corporation (AAC). • Historical AAPA Certificate (C2010/261) did not identify any sacred sites within the subject land. Avenira are in the process of updating the AAPA Certificate to cover the proposed subject land for the proposed activities as existing Certificate is no longer valid. • Archaeological survey (Hill, 2009) identified six low density silcrete knapping areas. Of these, one is of moderate scientific significance (~4km NE of the Arruwurra deposit) and the remaining five are of low scientific significance. The AW1 site is determined as being of moderate conservation significance as it is located within a sacred site restricted area and not near any proposed disturbances. The remaining sites (AW2, AW3, AW4, AW5, AW6) are determined to be of low significance. Management recommendations for Arruwurra sites are to apply for consent under the *NT Heritage Act* for all ground disturbing works within 30 metres of all silcrete outcrops. AW2 is the only site within 30m of the proposed haul road realignment area. • The ephemeral lakes within the cultural exclusion zones (located outside of the MLs) are considered as an important hunting ground as they provide seasonal refuge to larger species. • Through the CLC, consultation with Traditional Owners identified six sacred sites close to the project area. These sites have consequently been incorporated into cultural exclusion zones. No infrastructure or activities related to the project is to occur in these cultural exclusion zones. All of these cultural exclusion zones are located outside of the Mineral Lease. A search of the Aboriginal Areas Protection Authority (AAPA) Heritage Database identified two additional registered sites, north of the Barkly Highway, outside of the project area. • A search of the Australian Heritage Database and the NT Heritage Register identified no sites of non-Indigenous cultural heritage within the project area	• No sacred sites or cultural exclusion zones identified within disturbance areas. • One Aboriginal archaeological site identified within 30m of proposed road realignment.	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • AAPA Certificate application for proposed disturbance area. AAC will be involved in the surveys. • Avenira will seek consent under the NT Heritage Act for all ground disturbing works within 30 metres of all silcrete outcrops. • Management agreement to be in place prior to any disturbance works between Avenira and the AAC. Commitment to ongoing consultation with AAC Traditional Owners and NTG throughout life of Mine to determine appropriate end land use and closure objective.

Pre-Referral Screening Report

Wonarah Phosphate Project

Theme	Factor and Objective	Background information (about the project)	Environmental values, sensitivities (based on desktop and/or surveys)	Pre-referral screening questions						Comments on whether or not referral required
					Q1	Q2	Q3	Q4	Q5	
				Yes No	☐ ☒					
	Human Health Objective: Protect the health of Northern Territory population.	• Land clearing footprint is <100 ha – potential dust emissions • The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 34 km to the northeast of the Arruwurra deposit The community has four houses and associated buildings and an Indigenous population that fluctuates from 2 to 30 people according to the season. • The project is located wholly within enhanced freehold Aboriginal land owned by the AAC • Land use predominantly for traditional indigenous use, such as hunting and gathering and access to and use of sacred sites. • Other main land use that the area has been used for is mineral exploration since 1967, intermittently at Wonarah over the past 50 years. • Increased traffic on Highway – haulage from site to Tennant Creek • Potable water supply to be sourced from bores. Groundwater is fresh to brackish with elevated concentrations of iron and silica in the northern bores and at Arruwurra; boron was also high in the camp bore. • The Project is unlikely to impact drinking water, recreational water, air quality, bush tucker, increased biting insects or radiological limits.	• The Project is located within the Daly Roper Beetaloo Water Control District Declared Beneficial Use for Agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater. • The closest township is Tennant Creek, 240 km west of the project. • The closest service area is the Barkley Homestead roadhouse is located ~75 km directly to the NW of the Project area. • The Wunara Community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 10 km to the east of ML33343 boundary and approx. 34 km to the northeast of the Arruwurra deposit. • Project located immediately south of the Barkly Highway • Increased traffic on Barkly Highway – haulage from site to Tennant Creek / nearby railway siding for ~3mths	Yes No Uncertain N/A		☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	☐ ☒ ☐ ☐	Does not trigger referral: • The project is unlikely to result in human health impacts due to distance to nearest community, small scale, extent and short duration of Project. • Potable water will be tested regularly at the proposed camp and compared against ANZG 2018 Australian drinking water guidelines. Potable water will be treated as required i.e reverse osmosis plant.

APPENDIX G ENVIRONMENTAL RISK ASSESSMENT

Avenira Limited - Wonarah Phosphate Project Risk Assessment

Risk Matrix

Return to Front Screen

			Consequence Severity				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
Likelihood	5	Almost Certain	2 - Medium	2 - Medium	3 - High	4 - Very High	4 - Very High
	4	Likely	2 - Medium	2 - Medium	3 - High	4 - Very High	4 - Very High
	3	Possible	1 - Low	2 - Medium	3 - High	3 - High	4 - Very High
	2	Unlikely	1 - Low	1 - Low	2 - Medium	3 - High	3 - High
	1	Rare	1 - Low	1 - Low	1 - Low	2 - Medium	3 - High

Risk level and target action

Very High	Very High risk - Escalation to the Directors and MD attention needed, action plans and management responsibility specified
High	High risk - Senior Management attention needed, action plans and management responsibility specified
Medium	Medium risk - Manage by specific monitoring or response procedures, with management responsibility specified
Low	Low risk - Manage by routine procedures, unlikely to need specific application of resources

Avenira Limited - Wonarah Phosphate Project - Environmental Risk Assessment

Risk Assessment Criteria & Descriptions

Consequence or severity of Impacts	Score	Description
Severe	**5**	**Health** – death or widespread health effects, or toxic release off-site with detrimental effect. **Environmental** – extreme permanent changes to the natural environment (not able to be practically or significantly rehabilitated or alleviated). **Social** – major public outrage. **Financial** – huge financial loss (greater than A$500 million). Or the consequences are unknown.
Major	**4**	**Health** – extensive injuries. **Environmental** – substantial and significant changes to the natural environment or only partially able to be rehabilitated or alleviated. **Social** – will attract public concern in wider community. **Financial** – major financial loss (A$100 to 500 million). Or changes will be substantial if cumulative effects are considered.
Moderate	**3**	**Health** – medical treatment required. **Environmental** – significant local changes, but can be rehabilitated or alleviated with difficulty at significant cost and with outside assistance. **Social** – will attract concern of adjoining community. **Financial** – high financial loss (A$10 to 100 million).
Minor	**2**	**Health** – first aid treatment required. **Environmental** – on-site release immediately contained very local consequence with no significant long-term changes or may be simply rehabilitated. **Social** – not of significant concern to wider community. **Financial** – medium financial loss (A$1 to 10 million).
Insignificant No noticeable/measurable impact to values	**1**	**Health** – no injuries. **Environmental** – negligible environmental impact. **Social** – unlikely to be noticed by public. **Financial** – low financial loss (less than A$1 million).

Avenira Limited - Wonarah Phosphate Project - Environmental Risk Assessment
Risk Assessment Likelihood & Descriptions

Likelihood Categories	Score	Description
Almost certain	5	The impact will occur or is expected to occur. The impact occurs regularly in association with similar projects and/or in similar environments (the event is likely to occur once per year).
Likely	4	The impact will probably occur in most circumstance but there is some uncertainty about the likelihood. The impact has occurred on more than one occasion in association with similar projects and/or in similar environments (the event is likely to occur once every 1-2 years).
Possible	3	The impact could occur in some circumstances. The impact has occurred infrequently on similar projects and/or in similar environments (the event is likely to occur once every 2-5 years).
Unlikely	2	The impact is not expected to occur. The impact occurs very infrequently on similar projects and/or in similar environments (the event is likely to occur once every 5-10 years).
Rare	1	The impact is very unlikely to occur, or only occur in exceptional circumstances. The impact has not occurred on similar projects and/or in similar environments (the event is unlikely to occur in any 10 year period).

Risk ID	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions / assessment outcomes	L*	C*	IR*	Summary of Controls	L*	C*	RR*
1	Air quality	Land clearing	Dust emissions	Decrease in air quality at Wunara due to dust emissions from land clearing activities	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18km closest section of the haul road and approx. 34 km to the northeast of the Arruwurra deposit) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	1 - Low	Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion. • Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion. • Watering areas to be disturbed immediately prior to clearing during windy conditions. • Undertake dust suppression • Using existing disturbance areas where possible to reduce land disturbance requirements • Bitumen of T-intersection from site access road to Barkley Hwy	1	2	1 - Low
2	Air quality	Land clearing	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from land clearing activities	>20km direct from mining disturbance to the Barkley Hwy. ~18km closest section of the haul road is to the Wunara community and approx. 34 km to the northeast of the Arruwurra deposit Dirt haul road joins the Barkley Hwy -potential dust for motorists Land clearing footprint is <100 ha.	3	2	2 - Medium	Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion. • Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion. • Watering areas to be disturbed immediately prior to clearing during windy conditions. • Undertake dust suppression • Using existing disturbance areas where possible to reduce land disturbance requirements • Bitumen of T-intersection from site access road to Barkley Hwy	2	2	1 - Low
3	Air quality	Construction of infrastructure	Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions	In practice, emissions of sulfur dioxide, nitrogen dioxide and carbon monoxide from open cut mines, which would span a similar distance, are much too small and the equipment too widely dispersed for these to cause exceedances of the ambient air quality criteria. Land clearing footprint is <100 ha.	3	2	2 - Medium	• Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. • Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently. • Conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions. • Using existing disturbance areas where possible to reduce land disturbance requirements • Short duration of bulk test sample activities	2	1	1 - Low
4	Flora	Land clearing	Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species)	Land clearing footprint is <100 ha. While the diversity of species may remain the same following vegetation clearing, the density of individual plants will reduce in the short term. The attraction of grazing animals to the project area will be prevented wherever possible and undertaken in accordance with the mitigation and management measures outlined above. The area will be actively managed to prevent overgrazing from native and introduced fauna (e.g., kangaroos or camels). The main vegetation community of the project area is described as Eucalyptus opaca, (bloodwood) low open woodland with Triodia pungens (soft spinifex) hummock grassland understorey (Wilson et al. 1990). This particular vegetation community covers 28095.3 km2 in the Northern Territory (Wilson et al. 1990), of which the project area constitutes <0.004% of this area.	3	2	2 - Medium	Avenira has minimised, where practical, the area of vegetation required to be cleared by using existing disturbances. Other measures to avoid, mitigate and manage the risks associated with reduced species abundance include: • Minimising the area of direct land clearing, and only clearing areas immediately prior to their development. • Minimising the area of direct land clearing in areas sensitive to disturbance, such as erosion sensitive soils and drainage lines. • Ensuring the development and implementation of relevant clearance protocols. • Restricting clearing activities to existing disturbed areas, where possible. • Progressively rehabilitating disturbed areas, including mine pits, and avoiding unnecessary future disturbance of these areas. • Ensuring vegetation debris (e.g., wood) on areas that do not require clearing is left in situ and not collected for firewood or other purposes. • Consulting with the AAC for clearance approval of potentially culturally significant trees. • Minimising the potential for water to pool in areas where it is applied as a dust suppressant (e.g., along unsealed access roads) to reduce the attraction of grazing animals.	2	1	1 - Low
5	Flora	Land clearing	Removal of vegetation / disturbance	Significant Impacts to Threatened Species due to loss of habitat and direct mortality	• No vegetation communities or flora species listed under the EPBC Act identified in the project area during field surveys or desktop assessment. • No vegetation communities listed under the TPWC Act were recorded in the project area. • Species of conservation significance communities listed under the TPWC Act that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas's) include flora species Bonamia alatisemina, Distichostemon barklyanus, Heliotropium ballii, Heliotropium pulvinum, Sporobolus latzii, Triumfetta deserticola, Bergia barklyana and Hibiscus brachychlaenus. • Project area lies within the 'Wonarah Beds' Site of Botanical Significance (SOBS). 6.7% of the Wonarah Beds SOBS is overlain by the MLs. Of this <0.07% will be within the proposed disturbance footprint if of the areas of the Wonarah Beds SOBS. • White et al. (2000) note that there is the potential for a number of species of conservation significance occurring within the Wonarah Beds SOBS. Land unit mapping derived suggested that Sporobolus latzii occurs within the ephemeral lakes land unit, the largest of which occurs to the north of the Arruwurra prospect. This area is currently within a cultural exclusion zone which prevents mining activities within the area, limiting the likelihood of works impacting upon this known record. Furthermore, proposed works are located away from the ephemeral lake land unit thus minimising impacts on this species potentially occurring elsewhere in this land unit (LES 2009). • The area may potentially contain further threatened species that have not yet been located; however, it is unlikely that, were these species found to be present, project-related disturbance will result in significant impacts at a local level. Any impacts that did result would be insignificant at a regional, territory and national scale. All habitat types to be disturbed by the project are common in the region and any impact to threatened species will be limited.	3	2	2 - Medium	Along with measures to mitigate and manage the risks associated with reduced species abundance outlined above, measures specifically designed to avoid, minimise and manage significant impacts to threatened species include: • Conducting walkovers of land to be cleared to identify plant species of conservation significance. • Continually monitoring low lying areas subject to inundated for the plant species S. latzii. If found, a Flora Management Plan will be developed to avoid and/or minimise the impacts to this species. • Erecting flagging tape to mark 'no-go' zones to ensure areas to be protected are clearly defined, identified and avoided and that clearing and ground disturbance only occur within designated areas. • Investigating the opportunities to use TWPC Act listed species known to occur in the region in rehabilitation. • Avoiding the clearance of vegetation communities associated with ephemeral lakes, with such areas classified as 'no-go' areas and flagged accordingly. • Mitigative measures outlined in LES (2009) to be implemented (fire management, feral animals, weeds, pre-clearance surveys, education of workforce for ID of threatened species, minimising clearing especially near drainage lines, progressive rehabilitation, monitoring programs).	2	2	1 - Low
6	Flora	Storage and handling of hazardous materials	Spills (liquid, solids, and other dangerous material)	Loss of vegetation or degradation of vegetation health due to hazardous material contamination to soil, surface water and/or groundwater	With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation emergency response management plan, it is unlikely that fuels, oils and other chemicals will report to downstream environments. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit.	3	2	2 - Medium	• Above-ground fuel storage tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled	2	2	1 - Low
7	Fauna	Land clearing	Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species) due to removal of habitat	The disturbance footprint is <100 ha. As a result of vegetation clearing, that habitat will be lost during operations and fauna may be forced out of the area or die. Fauna may also move out of the immediate vicinity of the mine due to noise, light, dust and vibration emissions. Therefore, it is possible that the abundance of fauna species present in the project area and surrounds will be reduced for the life of the project. However, due to the abundance of similar flora communities and habitat surrounding the project area small scale, duration and extent of mining operations these impacts are unlikely to impact on fauna communities in the long term. None of the project infrastructure will encircle habitats and prevent fauna from moving between habitat areas.	3	2	2 - Medium	Project footprint has been minimised to avoid disturbance to new areas where possible. Other measures to avoid, mitigate and manage the risks associated with habitat removal or change include: • Minimising and consolidating areas of vegetation to be cleared for access tracks and infrastructure pathways so that large blocks of habitat, rather than small fragments, are preserved. • Rehabilitating cleared land both progressively during the life of the project and following project completion. • Regularly inspecting potential 'fauna traps' such as temporary trenches required during construction. • Progressive clearing as required.	2	2	1 - Low
8	Fauna	All activities	Noise, light and vibration	Reduced Species Abundance (Density and Diversity of Species) due to deterrence by noise, light and vibration from a variety of project activities	Species sensitive to disturbance by noise, vibration and light from mining and drilling activities are likely to relocate to other suitable habitat in the project area or surrounds.	3	2	2 - Medium	• Locating noisy and illuminated infrastructure (e.g., crushing and screening plant) close together to localise areas affected by noise and light from equipment. • Where possible, locating vehicle and machinery access roads outside high-quality habitat to minimise the potential for disturbance to resident fauna. • Limiting the number of roads constructed in the project area. • Blasting during the day to minimise the potential for disturbance to nocturnal species such as the dunnarts which forage at night and bird and mammal species particularly active at dawn and dusk.	2	2	1 - Low
9	Fauna	Land clearing	Removal of vegetation / disturbance	Significant impact to threatened species due to removal and disturbance of habitat	• Land clearing proposed disturbance footprint is <100 ha. • No habitats of ecological significance were recorded during LES field surveys in the project area • Species of conservation significance that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas's) include fauna species, Australian bustard (Ardeotis australis), northern nailtail wallaby (Onychogalea unguifera), long-haired rat (Rattus villosissimus) and woma (Aspidites ramsayi). Known to be present: • Australian bustard - due to the highly mobile nature of the species and widespread availability of habitat, small, localised disturbance is not likely to affect its conservation status. • Northern nail-tailed wallaby - unlikely to be impacted by the project due to its ability to move into other suitable surrounding habitat. Potentially present: Given the ubiquitous nature of the habitat in the project area and surrounds, the likelihood of any significant impacts on fauna of conservation significance is unlikely. Due to the limited presence of fauna of conservation significance any impacts to populations (i.e., the removal of a few individuals) would be minor.	2	2	1 - Low	To mitigate impacts to significant fauna the following techniques will be implemented: • Undertaking a walk over survey of all areas to be disturbed prior to commencement of works to locate the presence of any significant species. Rescue and relocation protocols will be developed in consultation with NT National Parks and Wildlife Service and/or DEPWS • Training of key staff in the identification of significant species and any traces left by them. • Managing pest species and native predators	2	2	1 - Low
10	Groundwater	Water use	Groundwater drawdown	Groundwater drawdown due to overextraction for project related water use	• Water will be required for road construction, dust suppression for roads, crushing and screening plant and domestic / potable use for camp. The total water demand during construction is estimated to peak at 8 L/s • Water will be sourced from existing bores - using the exploration camp bore for camp potable water and bores at Arruwurra for mining. • Proposed bulk test sample pit depth is 21m • Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated. Dewatering requirements are therefore likely to be negligible amd insignificance groundwater drawdown.	2	2	1 - Low	• Avenira groundwater monitoring program will monitor groundwater levels. • Groundwater extraction licence will be obtained as required under the Water Act for volumes >5ML/yr per parcel of land	2	2	1 - Low

Risk ID	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions / assessment outcomes	L*	C*	IR*	Summary of Controls	L*	C*	RR*
11	Surface water	Land clearing	Erosion and sedimentation	Reduced surface water quality due to erosion and sedimentation and increased turbidity	• <100 ha of land and soils will be disturbed by land clearing and development for the bulk sample activities. • Semi-arid environment average rainfall 300-400mm/yr. No receiving drainage lines within the Project area. • Soil types suitable for landuse – existing Arruwurra Pit from 2009 bulk test sample from previous operator (Minemakers). No obvious erosion or sedimentation issues presenting on satellite imagery beyond disturbance footprint of existing infrastructure. • Proposed disturbance footprint flat to <2% slope • One distinctive soil class within the project area: By4 - composed of undulating ridge and slope terrain on lateritic sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts (> 60%) of mixed and variable gravels or ironstone gravels, and also uniform coarse sands with some gravels on ridges and upper slopes generally. Kandosols and Rudosols dominate the sand plains within the project area. • Erodibility of soils was assessed through combining erosivity potentials of classified soils in accordance with descriptions of arid land soils and topography. Most soils were found to have low erodibility potentials, except deep soils (mostly Rudosols with loose rock aggregations) on slopes. • Waste rock storages will be vulnerable to erosion and sediment mobilisation in the short and long term by wind and seasonal rains • Release of fugitive sediment from the project area will be minimised by waste dump design and construction • Implementation of on site sediment control measures, which include diversion drains to separate clean and dirty water and appropriately designing sediment control structures will minimise the release of fugitive sediment off the Mineral Lease. High sediment loads are likely to occur only during high flow periods following long dry periods in semi-arid environments; therefore any sediment impacts in the overall context are likely to be minimal.	3	2	2 - Medium	• Site surface water management will be based on the principle of diverting clean surface water runoff away from disturbed areas and into existing natural watercourses and drainage lines, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment. • Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Runoff from the waste rock stockpiles is likely to generate sediment-laden stormwater only during high intensity rainfall events. Waste dump designed to limit erosion and sedimentation (maximum height 20m) and final contoured 14-degree slope with berms every 10 vertical meters that are 3.7m wide. • Progressive clearing as required.	2	2	1 - Low
12	Surface water	Storage and handling of hazardous materials	Spills (liquid, solids, and other dangerous material)	Reduced surface water quality due to contamination	With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation emergency response management plan, it is unlikely that fuels, oils and other chemicals will report to downstream environments. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit. No receiving drainage lines within the Project area.	3	2	2 - Medium	• Above-ground fuel storage tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled	2	2	1 - Low
13	Indigenous and non-indigenous cultural heritage	All activities	Damage or disturbance to heritage or Aboriginal Sacred Sites	Loss of heritage and impacts to culture sites of significance due to damage/disturbance of sacred sites and archaeology	There are sacred sites and a site of moderate archaeological significance outside the mineral lease. There are four identified sites of low archaeological significance and one of moderate archaeological significance within the mineral leases. There is one sites of low archaeological significance outside the ML within 30m of the haul road realignment. Although the site has been surveyed by an archaeologist and Traditional Owners, there is low potential for unidentified heritage to exist within the disturbance area. AAPA Certificate is no longer valid, Avenira are in discussions with NLC to have it updated. If the Indigenous cultural exclusion zones are disturbed, it is likely that the disturbance would attract the concern of the adjacent Arruwurra Aboriginal Corporation (AAC), Wunara community and associated parties within the wider community	3	2	2 - Medium	• Set up cultural exclusion zones around sacred sites • AAPA authority certificate application in progress and involves relevant groups • Consultation with Traditional Owners early on in project development to identify exclusion zones. • Avenira will seek consent under the NT Heritage Act for all ground disturbing works within 30 metres of all silcrete outcrops. • Disturbance permit protocols and procedures to be adhered too • Minimise disturbance • No driving off designated tracks • All Avenira' employees will be made aware of the location of these cultural exclusion zones through project inductions and access (and therefore disturbance) to these areas will be prohibited. • Chance find / stop work procedures will be implemented	2	2	1 - Low
14	Air quality	Mining operation, including management of waste rock, ore and topsoil storage	Dust emissions	Decrease in air quality at Wunara due to dust emissions from mining activities	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18km closest section of the haul road and approx. 34 km to the northeast of the Arruwurra deposit) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	1 - Low	Manage waste rock, ore and topsoil storage, including such measures as: • Positioning the stockpiles lengthways to the predominant wind direction. • Minimising the slope of the upwind surfaces. • stockpiling coarser material on the outer slopes of stored material to prevent wind blown dust and protecting with cleared vegetation. • Watering stockpiles to prevent wind losses when required (e.g., during dry windy weather, when stockpiles have been recently formed, and have surface dust). • Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement offsite. • Cease mining and clearing operations during severe meteorological conditions (wind speeds above around 40 km/h) causing extreme levels of dust. • Spray water and/or the dust suppressant agents on unsealed trafficked areas and other dust generating areas. • Reduce speed limit in sensitive areas • Avenira will keep daily records of the: – Operational hours of all water trucks. – Amount of water and dust suppressant used. – Numbers of water trucks in operation. – Time any mining operations are ceased due to severe meteorological conditions	2	1	1 - Low
15	Air quality	Drilling activities	Dust emissions	Decrease in air quality - visual amenity, dust impacts to vegetation	• Mine site is remote from sensitive receptors. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18km closest section of the haul road and approx. 34 km to the northeast of the Arruwurra deposit) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease. • Dust deposition expected to occur within the Arruwurra ML where grade control drilling is planned	3	2	2 - Medium	• Dust suppression will be undertaken where possible • Implementation of erosion and sediment control practices to improve stabilisation of cleared areas to prevent wind erosion, which will minimise dust emissions. • Progressive clearing of drill pads as grade control schedule required • Minimise size of drill pads to accommodate required drill rig	3	1	1 - Low
16	Air quality	Mining operation, including management of waste rock, ore and topsoil storage	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from mining activities	Given the dirt haul road joins the Barkley Hwy , the movement of nuisance dust off the mineral lease from haulage is possible. The consequence of dust nuisance and amenity impacts for motorists is considered moderate, as this is an offsite impact and if visibility is reduced they will have to adjust their driving accordingly. >20km direct from mining disturbance to the Barkley Hwy.	3	2	2 - Medium	• Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement offsite. • Bitumen of T-intersection from site access road to Barkley Hwy • Reduce speed limit near Barkley Hwy intersection • Spray water and/or the dust suppressant on unsealed trafficked areas and other dust generating areas. • Avenira will keep daily records of the: – Operational hours of all water trucks. – Amount of water and dust suppressant used. – Numbers of water trucks in operation. – Time any mining operations are ceased due to severe meteorological conditions	2	2	1 - Low
17	Air quality	General vehicle movement	Dust emissions	Decrease in air quality at Wunara due to dust emissions from vehicle movement on unsealed roads within the mineral lease	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18km closest section of the haul road and approx. 34 km to the northeast of the Arruwurra deposit) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	1 - Low	Manage mine traffic, including such measures as: • Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use. • Prohibiting off road driving. • Restricting site access to necessary site vehicles only. • Limiting parking of vehicles to designated parking areas to minimise soil disturbance. • Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust • Limiting load sizes of haul trucks on-site to ensure material is not above the level of the vehicle sidewalls • Bitumen of T-intersection from site access road to Barkley Hwy	2	1	1 - Low
18	Air quality	General vehicle movement	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from vehicle movement on unsealed roads within the mineral lease	Given the proximity of unsealed roads within the mineral lease and the Barkly Highway, the movement of nuisance dust off the mineral lease is possible. The consequence of dust nuisance and amenity impacts for motorists is considered moderate, as this is an offsite impact and if visibility is reduced they will have to adjust their driving accordingly, however dust generated is expected to be limited and there are mitigations available .	3	3	3 - High	Manage mine traffic, including such measures as: • Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use. • Prohibiting off road driving. • Restricting site access to necessary site vehicles only. • Limiting parking of vehicles to designated parking areas to minimise soil disturbance. • Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust • Bitumen of T-intersection from site access road to Barkley Hwy • Limiting load sizes of haul trucks on-site to ensure material is not above the level of the vehicle sidewalls	1	3	1 - Low
19	Air quality	Haulage (including loading and unloading) of ore	Dust emissions	Decrease in air quality due to heavy vehicles travelling along the ore transport route, for people using rest stops, the Barkly Roadhouse, and residences along the transport route	All public roads used for the transport of ore will be sealed roads which will reduce the potential to generate dust through liberation of particulate matter from the road surface and while in transport, the ore will be covered so loss of material and airborne dust will be minimal. While the closest sensitive receptors to the transport route are the rest areas and the Barkly Roadhouse (all located less than 100 m from the transport route), the transport route and method will minimise any potential dust generation. It is highly unlikely that air quality will be affected by dust generated through the transport of ore.	2	2	1 - Low	Dust will be minimised during the transport of ore from the mine site to the rail siding by: • Haulage contractors implementing management measures to prevent any product loss while transporting product from the mine site to the rail siding • Using covered haul trucks for the transport. • Minimising double handling • Using covered rail wagons during the transport of ore from the rail siding to East Arm Port. • Using purpose-designed and built ore storage and handling facility at East Arm Port To reduce the amount of dust carried on vehicles from site onto the Barkly Highway, Avenira will: • Compact the soil at ore loading and unloading sites. • Prohibiting off road driving. • Restricting site access to necessary site vehicles only. • Limiting parking of vehicles to designated parking areas to minimise soil disturbance. • Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust • Bitumen of T-intersection from site access road to Barkley Hwy	2	1	1 - Low
20	Air quality	Power generation and use	Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions	Even in large mines, the rate of emission of sulfur dioxide, nitrogen dioxide and carbon monoxide from vehicles and equipment are small compared with the emissions from traffic in an urban setting. For example, the traffic travelling on 3 km of arterial road carrying, for example, 60,000 vehicles per day and consuming 6,000 L of fuel per day would not normally cause exceedances of the ambient air quality criteria. In practice, emissions of sulfur dioxide, nitrogen dioxide and carbon monoxide from open cut mines, which would span a similar distance, are much too small and the equipment too widely dispersed for these to cause exceedances of the ambient air quality criteria.	2	2	1 - Low	• Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. • Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently. • Conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions.	2	1	1 - Low
21	Air quality	Non-ore waste management	Disposal of waste	Decrease in air quality due to odour from sewage treatment plant and putrescible waste landfill causing nuisance for sensitive receptors (mainly residents of Wunara community)	Emissions of odour from the sewage treatment plant are not expected to be detectable off-site or in the accommodation camp. Even if odorous emissions were to occur, which would be rare, they will be extremely localised and will have insignificant consequences. Therefore, the residual risk of odorous emissions is low.	2	1	1 - Low	Avoidance • Location of the sewage treatment plant will comply with Northern Territory's Code of Practice for the small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent (DHF, 1998) and the EPA guidelines that specify a minimum separation distance of 100 m for plants servicing less than 1,000 people. • The putrescible waste landfill has been designed with consideration of, and will be managed in accordance with, the Northern Territory Government's Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory (EPA, 2003). • Sewage treatment plant to be used on-site will be a package membrane bio-reactor design. This type of treatment plant does not require any permanent standing wastewater ponds and will be covered to mitigate any potential entry by mosquitoes. The need for specific measures will be considered if complaints are received, taking into account frequency of occurrence, intensity, duration, offensiveness and location	2	1	1 - Low

Risk ID	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions / assessment outcomes	L*	C*	IR*	Summary of Controls	L*	C*	RR*
22	Greenhouse gas emissions	Power generation and use	Exhaust emissions and diesel fuel consumption	Significant increase in greenhouse gas emissions	• Operation of plant and equipment will result in some GHG emissions. However, given the limited clearing, short duration of the bulk test pit and limited plant and equipment in operations during this period. the project will not exceed Large Emitters thresholds.	2	2	1 - Low	• Develop and apply policies and procedures for efficient mine operation that will ensure fuel use is minimised. • Minimise haul distances to minimise diesel use in vehicles and subsequent combustion emissions. • Monitor energy consumption (e.g., diesel and electricity) and calculate greenhouse gas emissions. This data can then be used to identify and address any key opportunities to reduce greenhouse gas emissions. • Identify and assess economically viable opportunities for reductions in emission rates, e.g., reducing areas of vegetation clearance and exploring opportunities to use more efficient fuel technology such as natural gas. • Use renewable energy sources where available and viable (e.g. solar hot water systems, monitoring systems powered by solar energy). • Ensure that vehicles and equipment are mechanically sound, serviced regularly and fitted with appropriate emission control equipment. • Use energy efficient lighting in all accommodation and office areas. • Use 5-star appliances in accommodation and offices where available (e.g., refrigerators, air conditioners and cookers). • Continue to pursue opportunities to reduce combustion emissions from ore transportation through development of a rail link between the mine and Tennant Creek.	2	1	1 - Low
23	Noise and vibration	Mining operation, including management of waste rock, ore and topsoil storage	Noise and vibrations from machinery and equipment	Disturbance and noise nuisance to Wunara community	• The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 34 km to the northeast of the Arruwurra deposit and ~18km from the closest section of the haul road • >20km direct from mining disturbance to the Barkley Hwy. • Limited blasting requirement for bulk test sample	2	2	1 - Low	Avoidance through design. Regardless, following mitigations apply: • Service all plant, machinery and vehicles regularly. • Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles. • No unauthorised entry • No public access • Turn off machinery when not in use • Monitor noise impacts by complaint, developing additional mitigation measures if necessary • Strictly manage blasting procedures to ensure the comfort of employees and to protect mine infrastructure. • Design each blast using a suitably qualified person, with initial blasts being conservatively designed. • Monitor blasting impacts by complaint, developing additional mitigation measures if necessary	1	2	1 - Low
24	Noise and vibration	Drilling activities	Noise and vibrations from machinery and equipment	Disturbance and noise nuisance to Wunara community	• The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 34 km to the northeast of the Arruwurra deposit where drilling activities are proposed	2	2	1 - Low	Avoidance through design. Regardless, following mitigations apply: • Service all plant, machinery and vehicles regularly. • Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles. • Monitor noise impacts by complaint, developing additional mitigation measures if necessary • No unauthorised entry • No public access • Exclusion zones in working drill area - site inductees only • Turn off machinery when not in use	1	2	1 - Low
25	Noise and vibration	Haulage (including loading and unloading) of ore	Noise and vibrations from machinery and equipment	Disturbance and noise nuisance to the Barkly Roadhouse and residences along the transport route	• Potential impacts to the Wunara community as a result of noise, vibration and dust are limited by the large separation distance between the mining, drilling and haulage activities and the community (i.e., ~18km closest section of the haul road and 34 km from the Arruwurra deposit) and the prevailing wind direction, which is a southeasterly direction (i.e., the wind originates from the southeast and travels northwest) away from the community which is located east of the Mineral Lease. • All public roads used for the transport of ore will be sealed roads which will reduce the potential to generate dust through liberation of particulate matter from the road surface and while in transport, the ore will be covered so loss of material and airborne dust will be minimal. While the closest sensitive receptors to the transport route are the rest areas and the Barkly Roadhouse (all located less than 100 m from the transport route), the transport route and method will minimise any potential dust generation.	2	2	1 - Low	• Service all vehicles regularly. • Install and maintain standard noise abatement devices (e.g., mufflers) on vehicles. • Impose speed limits on ore trucks. • Monitor noise impacts by complaint, developing additional mitigation measures if necessary. • Speed restrictions and diversions to bypass build-up areas where available • Limit use of air brakes in built up area	2	2	1 - Low
26	Landform, geology and soils	Topsoil stockpiling	Inappropriate topsoil removal and storage	Reduction in soil quality due to mixing of topsoil and subsoil through inappropriate topsoil removal and storage	By following the management and mitigation measures to handle, store and replace excavated topsoil and subsoil, it is unlikely that the project will result in a significant long term reduction in soil quality due to an altered profile. Should it occur, the impacts of this altered profile will be minor as the re-handling of soil can occur prior to machinery being moved off-site at the completion of mining.	3	2	2 - Medium	• Prior to development of any site infrastructure, including the pits, the topsoil layer will be stripped. Where possible stripped topsoil will be immediately reused elsewhere to preserve the seed store and nutrients. • When immediate reuse is not possible, topsoil will be stored in stockpiles no higher than 2 m and adjacent to the area and around the pit as a bund in readiness for reuse in rehabilitation. • Where possible, stockpiles will be respread within three to six months of removal.	2	2	1 - Low
27	Landform, geology and soils	Mining operation, including management of waste rock, ore and topsoil storage	Compaction of soils	Reduced soil quality due to soil compaction and reduced permeability from heavy machinery operating on soils	Soil will be compacted during construction and operation of the project. However, management and mitigation measures will be used to minimise the potential for this and to rehabilitate compacted soil. These measures are readily available and standard practice in earthworks activities. Should it occur, the consequence of this impact will be minor, as it will be relatively straightforward to rehabilitate.	3	2	2 - Medium	• All areas where the soil has been compacted during construction and operation (other than those with infrastructure to remain after closure) will be ripped, spread with topsoil and revegetated with native species	2	2	1 - Low
28	Landform, geology and soils	Storage and handling of hazardous materials	Spills and leaks from fuel storages	Reduced soil quality due to contamination of soils from seepage from putrescible waste and spills of chemicals/fuels	Soil may be locally contaminated by project activities (e.g., spill of fuel, discharge of hydraulic fluid); however, spill response measures will be followed to ensure that the impacts of the spill are minimised. Widespread contamination from mining activity is unlikely. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit.	3	2	2 - Medium	• Above-ground fuel storage tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled • If mining works result in contamination of the soil, then the soil will be appropriately remediated and site contamination assessment will be carried out	2	2	1 - Low
29	Landform, geology and soils	Topsoil stockpiling	Erosion and sedimentation	Reduced soil quality due to erosion and sedimentation of disturbed soils and stockpiled soils	• <100 ha of land and soils will be disturbed by land clearing and development for the bulk sample activities. • erosion may affect the quality of soil in the project area. However, management and mitigation measures will be used to minimise the spatial and temporal extent of any potential erosion. These measures are common to the mining and earthworks industries and will be adapted as site conditions demand.	3	2	2 - Medium	• Progressive clearing • Restricting clearing to essential areas and minimising the area of exposed cleared land. • Watering unsealed roads and other dust sources during windy conditions. • Minimising the period of time subsoil is exposed and topsoil is stored. • Minimising disturbance to the ground layer by restricting machinery access from areas not required for project works, and through selection of equipment that will minimise disturbance (e.g., track type, weight, weight to track size ratio). • Topsoil stockpiles maximum height 2m Measures specific to controlling sediment, and therefore maintaining the local quality of soil, include: • Controlling drainage and diverting it away from infrastructure. • Diverting clean water away from disturbed areas through diversion channels. • Directing runoff from exposed subsoil to the pit	2	2	1 - Low
30	Land use	All activities	Restricted access to the mineral lease	Reduced availability of land for traditional hunting and gathering	The loss of land available for hunting and gathering will be temporary The total area (MLs) that will not be available for traditional hunting and gathering as a result of mining is 2.3% of the total land owned by and available to the Arruwurra Aboriginal Corporation (approximately 611,051 ha). This provides a significant amount of similar land surrounding the project area that is available and suitable for hunting and gathering purposes. Avenira will have an access and land use agreement with the AAC Traditional Owners	3	2	2 - Medium	• The immediate loss of land for traditional hunting and gathering will be compensated for, as agreed during discussions and negotiations with the AAC Traditional Owners and Avenira and will be formalised in a Mining Agreement between the parties. • Rehabilitation and revegetation of the project area post mining will assist in the project area being suitable for hunting and gathering use after mining has finished	3	1	1 - Low
31	Land use	All activities	Restricted access to areas surrounding the mineral lease	Restriction of Traditional Owner access to sites of cultural significance	It is almost certain that the Traditional Owners residing in, or accessing the culturally significant sites from, the Wunara Community will have a reduction in their ease of access to these sites as a result of the project; however, access to the sites will not be restricted as a result of the mining activities. Safe, alternative access routes will be developed in consultation with the Traditional Owners.	3	2	2 - Medium	• Prior to construction of the project Avenira will develop alternative access routes to the sacred sites in consultation with the AAC Traditional Owners. These access routes will be designed to ensure safe access to the sites and the safe operation of the mine; it is likely that access routes will be restricted to the western side of the Mineral Lease boundary and not allow for unauthorised crossing of haul roads	3	1	1 - Low
32	Flora	All activities	Removal of vegetation / disturbance	Reduced Conditions Favourable for Plant Growth due to dust and disturbance	Dust suppression measures, such as water trucks, will be used throughout the life of the mine to minimise dust emissions. However, given the nature of operations activities and the semi-arid environment, some dust generation is likely, which is likely to contribute to reduced conditions for plant growth. Studies on commercial crops and on vegetation in higher rainfall areas do not show any adverse effects on vegetation at dust deposition levels of the order of 4 g/m2/month, hence detectable effects on vegetation are only likely within a few tens of metres of actively mined areas. Given the high background dust levels it is expected that local flora species will be tolerant of similarly high dust deposition levels. Given the design of the project activities and management and mitigation measures, it is unlikely that disturbance will reduce conditions favourable for plant growth beyond the immediate footprint. The effect of reduced conditions favourable for plant growth is insignificant. Impacts will be localised in nature, and able to be rehabilitated both progressively and following project completion.	4	1	2 - Medium	• Measures designed to avoid, minimise and manage the risks associated with increased rates of erosion and dust generation • Progressive clearing as required	3	1	1 - Low
33	Flora	General vehicle movement	Weed introduction and spread by machinery and equipment	Reduced habitat quality due to introduction of new weeds and/or increased density and distribution of existing weeds	Weed management measures such as minimising the area of vegetation disturbed, and regularly monitoring and promptly controlling any outbreaks of weed infestation, will reduce the likelihood for significant increases in the density and distribution of weeds. Measures to prevent the introduction of new weed species, and limit their potential to become established if present, will ensure that it is unlikely that new weed species will present a threat to the native flora of the region	3	3	3 - High	Measures designed to avoid, minimise and manage the risks associated with weed infestation as a result of the project include: • Minimising the area of vegetation to be cleared. • Using targeted weed control measures for any observed significant increase in the distribution or density of existing weeds, particularly buffel grass. • Inspecting construction areas for weed outbreaks following rainfall events. • Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides and recently cleared areas. • Controlling and/or preventing weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction during respreading of topsoil. • Instigating the ongoing rehabilitation of disturbed areas to reduce the potential for weed species to become established. • Liaising with NTG Weeds Branch on appropriate measures to eradicate or control weed outbreaks, should they occur • Ensuring that vehicles and project equipment arrive on site clean and free of vegetative matter, seeds and mud. • Focussing on the control of declared weed species present in and around the project area, and preventing their spread during the life of the project. • Using targeted weed control measures for new populations of weeds identified in previously uninfested areas	2	2	1 - Low

Risk ID	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions / assessment outcomes	L*	C*	IR*	Summary of Controls	L*	C*	RR*
34	Flora	Construction of infrastructure	Alteration of surface water flows	Loss of riparian vegetation due to reduced water availability for riparian vegetation due to alteration of surface water flows	It is unlikely that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be insignificant due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event.	2	2	1 - Low	• Mine infrastructure (waste dump and haul road) located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Project components located to minimise changes to the flow regime. • Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing natural watercourses or drainage lines.	2	1	1 - Low
35	Fauna	Mining operation, including management of waste rock, ore and topsoil storage	Acid Rock Drainage (ARD) from WRD	Reduced Species Abundance (Density and Diversity of Species) due to use of contaminated water by fauna	Following significant rainfall, surface runoff may contain sediment and metal concentrations that have the potential to be toxic to wildlife. However, geochemical analysis has revealed high levels of metals or toxins in sedimentation is unlikely. It is assumed surface water management actions will be effective	2	2	1 - Low	• Monitoring of water quality from WRDs, stockpiles and pit water • Sediment and erosion control measures • Containment and reuse of mine affected water	2	2	1 - Low
36	Fauna	All activities	Increased pests and vermin	Impacts to fauna due to increased abundance of introduced species	Introduced species are already present in the project area in relatively low densities. Management and mitigation measures will provide for the control of introduced species and it is unlikely that the density and distribution of these species in the project area will increase as a result of project activities.	2	2	1 - Low	Measures designed to manage and mitigate the risks associated with an increased abundance of introduced species include: • Controlling existing feral animal populations • Targeting new populations, or significant increases in the current population, of foxes and/or feral cats. • Ensuring that waste management procedures are diligently followed to reduce potential resources for these species. • Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species (e.g., camp and around water sources).	2	1	1 - Low
37	Groundwater	Storage and handling of hazardous materials	Spills (liquid, solids, and other dangerous material)	Reduced groundwater quality due to spills or seepage of hazardous materials and/or waste	Hazardous materials and chemicals stored on site will be minimal, with notable items being fuel, and sundry lubricants and cleaning chemicals. All hazardous materials stored on site will be contained within bunded areas and will be managed to minimise spillage. The implementation of the spill management procedures in the waste management plan will also minimise any risk of contamination of groundwater aquifers as a result any spills. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit. No magazine / explosives storage proposed for storage onsite	3	2	2 - Medium	• Above-ground fuel storage tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled • Appropriately storing and managing hazardous substances on-site • If a reduction in groundwater quality does occur, it will be detected by the groundwater monitoring program and the necessary remedial measures will be put in place.	2	2	1 - Low
38	Groundwater	Water use	Groundwater drawdown	Reduced groundwater quality due to groundwater drawdown increasing salinity due to reductions in dilution of salts in the aquifer due to overextraction of groundwater	Regional groundwater quality data show groundwater salinities range from 500 to 4,000 mg/L TDS. Groundwater across the Barkly Tableland is used extensively for stock watering purposes; acceptable salinity limits can be as high as 5,000 mg/L TDS (or 7,000 µS/cm EC) (ANZECC/ARMCANZ, 2000). Water use is minimal and not likely impact groundwater quality.	2	2	1 - Low	• Ensuring the extraction of groundwater does not exceed sustainable yield limits • Groundwater extraction licence will be obtained as required under the Water Act for volumes >5ML/yr per parcel of land • Avenira groundwater monitoring program will monitor groundwater quality	2	2	1 - Low
39	Surface water	Construction of infrastructure	Alteration of surface water flows	Alteration to surface water flows due to construction of infrastructure for the mine and mining-related alteration of the landform	• No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit. • No physical works proposed in any waterway • No surface water extraction proposed • Seasonally flooded swamps occur in the southwest of the project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding. Contributing factors to such extensive flooding include Arruwurra deposit located in a topographic low; within a large upstream catchment area of the watercourse and the lack of discernible channel. It is unlikely that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be insignificant due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event.	3	1	1 - Low	• Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing drainage lines.	2	1	1 - Low
40	Socio-economic	Workforce	Workforce influences local community	Social disruption due to changes in population and demographics.	A change in regional demographics may result an influx of mine workers who are typically male and in their 20s to 40s; this could contribute to social disruption in Tenant Creek and Wunara due to increased law and order issues, tension between newcomers and existing residents and increases in drug and alcohol use. The fly-in fly-out (FIFO) workforce will increase the temporary population of the Barkly Tableland region. Given the insular nature of FIFO operations, this population increase may not translate into population benefits for this region (i.e., disposable incomes of the mine workers is spent in their home localities and not within the region of their employment), but will have positive benefits for other communities (e.g., those hosting the FIFO employees).	3	3	3 - High	• Accommodation of majority of workforce in purpose-built facilities. • Strict enforcement of company policy regarding standards of behaviour. • Maintenance of complaints register.	2	2	1 - Low
41	Socio-economic	Workforce	Workforce influences local community	Increased competition for skilled labour.	The workforce will be preferentially sourced from the local, regional, territory and then national level. Providing employment opportunities for the local community will be a priority and will be determined by the skills of people living in Wunara and Tennant Creek. Sourcing labour from within the existing, local, labour market will increase local employment opportunities and may provide incentives for more skilled workers to move to the area and for skilled workers who have left the area to return to country. This type of structural adaptation in the workforce is common to the entry of any new industry into an area and is likely to create opportunities for both the existing and future workforce. Avenira will preferentially source labour from Wunara and Tennant Creek.	3	1	1 - Low	• Work with existing training providers to ensure that programs they deliver will provide appropriate training programs. • Inform local community of the types of jobs that will be required and the skills and qualifications people will require to fill them. • Use local businesses to fill contract positions where contractors are competitive and appropriately skilled. • Support the development of business opportunities within the local Indigenous community. • Implement stakeholder consultation plan.	2	1	1 - Low
42	Socio-economic	Workforce	Increased local population	Pressure on existing emergency services	The provision of site-based emergency response teams and medical assistance, combined with the strong safety culture, operational and management systems implemented through all phases of operation, make it unlikely that significant pressure will be placed on existing emergency services. If externally provided emergency medical evacuation was required, the Royal Flying Doctor Service would be used. The expected infrequent reliance on external emergency and medical services results in this impact having a minor consequence. Avenira will liaise with local emergency services to ensure they have capacity to deal with any credible mine-related emergencies that may occur.	2	2	1 - Low	• Implement workplace health and safety processes and procedures throughout all phases of the project. • Provide on-site emergency response team and facilities. • Consult with local emergency services.	2	2	1 - Low
43	Socio-economic	Workforce	Increased local population	Inadequate existing infrastructure and community services.	Employment of local people will not place additional strain on existing infrastructure services such as power, water and schooling as they are already using these services. The fly-in-fly-out workforce will be workers only (i.e., not families) and will not be located in Tennant Creek, so it should not place significant pressure on existing infrastructure services. Given this, it is unlikely that the project will result in existing infrastructure and community services being inadequate.	2	2	1 - Low	• Liaise with the Barkly Shire Council and Northern Territory Government to assist future planning and development activities.	2	2	1 - Low
44	Socio-economic	Workforce	Increased local population	Reduced availability and affordability of housing at Tennant Creek and Wunara	The provision of accommodation villages at the multi-user hub and mine site make it unlikely that the project workforce will impact the availability and affordability of housing and accommodation. It is recognised that there may be pressure on housing associated with the flow-on effects of the mine (i.e., the increased business development in Tennant Creek); however, the direct project workforce will be accommodated within the villages. Traditional Owners who return to the area to work at the mine may wish to live in the community. With a total of four houses, the Wunara community does not have the housing to provide for a significant influx of such people, although it is not known how many people this is likely to be. Therefore, it is possible that there will be a lack of accommodation for Traditional Owners who return to country. This may require them to construct additional houses. However, Traditional Owners interviewed have highlighted the return to country of these people as a major potential positive benefit of the project. Accommodation for employed Traditional Owners will be available at the workers camp for these people until suitable additional housing can be constructed.	2	2	1 - Low	• Consultation with government, shire council, AAC / Traditional Owners.	2	2	1 - Low
45	Socio-economic	Haulage (including loading and unloading) of ore	Increased road traffic on major roads	Increased traffic on roads, with a consequent safety risk and reduced amenity for road users.	It is assumed transport drivers will adhere to speed limits and regular servicing will be effective. It is also assumed other road users will drive to the conditions and speed limits. The project is small scale, extent and short duration so unlikely to impact in the long-term	2	2	1 - Low	• Impose speed limits on ore trucks. • Ensure all vehicles are mechanically sound and serviced regularly	2	2	1 - Low
46	Socio-economic	Workforce	Workforce influences local community	Increased availability and affordability of drugs and alcohol, with consequent negative social impacts.	Although Avenira has proposed controlling access to the bar to only those people employed on site or legitimately visiting the site in connection with the operation, there is still the potential for alcohol to be taken onto site illegally. Avenira believes that with responsible management and implementation of the drug and alcohol management plan, impacts to the residents of the Wunara Community will be prevented. The availability of self-testing facilities at both the multiuser hub and mine site accommodation villages will allow the opportunity to prevent a person from presenting for work in an unfit condition and thereby risk losing their employment. The reality is that wherever there is money there is the potential for drugs to be brought into the community. Avenira believes a zero tolerance approach to drugs, supported by a random testing regime, will deter most people from risking possessing or using drugs while on-site. Through the strict management of the consumption and supply of alcohol in the accommodation villages, the likelihood of increased social problems due to drug and alcohol use as a result of the project is unlikely.	3	2	2 - Medium	• Implement a drug and alcohol management plan. • Implement substance abuse testing and management in all aspects of the operation. • Implement random drug and alcohol testing. • Zero tolerance approach for rules about drugs and alcohol. • Provide self-testing facilities at both the multiuser hub and mine site accommodation villages.	2	2	1 - Low
47	Traffic and transport of ore	Haulage (including loading and unloading) of ore	Increased road traffic on major roads	Adverse effects on safety due to increased road traffic.	It is possible that there will be an increased risk of accident on a public road due to mine related traffic. The implementation of the traffic management plan will ensure that road transport of ore will be conducted in a responsible and legal manner with minimal disruption to other road users, particularly as the road trains hauling ore to the multi-user hub and back will not enter Tennant Creek. The consequence of an increased risk of accident is moderate as it will attract the concern of the community. However, when the risk of traffic accidents is placed into context of normal day-to-day driving undertaken by the general public, the risk will most likely be lower.	3	3	3 - High	• Carry out any road upgrades prior to the commencement of ore transportation. • Develop traffic management plan. • Adequate road maintenance by government.	1	3	1 - Low

APPENDIX H ARCHAEOLOGICAL SURVEY ARRUWURRA BLOCK-BARKLY HIGHWAY NT

Proposed Minemakers Phosphate Mine (MLA 27244) Archaeological Survey Arruwurra Block- Barkly Highway NT.

Prepared for Central Land Council, ALICE SPRINGS

June 2009.

Tim Hill (BA Hons. Archaeology.)

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Executive Summary and Recommendations

The area covered by this archaeological assessment is the proposed Mine Makers phosphate mine (ML 27244) at the Arruwurra block on the Barkly HIghway, Northern Territory. The assessment was commissioned by Central Land Council and is structured following the Office of Environment and Heritage Scope of Works for archaeological assessment.

A total of 12 km was surveyed with a ground visibility being greater than 50% across the entire area. A series of knapping/discard sites were recorded at each of the silcrete outcrops included within the survey. The sites are all similar in composition-being consistently low density knapping debris with very low densities of primary flakes. All artefacts are located in close proximity of the outcropping silcrete. It is highly likely that additional knapping sites exist on all of the silcrete outcrops within the proposed mining lease.

[redacted]

- Apply for consent under the Heritage Conservation Act 1991 for all ground disturbing works within 30 metres of all silcrete outcrops.

Table of Contents

1. Introduction

The area covered by this archaeological assessment is the proposed Minemakers Australia Pty Ltd phosphate mine at the Arruwurra block on the Barkly Highway, Northern Territory. The assessment was commissioned by Central Land Council and is structured following the Office of Environment and Heritage Scope of Works for archaeological assessment.

A total of 12 km was surveyed with a ground visibility being greater than 50% across the entire area. A series of knapping/discard sites were recorded at each of the silcrete outcrops included within the survey. The sites are all similar in composition-being consistently low density knapping debris with very low densities of primary flakes. All artefacts are located in close proximity of the outcropping silcrete. It is highly likely that additional knapping sites exist on all of the silcrete outcrops within the proposed mining lease.

The field survey and report preparation was undertaken by Tim Hill (Tim Hill Heritage Management and Planning) in May 2009.

2. Physical environment

The proposed works are located within the Arruwurra Block situated on the Barkly Highway- approximately 70km east of The Barkly Homestead. The study area is located within the Davenport-Murchison Ranges bioregion. The Davenport-Murchison Ranges bioregion comprises low but rugged rocky hills, formed from folded volcanics and sandstone, siltstone and conglomerates, which contrast starkly with the generally flat sandplain surrounds of the Tanami bioregion and Mitchell Grass Downs to the east. Soils are generally shallow lithosols, but deep fine-grained alluvial soils occur in the valleys and surrounding plains. Vegetation includes hummock grasslands and low open woodlands dominated by eucalypt and *Acacia* species. The climate is arid tropical with summer rain.

Two land-units were defined within the study area based on the classification system proposed by Peter Latz for Central Australia (Latz 1995).

1. Spinifex Communities on sandplains and dune fields. The majority of the lease is low lying sand plain dominated by hard spinifex and acacia shrubs and small trees.
2. Spinifex communities on hills. The hill areas within the lease are dominated by coarse outcropping silcrete with a very low (less than 10 metres) relief. Soils in these areas appear to be relatively thin with low nutrient levels. The hills are characterised by an absence of a tree or shrub storey.

Drainage within the immediate area of the study appeared to be extremely ephemeral and would provide useable water for only a short period after rainfall events. No major drainage lines or minor creeks were observed and water appeared to be available only at soakages (previously recorded but not sited during the survey)

3. Cultural Setting

3.1. Aboriginal land-use

Detailed historical and anthropological records of traditional and semi-traditional Aboriginal landuse of the Alyawarra language group to the immediate south of the study area have been undertaken by O'Connell and Hawkes (1984). This work was undertaken to test ecological based models of resource use derived from theories of human behavioural ecology. O'Çonnell and Hawkes generally concluded that Alyawara men focused their hunting efforts within mulga and open woodlands in preference over floodplains. The results of the studies for women were less conclusive due to the presence of commercially manufactured flour in the diet which significantly skewed womens foraging patterns away from seed collection and processing towards specific plant resources and smaller animals. The study also noted the value of resources- specifically kangaroo- which allowed men to demonstrate skill and participate within complex kinship/exchange systems.

Anthropological work undertaken to the south of the study area within the Agharringa language area (affiliated with Alyawarra) identify the importance of specific sites along dreaming lines to define land ownership and rights to utilise and manage country (Moyle 1986 in Sutton 1995). Moyle identified that Agharringa men sing entire verses of stories well outside Agharringa country but do not claim ownership of those sites- or necessarily know the location of the sites.

A regional scale archaeological survey undertaken for the Katherine to Camooweal Optical Fibre Cable project (Lance 1990) identified a pattern of sites associated to major rivers and sources of suitable stone material. At these locations sites were spatially extensive and had high artefact densities.

A major excavation at Lake Woods recorded archaeological sites dating potentially to the pleistocene period (Smith 1986). While the archaeological materials were in-situ within ancient lake sands the typology of the stone artefacts was consistent with sites of not older than 6000 years. These include bifacial points, adzes, seed grinding implements, retouched flakes and a few small cores.

Ken Mulvaney (1997) undertook research at the Kurutiti sandstone quarry (Helen Creek) to understand trade and exchange patterns within the region. In addition to the sandstone quarry the site also has a large rock engraving complex and a number of living areas. Mulvaney proposes that Kurutiti was a regionally significant site and that sandstone was traded across the Barkly Tablelands and that the grindstones- and more importantly seed grinding- were an important part of ceremonies and cultural exchange in the region.

3.2. Archaeological Predictive Model

1. Spinifex Communities on sandplains and dune fields - Low archaeological sensitivity.
2. Spinifex communities on hills - Moderate to high archaeological sensitivity. High likelihood of silcrete quarries.

4. Previous Archaeological research

A search of the Heritage Database identified no sites in the immediate or surrounding area.

5. Methodology

The field survey aimed to sample the identified land units across the proposed development. The survey utilised meandering pedestrian transects to focus survey effectiveness in areas with greater visibility (Table 1). Sites were marked using GPS waypoints. Archaeological materials were identified by definable characteristics (notably prominent bulb of percussion, point of force application, distinct and/or retouched margins). A total of 7.7km was surveyed in the *Spinifex Communities on sandplains and dune fields* and 5.8km surveyed in the *Spinifex communities on hills*. The survey was supported by traditional owners and a CLC staff member.

6. Results.

A complex of low density silcrete knapping/discard areas was recorded across the proposed mine area. Knapping areas were immediately associated to outcropping silcrete and the individual knapping areas had the greatest densities within the immediate area of the source material. Artefacts densities ranged from 0.2-1 artefact m^2. All artefacts were simple and primary flakes with no signs of retouch- although several had signs of edge damage. Few artefacts showed signs of platform preparation.

[redacted]

7. Discussion.

7.1. Assessment of predictive model

1. *Spinifex communities on sandplains and dune fields.* The prediction of low archaeological sensitivity across the sandplains was supported with only [redacted] A likely factor contributing to this is the apparent lack of any form of drainage which would collect water after rains. Significant vegetation growth following high rainfall in 2008 likely also impacted on the effectiveness of the survey and as such it was impossible to record the exact location of the soakage. Of note is that AW 1 is similar to the other sites occurring on a very small outcrop of silcrete within the sand plain.
2. *Spinifex communities on hills.* The prediction of moderate to high archaeological sensitivity was supported with a series of knapping areas at each of the silcrete outcrops surveyed. Of note are that the sites are directly associated to available stone material and showed little evidence of efficient use of the available material. This indicates that use of the area was fairly task specific with groups of people moving through each area quickly and utilizing only so much of the silcrete as required for immediate or imminent tasks. There is little to suggest that the silcrete was systematically knapped for trade or for the production of complicated tools. There is a high confidence that all of the outcropping silcrete across the proposed mine would have consistent archaeological evidence.

7.2. Potential cultural significance.

The Arruwurra archaeological sites have potential cultural significance to Alyawarra and Wakaya people as a tangible link to past geographies and use of the area. It is noted that the archaeological sites were not recorded during the original sacred sites survey with senior traditional owners. During the survey the significance of archaeological sites to traditional owners ranged from quite important during the initial part of the survey to of low importance by the end of the survey.

7.3. Potential scientific significance.

The follow factors contribute to the scientific significance of the Arruwurra site

- Overall it has very low artefact densities.

[redacted]

- The Arruwurra sites appear to have not been significantly impacted by previous land use or disturbance.

7.4. Statements of significance

[redacted]

8. Summary and Recommendations.

8.1. Summary.

A total of 12 km was surveyed with a ground visibility being greater than 50% across the entire area. A series of knapping/discard sites were recorded at each of the silcrete outcrops included within the survey. The sites are all similar in composition-being consistently low density knapping debris with very low densities of primary flakes. All artefacts are located in close proximity of the outcropping silcrete. It is highly likely that additional knapping sites exist on all of the silcrete outcrops within the proposed mining lease.

[redacted]

8.2. Recommendations

- Apply for consent under the Heritage Conservation Act 1991 for all ground disturbing works within at least 30 metres of silcrete outcrops across the area of the proposed mining lease.

9. References.

Lance, A. 1990. *A preliminary archaeological study of the Katherine to Camooweel optical fibre cable route.* Unpublished report to National Heritage Studies, Adelaide.

Mulvaney, K.J. 1997. *More than a chip of the old block. A prehistoric sandstone quarry: The notion of production and exchange.* Unpublished Masters Thesis, Northern Territory University.

O'Connell, J.F and Hawkes, K. 1984. Food choice and foraging sites among the Alyawarra. *Journal of Anthropological Research 40:504-435.*

Smith, M.A. 1986. An investigation of possible pleistocene occupation at Lake Woods, Northern Territory. *Australian Archaeology* No. 22:60-74.

Sutton, P. 1995. Country. Aboriginal Boundaries and land Ownership in Australia. *Aboriginal History Monograph 3.* Australian National University, Canberra.

Veth, P., M. Smith and P. Hiscock. 2005. *Desert Peoples. Archaeological Perspectives.* Blackwell Publishing, Carlton.

Map 1. Location of recorded archaeological sites
(This map contains confidential information and as such cannot be put on public display; however, all pertinent information from this map is included in the EIS).

Appendix 1: Site data.

Site Name	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

APPENDIX I SECURITY CALCULATION

AT3-010		last review: June 2009

DITT Security Calculation Form

Security Summary

Details: This calculation corresponds with section 6.1 of the MMP			
Assessment Date	16/05/2023	**Mining Officer**	JTyne
Project	Wonarah Phosphate Project	**Authorisation #**	TBD
Operator	Avenira Limited	**Operator Contact**	Steve Harrison
MMP reference	36:M2013/0039-0624~0001		

New Authorisation	MMP Renewal/amendment	Audit Finding	Client Request
X			

Domains	Calculated Cost
1: Site Infrastructure	$15,800.00
2: Extractive Workings - Sand, Clay & Gravel	$0.00
3: Hard Rock Pits & Quarries	$30,100.00
4: Underground Workings	$0.00
5: Tailings Storage Facilities and Dams	$28,080.00
6: Stockpiles & Waste Rock Dumps	$0.00
7: Exploration	$0.00
8: Access and Haul Roads	$0.00
9: River Diversions	$0.00
Decommissioning & Post Closure Management	$5,400.00
Sub-Total - All Domains	$79,380.00
CONTINGENCY @15%	$11,907.00
TOTAL COST	$91,287.00
10% Discount	$9,129

NORTHERN TERRITORY GOVERNMENT

DISTURBANCE AREA INVENTORY				
Whole of site summary	**Total Area (ha)**	**Progressively rehabilitated area**	**Remaining area**	
Lease surface area				
Disturbed operational area				
Above grade landforms				
Waste rock dump #1				
Waste rock dump #2				
Waste rock dump #3				
Waste rock dump #4				
ROM/Stockpile				
Tailings Dam #1				
Tailings Dam #2				
Tailings Dam #3				
Tailings Dam #4				
Mining area #1	1.6			Bulk sample pit and clearing for ROM
Mining area #2				
Mining area #3				
Mining area #4				
Mining area #5				
Mining area #6				
Extractive areas				
haul roads				
access roads				
water ponds/dams	0.8			turkey nest
Area of infrastructure				
camp area				
area of drill pads and sumps				
costeans/pits				
tracks/roads				
other				
TOTAL	**2.4**			

NORTHERN TERRITORY GOVERNMENT

Domain 1: Infrastructure

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Process Plant, Mill, Crusher area	disconnect and terminate services	@	10000-27500	26700.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.	
	demolish remove conveyor system	m	100-250	140.00		0.00	Enter the total length of conveyors	
	demolish/remove crusher, process plant and mills	m^2	160-210	210.00		0.00	enter the total surface area of process plant and mills etc. If multi-story the area should be the sum of the surface area of all floors.	
	remove concrete pads and footings	m^2	10-30	15.00		0.00	enter the total area of buildings, workshops etc. Cost dependent on thickness. Assume $10/m2 for <300mm thick, $30/m2 for >300mm thick. (default $15 if unknown)	
	remove mobile plant	hr	140-300	200.00		0.00	consider distance to remove all mobile plant to the nearest centre or to Darwin.	
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.	
	deconstruct and remove large tanks - eg leach	@	35000-165000	35000.00		0.00	enter the number of tanks	
	deconstruct and remove small tanks	@	10000-30000	10000.00		0.00	enter the number of tanks	
						0.00		
Main Workshop and Stores area	disconnect and terminate services	@	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area. Are there any remote or field based workshops to include	
	remove concrete pads and footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. Include any areas of carpark and washdown pads, bulk fuel bunding and refuelling areas.	
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.	
	underground tank removal - large hydrocarbon (>5000L)	@	48000-82500	60000.00		0.00	removal of underground tank and all pipework, bunds and any contamination	
	underground tank removal - small hydrocarbon (up to 5000L)	@	20000-21000	20000.00		0.00	removal of underground tank and all pipework, bunds and any contamination	
	above ground tank removal - hydrocarbon	@	200.00	200.00	4	800.00	enter number of tanks	
	remove hydrocarbon contamination	m^3	3.00-5.00	5.00	3000	15000.00	enter the volume to be removed to pit void for appropriate rehabilitation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.	
	remediation on site of hydrocarbon contamination	m^3	30-55	40.00		0.00	enter the volume of material requiring onsite remediation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.	
						15800.00		
Administration	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.	
	remove bitumen from sealed carparks etc	m^2	12.00-17.00	17.00		0.00	enter total area of carparks. Includes removal offsite to appropriate facility	
	remove concrete pads, footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)	
	waste disposal offsite	@	650	650.00		0.00	assumes removal offsite to a waste disposal facility. Adjust if disposing at onsite facility	
						0.00		
Sewerage/Water treatment plant	disconnect and terminate services	item	2500-5000	2500.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.	
	remove contaminated soil	m^3	3.00-5.00	5.00		0.00	removal to pit void for appropriate rehabilitation	
						0.00		
Accommodation Camp	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.	
						0.00		
Airstrip, borefields, other	remove concrete pads footings and bitumen	m^2	10-30	10.00		0.00	enter total area (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)	
	demolish and remove sheds and storage tanks	m^2	70-90	75.00		0.00	enter area of sheds and tanks	
	production/dewatering bore closure	@	2000-3300	2000.00		0.00	sealing and rehabilitation	
	observation bore closure	@	500	500.00		0.00	includes sealing and rehabilitation to make safe.	
						0.00		
Revegetation Activities - all infrastructure areas	Deep rip	ha	550-1100	1100.00		0.00	Enter all areas disturbed by infrastructure from above, including laydown areas Assume highly disturbed and compacted areas - see assumptions.	
	source cart and spread topsoil	m^3	2.50-5.50	5.50		0.00	assume minimum of 10cm depth	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Other	remove powerlines	km	9800-15000	15000.00		0.00	include dismantling and removal of lines and poles from the site	
	remove pipelines	km	1400-1800	1400.00		0.00	remove polypipe >300mm diameter. Assumes removal by 3 persons via truck to nearest location.	
						0.00		
DOMAIN 1 TOTAL						$15,800.00		

NORTHERN TERRITORY GOVERNMENT

Domain 2: Extractive Workings - Sand, Clay & Gravel

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Pits	Scaling, battering for stabilisation	m^2	1.21-3.00	3.00		0.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation	
	backfilling of pits	m^3	4.00-5.00	5.00		0.00	enter volume of material to be backfilled into pit	
	abandonment bund and pit access closed	m	20.00-63.25	50.00		0.00	required where final pit includes steep faces. Includes bund around pit and closure of ramp. Bund assumed to be 2m high and 5m wide at base	
	structural works for drainage	ha	700-1500	1500.00		0.00	earthworks for banks and drains to manage surface water .	
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that pit material is suitable as a growth medium	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program as required, dependent on material to be ripped eg sand, gravel, clay. Assume low to medium level disturbance - see assumtpions	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
	signage	@	50	50		0.00	enter number of warning signs as approriate	
						0.00		
Sediment Management	sediment traps/dams	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 2 TOTAL						$0.00		

Domain 3: Hard Rock Pits and Quarries

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Stabilisation of Pits	Drill and blast faces to make safe OR	m^3	1.20-1.60	1.60		0.00	Volume is worked out be multiplying length of bench by width and height to reduce angle to make it safe.	
	scaling, battering, pushing walls	m^3	1.21-3.00	3.00		0.00	volume requiring reshaping	
	abandonment bund and pit access closed	m	19.00-63.25	30.00		0.00	required where final pit includes steep faces (>18o). Includes bund (2m high , 5m base) around pit and closure of ramp	captured in DSO sec calc
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program around pit and pit floors as required	
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water .	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
	fencing	m	10.0-30.0	30.00	1000	30000.00	construct a standard stock fence around the site	additional fencing due to increased pit
	signage	@	50	50	2	100.00	enter number of warning signs as appropriate	
						30100.00		
Infill of pits	infill with tailings or waste rock	m^3	2.00-4.00	4.00		0.00	haul and dump of waste rock or tailings. Distance needs to be considered.	will be in dso security calc
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping	
	source cart and spread suitable material for growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium and only if does not require egineered capping design for ARD/metals mitigation. Assume min thickness of 0.5m	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water on top of capped pit area if required.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Sediment Management	sediment traps/dams	m^3	2.5-2.9	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 3 TOTAL						$30,100.00		

NORTHERN TERRITORY GOVERNMENT

Domain 4: Underground Workings

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Portals, Declines and Shafts	barricading portal/declines/adits	@	1500-2500	2500.00		0.00	barricading of portal with steel grill to make safe and ensure access cnnot be gained but will allow movement of bats	
	sealing portal/decline	@	15000-25000	25000.00		0.00	OR sealing portal with concrete and backfill to make safe and ensure access cannot be gained	
	capping/sealing shafts	@	10000-25000	10000.00		0.00	cap shafts using reinforced concrete slab. Dependent on size	
	shaft infilling	m^3	8.00-20.0	10.00		0.00	filling of shafts using onsite material	
	seal ventilation fans	@	27500	27500.00		0.00	seal and rehab ventilation fans to make safe.	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program in area as required	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
DOMAIN 4 TOTAL						$0.00		

Domain 5: Tailings Storage Facilities and Dams

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Water Dams, Ponds	clean water dams - stabilise and make safe	@	2000-2200	2000.00		0.00	minor earthworks	
	or backfill to natural surface	m^3	2.00-5.00	2.00	12000	24000.00	backfilled with onsite material. Haul distance sliding scale from $2/m3 for up to 1km, up to $5/m3 for up to 5km or greater.	
	dirty water dams - drain and remove sediment	m^3	5.00-7.50	7.50		0.00	includes draining the dam to the pit or other appropriate place, removing 500mm of potentially contaminated sediments to be buried in the pit or other disposal area. Must consider the distance from dam to disposal area.	
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping	
	source cart and spread suitable material for capping/growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium Assume min thickness of 0.5m	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	final trim, deep rip	ha	550-1600	1600.00	1	1280.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1500.00	1	1200.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation be direct seeding	ha	1200-2000	2000.00	1	1600.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						28080.00		
Tailings Dams	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the TSF. Must have appropriate chemical and physical properites. Required whether for engineered design or growth medium.	
	apply capping design treatment as required eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from TSF. Capping layer assumed to be no less than 2m thick.	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	reshape walls and surrounds	ha	1400-5500	1400.00		0.00	area requiring stabilisation and reshaping works around the walls of the emplacement	
	fianl trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation be direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
	seepage management - recovery and treatment	@	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.	
	seepage management - wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning	
Other						0.00		
						0.00		
DOMAIN 5 TOTAL						$28,080.00		

NORTHERN TERRITORY GOVERNMENT

Domain 6: Stockpiles & Waste Rock Dumps

existing wrd capture in prev mmp, dso wast rock dump captured in next state of security

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Oxide waste rock dumps and extractive product stockpiles	Recontouring/battering for stabilisation	m^2	2.00-3.60	3.60		0.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation	
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00		0.00	enter the area requiring minor reshaping to 12-18° slopes and deep ripping to enhance revegetation	
	unshaped requiring major earthworks, trim and deep rip	m^3	1.21-4.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° Or as specified in MMP) and deep ripping	
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of WRD.	
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that WRD material is suitable as a growth medium	
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	carting of stockpiles offsite or WRD to pit. Consider carting distance	
	trim, deep rip if required	ha	550-1600	1600.00		0.00	ripping stockpiles or surrounds if required.Assume ripping of waste rock dumps undertaken during reshaping.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Waste rock dumps with AMD or metals	unshaped requiring major earthworks, trim and deep rip	m^3	4.00-6.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° or as specified in MMP) and deep ripping	
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00		0.00	enter the are requiring minor reshaping and deep ripping to enhance revegetation	
	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the WRD. Must have appropriate chemical and physical properites.	
	apply capping design treatment eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from WRD. Capping layer assumed to be no less than 2m thick.	
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	removal to pit. Haulage distance needs to be considered at an additonal $1/km	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that capping material is suitable as a growth medium	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	700.00		0.00	earthworks for banks and drains to manage surface water on top of WRD area if required.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Leachate and sediment management	Active recovery treatment of problem leachate	item	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.	
	Wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning	
	dams for sediment control	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 6 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 7: Exploration

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Drillholes, Pads, sumps, costeans	capping drillholes 30cm below ground	@	80-275	80.00		0.00	Cut collar, insert plug and backfill. Assume using, concrete or plastic cone plugs or bridge (no 'occy' plugs) Depends on number of holes	
	grout with concrete	@	1250	1250.00		0.00	Assume total grouting of drillhole	
	empty and remove plastic sample bags	hole	25-235	100.00		0.00	return cuttings to hole and remove plastic bags to a waste disposal facility. Bags cannot be disposed of on site.	
	ripping/scarifying pads	ha	440-2500	1600.00		0.00	Minor ripping/scarifying of pads to depth of 0.3m to assist vegetation in areas of flat/gentle terrain, includes sump infilling. Sumps should not remain open for extended periods of time.	
	reshape drill pads	@	320	320.00		0.00	Required in steep terrain where earthworks required with excavator/dozer to return pad to slope and establish erosion control, includes sump infilling. Using PC650 excavator or equivalent assumes one pad per hour @$320/hr.	
	infilling costeans	m^3	2.00-3.00	3.00		0.00	Backfilling of all costeans/trenches. Assumes material does not have to be carted.	
	bulk sample pits	m^3	2.00-8.00	2.00		0.00	dependent on depth of pit and if battering of walls required to form to 18° slope	
	contouring for erosion control	ha	700-1540	1500.00		0.00	minor pushing to construct water management structures such as contour banks and diversion drains as required.	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program. **this may be carried out when reshaping pads	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha if required. Required where area of disturbance is significant.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
Tracks and Gridlines	ripping/scarifying minor tracks and gridlines	km	120-500	500.00		0.00	assume using grader or equivalent to rip to 0.3m and no windrows, establishing erosion control measures (eg bunds) as required	
	ripping major tracks and roads	km	550-1000	1000.00		0.00	pushing in windrows and ripping track and establishing erosion control measures (ie bunds) across tracks as required	
	removal of gridpegs	item	1500	1500.00		0.00	includes removal offsite of all grid pegs in exploration area	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program if required	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
DOMAIN 7 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 8: Access and Haul Roads								
Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Haul Roads	remove ARD material from road	m3/bcm	2.50-5.50	5.50		0.00	where haul road has been constructed with waste rock material that is leaching ARD removal and disposal in pit or similar will be required	
	reshape and deep rip	ha	2000-5000	5000.00		0.00	windrows are pulled back and edges battered, area is deep ripped (road 12mwide)	
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required.	
						0.00		
Access Roads	breaking and removal of bitumen	m3	12.00-17.00	17.00		0.00	Includes area of bitument in roads car parks etc which needs to be removed and disposed of appropriately	
	reshape and deep rip	ha	2000-5000	2500.00		0.00	windrows are pulled back and edges battered, area is deep ripped	
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required.	
						0.00		
Revegetation activities - all roads	source cart and spread topsoil	m^3	2.50-5.50	5.50		0.00	assume minimum of 10cm depth	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
DOMAIN 8 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 9: River Diversions

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Creek/River	channel maintenance	m	165.00	165.00		0.00	Includes earthwork repairs and stabilisation following flow events.	
	vegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	vegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	vegetation maintenance	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
DOMAIN 9 TOTAL						$0.00		

Decommissioning & Post Closure Management

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Decommissioning and Closure	mobilisation/demobilisation	km	10.00-15.00	15.00		0.00	determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 5 pieces of machinery required per site. Adjust formula if necessary.	Previously included
	Contaminated site assessment	@	35000	35000.00		0.00	has a contaminated site assessment been undertaken? If not this should be included for large metalliferous mines.	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	5	1,200.00	Include total disturbed area , consider for minimum of 2 years during closure for larger sites only. Entry automated form 'Key Information' tab.	
	Contractor accommodation, messing and travel costs	man day	210-320	320.00		0.00	Assume 5-9 people required for 2-10 weeks (or more) depending on size of site *quantity = number of days X number of people (eg 9 persons for 50 days = 450 man days)	
	Closure management	yr	110,000 - 300,000	110000.00	0	0.00	This includes project manaement team assuming 1 - 3 persons based on the magnitude of the process salaries, oncosts, tender preparation and closure report and coordination of works. Consider part of year only for small sites.	will be included in DSO Calc
Post Closure	mobilisation/demobilisation	km	10.00-15.00	15.00		0.00	Determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 1 piece of machinery required per site.	will be included in DSO Calc
	Post closure water monitoring	yr	adjust post closure worksheet - no entry required			0.00	Monitoring and measurement requirements that may be needed following the closure of the project - use the 'post closure worksheet' Estimated quanity refers to number of years required post closure	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	7	1,800.00	Include total rehabilitated area , assumed for minimum of 3 years post closure Entry automated form 'Key Information' tab.	
	Earthwork maintenance	ha	1,100	1100.00	0	0.00	Assume 20% failure rate for the total areas of contructed landforms (eg WRDS, TSF etc) for a period of 2 years (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Revegetation maintenance, monitoring & assessment	ha	1,250 - 2,500	2500.00	1	2,400.00	Assume a 20% failure rate for all disturbed areas for a period of 2 years. (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Project management	yr	20,000	20000.00		0.00	This includes tender preparation, financial reporting procurement, contractor management etc. Time frame assumed is 1-10 years depending upon the site & the complexity of the issues present	will be included in DSO Calc
	fire break maintenance	km	50-75	72.00		0.00	Grading of firebreaks during and after closure for a period of 1-10 years depending on site size *quantity = number km x number years	
						5,400.00		
POST CLOSURE TOTAL						5,400.00		

POST CLOSURE WATER QUALITY MONITORING WORKSHEET

SUMMARY

NOTE:
Operators must enter numbers in the blue boxes, to the appropriate timeframes and reflecting the structures present on individual sites.

Item	Component	Cost ($)
1	Groundwater monitoring - Analytical	$0
2	Surface water monitoring - Analytical	$0
3	Field sampling and Expenses	$0
4	Water quality interpretation & reporting	$0
	TOTAL	**$0**

1 GROUNDWATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site structures	Size (ha)	Enter the number of structures	Sampling points	Sampling per year	Enter the number of years 0-10	Subtotal cost ($)
Whole of site	All		5	2	10	0
Extraction bores for use after closure			1	2	10	0
Discrete infrastructure areas			3	2	10	0
Underground fuel storage areas			1	2	10	0
Pit voids/declines	All		3	2	10	0
Waste rock dump - oxide	<5		2	1	10	0
	5 - 20		3	2	10	0
	>20		4	2	10	0
Waste rock dump - mixed or sulfide	<5		2	2	10	0
	5 - 20		4	2	10	0
	>20		6	2	10	0
Tailings dam / residue disposal ponds	0 -20		3	2	10	0
	21 - 100		4	2	10	0
	100 - 150		6	2	10	0
	>150		10	2	10	0
Heap leach pad	<10		3	2	10	0
	>10		5	2	10	0
Water containment/retention ponds (water not suitable for passive release)	<10		2	1	10	0
	10 - 20		3	2	10	0
	>20		4	2	10	0
Waste disposal areas			2	1	10	0
Other						0
Other						0
Other						0
					sub total	*$0*

Denotes sampling of bores adjacent to structures

2 SURFACE WATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 1-10	Subtotal cost ($)
Water retaining structures with no discharge		1	1	10	0
Water retaining structures with possible discharge		1	2	10	0
Bioremediation structures		1	1	10	0

PLUS

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Perenial streams discharging from site		2	4	10	0
Ephemeral streams discharging from site		2	2	10	0

OR Please note: Fill out either the streams or the site operational complexity, size and climate section, but not both

Site operation complexity & size and climate	Default sampling sites	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Arid zone site - small to medium	5	1		0
Arid zone site - large	10	2		0
Wet/dry tropics site - small size, simple issues	10	2		0
Wet/dry tropics site - small size, moderate -complex issues	10	4		0
Wet/dry tropics site - medium size, simple issues	15	2		0
Wet/dry tropics site - medium size, moderate -complex issues	15	4		0
Wet/dry topics site - large size, moderate -simple issues	25	4		0
Wet/dry topics site - large size, moderate -complex issues	30	4		0
			sub total	*$0*

3 FIELD SAMPLING & EXPENSES

Assumptions:
Road travel <200km = day trip , 2 people, no accommodation, fuel (300km return) & expenses
Road travel 200 - 500km = minimum of 1 nights accom , 1 day travel + 1 night for each additional sampling day, 2 people , fuel (av 800km return)
Road travel >500km = minimum of 2 nights accom, 2 days travel + 1 night for each additional sampling day, 2 people, fuel (av 1600km return)
Fuel = $1.20/L @ 6km/L Accommodation & meals = $130 per person /per night Personnel = $800 per person per day Air travel = $2000 per person return Expenses (e.g. vehicle/consumables etc) $100/day

Travel and expenses	Enter No. of years 0-10	Distance from nearest centre eg Darwin	Quantity	Enter est. days each sampling trip	Subtotal cost ($)
Field trips - Road travel		<200km	4	1	0
		200 - 500km	4	1	0
		> 500km	4	1	0
Field trip - Air travel (Proof of availability & suitability required)			4	1	0
				sub total	*$0*

4 WATER QUALITY INTERPRETATION AND REPORTING

Item	Site size& water mgmt challenges	Quantity	Enter No. of yrs 0-10	Unit cost ($)	Subtotal cost ($)
Quaterly data collation & interpretation	small	3		2,500	0
	medium	3		5,000	0
	large	3		10,000	0
Annual data collation & interpretation	small	1		1,000	0
	medium	1		5,000	0
	large	1		20,000	0
Other reporting		1		5,000	0
				sub total	*$0*

Assumptions

Ripping
deep rip low level disturbance - 14G grader or equivalent with multishank ripper to 3m width. At $180/hr and at 3km/hr with 0.83 efficiency will cover 7500m2/hr = $240/ha
Deep rip medium level disturbance- Cat D6 with triple shank rippers ripping to a depth of 0.3m and 3m width covered per pass. At $220/hr and 2km/hr with 0.83 efficiency will cover 4980m2/hr = $441/ha
deep rip high level of disturbance and compaction - using a Cat D9 with multishank ripper to a width of 2.64m. At $300/hr and 1.6km/hr with 0.83 efficiency will cover 3320m2/hr = $900/ha

tracks
Assume D9 used to rip to depth of 0.3m, which can do 1.36km/hr. Assume $300/hr. Requires 2 passes on track ~5m wide = $440/km.
Windrows - 14G grader will grade in windrows at 3km/hr (2nd gear) and require two passes each side of road = 1500m of road/hr @ $180/hr =$120/km
two passes with grader to rip track <4m wide at 3km/hr =$120/km

grading firebreaks with 14G equivalent grader @$180/hr. Blade width of 14', travelling at ~5km/hr. Two passes required = 24minutes/km=$72/km

drillpads - major reshaping

using a Komatsu PC650 excavator or similar at $320/hr, can move 300bcm/hr assume one pad per hour

haul roads
haulroads assumed to be an average of 12m wide with an additional buffer of 5m each side of the road which has been cleared or significantly disturbed. Surfaces are heavily compacted and constructed of imported fill.

Road fill which may be ARD producing is removed using an excavator ($320/hr) and 3x50t dump truck ($750/hr), watercart @ $140/hr, dozer@$250/hr. Excavator will produce 300bcm/hr = $4.86/bcm

Stockpile/WRD removal/pit infill
Assume load and haul to pit using excavator and 3 dump trucks. Excavator ($320/hr) and 3 trucks ($840/hr total) as above = $3.87/bcm

bund - assume excavator and 3 dump trucks, with minimal haul distance (no greater than 1km.)
As per road fill above using and excavator and 3 trucks = $3.87/bcm. If bund is 5m wide and 2m high = 5m3/m then bund ~$19/m to construct

fertiliser - current (09/01/09) Landmark price per tonne for NPK fertiliser = $1487.50
fertiliser applied at 500kg/ha (best practice) = $743.75/ha
If applied at only 100kg/ha = $148.75/ha
application dependent on growth medium

RC drillpads assume average 10mx10m, DDH pads 10mx20m

post closure cost for pest, fire and weed management comes from contrators estimate for Woodcutters site

contractor costs for meals, accommodation, travel and supervision:
meals & accom @ $150/head/day
travel @$60/head/hr
supervision@$1000/day
so for 10.5hr day daily costs = $1845/hr/300bcm/hr of production = $6.15/bcm
This tool has assumed cost of $210-$320/man/day

AT3-010		last review: June 2009

DITT Security Calculation Form

Security Calculation Summary

Details: This calculation corresponds with section 6.2 of the MMP			
Assessment Date	16/05/2023	**Mining Officer**	JTyne
Project	Wonarah	**Authorisation #**	TBD
Operator	Avenira	**Operator Contact**	Steve Harrison
MMP reference	36:M2013/0039-0624~0001		

New Authorisation	MMP Renewal/amendment	Audit Finding	Client Request
X			

Domains	Calculated Cost
1: Site Infrastructure	$0.00
2: Extractive Workings - Sand, Clay & Gravel	$0.00
3: Hard Rock Pits & Quarries	$13,600.00
4: Underground Workings	$0.00
5: Tailings Storage Facilities and Dams	$0.00
6: Stockpiles & Waste Rock Dumps	$233,100.00
7: Exploration	$0.00
8: Access and Haul Roads	$30,600.00
9: River Diversions	$0.00
Decommissioning & Post Closure Management	$279,629.00
Sub-Total - All Domains	$556,929.00
CONTINGENCY @15%	$83,539.35
TOTAL COST	$640,468.35
10% Discount	$64,047

NORTHERN TERRITORY GOVERNMENT

DISTURBANCE AREA INVENTORY				
Whole of site summary	**Total Area (ha)**	**Progressively rehabilitated area**	**Remaining area**	
Lease surface area				
Disturbed operational area				
Above grade landforms				
Waste rock dump #1	4.1			increased wrd footprint
Waste rock dump #2				
Waste rock dump #3				
Waste rock dump #4				
Waste rock dump #5				
Tailings Dam #1				
Tailings Dam #2				
Tailings Dam #3				
Tailings Dam #4				
Mining area #1				
Mining area #2				
Mining area #3				
Mining area #4				
Mining area #5				
Mining area #6				
Extractive areas				
haul roads	3.6			proposed realignment
access roads				
water ponds/dams				
Area of infrastructure				
camp area				
area of drill pads and sumps				
costeans/pits				
tracks/roads				
other				
TOTAL	**7.7**			

NORTHERN TERRITORY GOVERNMENT

Domain 1: Infrastructure

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Process Plant, Mill, Crusher area	disconnect and terminate services	@	10000-27500	26700.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.	
	demolish remove conveyor system	m	100-250	140.00		0.00	Enter the total length of conveyors	
	demolish/remove crusher, process plant and mills	m^2	160-210	210.00		0.00	enter the total surface area of process plant and mills etc. If multi-story the area should be the sum of the surface area of all floors.	
	remove concrete pads and footings	m^2	10-30	15.00		0.00	enter the total area of buildings, workshops etc. Cost dependent on thickness. Assume $10/m2 for <300mm thick, $30/m2 for >300mm thick. (default $15 if unknown)	
	remove mobile plant	hr	140-300	200.00		0.00	consider distance to remove all mobile plant to the nearest centre or to Darwin.	
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.	
	deconstruct and remove large tanks - eg leach	@	35000-165000	35000.00		0.00	enter the number of tanks	
	deconstruct and remove small tanks	@	10000-30000	10000.00		0.00	enter the number of tanks	
						0.00		
Main Workshop and Stores area	disconnect and terminate services	@	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area. Are there any remote or field based workshops to include	
	remove concrete pads and footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. Include any areas of carpark and washdown pads, bulk fuel bunding and refuelling areas.	
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.	
	underground tank removal - large hydrocarbon (>5000L)	@	48000-82500	60000.00		0.00	removal of underground tank and all pipework, bunds and any contamination	
	underground tank removal - small hydrocarbon (up to 5000L)	@	20000-21000	20000.00		0.00	removal of underground tank and all pipework, bunds and any contamination	
	above ground tank removal - hydrocarbon	@	200.00	200.00		0.00	enter number of tanks	
	remove hydrocarbon contamination	m^3	3.00-5.00	5.00		0.00	enter the volume to be removed to pit void for appropriate rehabilitation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.	
	remediation on site of hydrocarbon contamination	m^3	30-55	40.00		0.00	enter the volume of material requiring onsite remediation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.	
						0.00		
Administration	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.	
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.	
	remove bitumen from sealed carparks etc	m^2	12.00-17.00	17.00		0.00	enter total area of carparks. Includes removal offsite to appropriate facility	
	remove concrete pads, footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)	
	waste disposal offsite	@	650	650.00		0.00	assumes removal offsite to a waste disposal facility. Adjust if disposing at onsite facility	
						0.00		
Sewerage/Water treatment plant	disconnect and terminate services	item	2500-5000	2500.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.	
	remove contaminated soil	m^3	3.00-5.00	5.00		0.00	removal to pit void for appropriate rehabilitation	
						0.00		
Accommodation Camp	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.	
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.	
						0.00		
Airstrip, borefields, other	remove concrete pads footings and bitumen	m^2	10-30	10.00		0.00	enter total area (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)	
	demolish and remove sheds and storage tanks	m^2	70-90	75.00		0.00	enter area of sheds and tanks	
	production/dewatering bore closure	@	2000-3300	2000.00		0.00	sealing and rehabilitation	
	observation bore closure	@	500	500.00		0.00	includes sealing and rehabilitation to make safe.	
						0.00		
Revegetation Activities - all infrastructure areas	Deep rip	ha	550-1100	1100.00		0.00	Enter all areas disturbed by infrastructure from above, including laydown areas Assume highly disturbed and compacted areas - see assumptions.	
	source cart and spread topsoil	m^3	2.50-5.50	5.50		0.00	assume minimum of 10cm depth	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Other	remove powerlines	km	9800-15000	15000.00		0.00	include dismantling and removal of lines and poles from the site	
	remove pipelines	km	1400-1800	1400.00		0.00	remove polypipe >300mm diameter. Assumes removal by 3 persons via truck to nearest location.	
						0.00		
DOMAIN 1 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 2: Extractive Workings - Sand, Clay & Gravel

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Pits	Scaling, battering for stabilisation	m^2	1.21-3.00	3.00		0.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation	
	backfilling of pits	m^3	4.00-5.00	5.00		0.00	enter volume of material to be backfilled into pit	
	abandonment bund and pit access closed	m	20.00-63.25	50.00		0.00	required where final pit includes steep faces. Includes bund around pit and closure of ramp. Bund assumed to be 2m high and 5m wide at base	
	structural works for drainage	ha	700-1500	1500.00		0.00	earthworks for banks and drains to manage surface water .	
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that pit material is suitable as a growth medium	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program as required, dependent on material to be ripped eg sand, gravel, clay. Assume low to medium level disturbance - see assumtpions	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
	signage	@	50	50		0.00	enter number of warning signs as approriate	
						0.00		
Sediment Management	sediment traps/dams	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 2 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 3: Hard Rock Pits and Quarries

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Stabilisation of Pits	Drill and blast faces to make safe OR	m^3	1.20-1.60	1.60		0.00	Volume is worked out be multiplying length of bench by width and height to reduce angle to make it safe.	
	scaling, battering, pushing walls	m^3	1.21-3.00	3.00		0.00	volume requiring reshaping	
	abandonment bund and pit access closed	m	19.00-63.25	30.00	450	13500.00	required where final pit includes steep faces (>18o). Includes bund (2m high , 5m base) around pit and closure of ramp	approx 1km pit perimeter, 550m already accounted for
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program around pit and pit floors as required	
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water .	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
	fencing	m	10.0-30.0	30.00		0.00	construct a standard stock fence around the site	
	signage	@	50	50	2	100.00	enter number of warning signs as appropriate	
						13600.00		
Infill of pits	infill with tailings or waste rock	m^3	2.00-4.00	2.00		0.00	haul and dump of waste rock or tailings. Distance needs to be considered.	
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping	
	source cart and spread suitable material for growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium and only if does not require egineered capping design for ARD/metals mitigation. Assume min thickness of 0.5m	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water on top of capped pit area if required.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Sediment Management	sediment traps/dams	m^3	2.5-2.9	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 3 TOTAL						$13,600.00		

Domain 4: Underground Workings

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Portals, Declines and Shafts	barricading portal/declines/adits	@	1500-2500	2500.00		0.00	barricading of portal with steel grill to make safe and ensure access cnnot be gained but will allow movement of bats	
	sealing portal/decline	@	15000-25000	25000.00		0.00	OR sealing portal with concrete and backfill to make safe and ensure access cannot be gained	
	capping/sealing shafts	@	10000-25000	10000.00		0.00	cap shafts using reinforced concrete slab. Dependent on size	
	shaft infilling	m^3	8.00-20.0	10.00		0.00	filling of shafts using onsite material	
	seal ventilation fans	@	27500	27500.00		0.00	seal and rehab ventilation fans to make safe.	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program in area as required	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
DOMAIN 4 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 5: Tailings Storage Facilities and Dams

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Water Dams, Ponds	clean water dams - stabilise and make safe	@	2000-2200	2000.00		0.00	minor earthworks	
	or backfill to natural surface	m^3	2.00-5.00	5.00		0.00	backfilled with onsite material. Haul distance sliding scale from $2/m3 for up to 1km, up to $5/m3 for up to 5km or greater.	
	dirty water dams - drain and remove sediment	m^3	5.00-7.50	7.50		0.00	includes draining the dam to the pit or other appropriate place, removing 500mm of potentially contaminated sediments to be buried in the pit or other disposal area. Must consider the distance from dam to disposal area.	
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping	
	source cart and spread suitable material for capping/growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium Assume min thickness of 0.5m	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation be direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
Tailings Dams	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the TSF. Must have appropriate chemical and physical properites. Required whether for engineered design or growth medium.	
	apply capping design treatment as required eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from TSF. Capping layer assumed to be no less than 2m thick.	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.	
	reshape walls and surrounds	ha	1400-5500	1400.00		0.00	area requiring stabilisation and reshaping works around the walls of the emplacement	
	fianl trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation be direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
	seepage management - recovery and treatment	@	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.	
	seepage management - wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning	
Other						0.00		
						0.00		
DOMAIN 5 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 6: Stockpiles & Waste Rock Dumps

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DPIR)
Oxide waste rock dumps and extractive product stockpiles	Recontouring/battering for stabilisation	m^2	2.00-3.60	3.60	41000	147600.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation	
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00	3.3	5280.00	enter the area requiring minor reshaping to 12-18° slopes and deep ripping to enhance revegetation	4.1ha WRD + 0.8ha existing stockpile - 1.6 ha accounted for in stage 1
	unshaped requiring major earthworks, trim and deep rip	m^3	1.21-4.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° Or as specified in MMP) and deep ripping	
	structural works for drainage	ha	700-1540	1500.00	4	6000.00	earthworks for banks and drains to manage surface water on top of WRD.	
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50	8200	45100.00	required if it has not been demonstrated that WRD material is suitable as a growth medium	0.2m depth over 4.1ha
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	carting of stockpiles offsite or WRD to pit. Consider carting distance	
	trim, deep rip if required	ha	550-1600	1600.00	4.10	6560.00	ripping stockpiles or surrounds if required.Assume ripping of waste rock dumps undertaken during reshaping.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00	3	18000.00	includes acquisition of tubestock, fertiliser and guarding as necessary	as per operator mmp
	revegetation by direct seeding	ha	1200-2000	2000.00	2	4000.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00	4	560.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						233100.00		
Waste rock dumps with AMD or metals	unshaped requiring major earthworks, trim and deep rip	m^3	4.00-6.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° or as specified in MMP) and deep ripping	
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00		0.00	enter the are requiring minor reshaping and deep ripping to enhance revegetation	
	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the WRD. Must have appropriate chemical and physical properites.	
	apply capping design treatment eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from WRD. Capping layer assumed to be no less than 2m thick.	
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	removal to pit. Haulage distance needs to be considered at an additonal $1/km	
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that capping material is suitable as a growth medium	
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required	
	structural works for drainage	ha	700-1540	700.00		0.00	earthworks for banks and drains to manage surface water on top of WRD area if required.	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						0.00		
Leachate and sediment management	Active recovery treatment of problem leachate	item	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.	
	Wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning	
	dams for sediment control	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps	
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material	
Other						0.00		
						0.00		
DOMAIN 6 TOTAL						$233,100.00		

NORTHERN TERRITORY GOVERNMENT

Domain 7: Exploration

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Drillholes, Pads, sumps, costeans	capping drillholes 30cm below ground	@	80-275	80.00		0.00	Cut collar, insert plug and backfill. Assume using, concrete or plastic cone plugs or bridge (no 'occy' plugs) Depends on number of holes	
	grout with concrete	@	1250	1250.00		0.00	Assume total grouting of drillhole	
	empty and remove plastic sample bags	hole	25-235	100.00		0.00	return cuttings to hole and remove plastic bags to a waste disposal facility. Bags cannot be disposed of on site.	
	ripping/scarifying pads	ha	440-2500	1600.00		0.00	Minor ripping/scarifying of pads to depth of 0.3m to assist vegetation in areas of flat/gentle terrain, includes sump infilling. Sumps should not remain open for extended periods of time.	
	reshape drill pads	@	320	320.00		0.00	Required in steep terrain where earthworks required with excavator/dozer to return pad to slope and establish erosion control, includes sump infilling. Using PC650 excavator or equivalent assumes one pad per hour @$320/hr.	
	infilling costeans	m^3	2.00-3.00	3.00		0.00	Backfilling of all costeans/trenches. Assumes material does not have to be carted.	
	bulk sample pits	m^3	2.00-8.00	2.00		0.00	dependent on depth of pit and if battering of walls required to form to 18° slope	
	contouring for erosion control	ha	700-1540	1500.00		0.00	minor pushing to construct water management structures such as contour banks and diversion drains as required.	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program. **this may be carried out when reshaping pads	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha if required. Required where area of disturbance is significant.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
Tracks and Gridlines	ripping/scarifying minor tracks and gridlines	km	120-500	500.00		0.00	assume using grader or equivalent to rip to 0.3m and no windrows, establishing erosion control measures (eg bunds) as required	
	ripping major tracks and roads	km	550-1000	1000.00		0.00	pushing in windrows and ripping track and establishing erosion control measures (ie bunds) across tracks as required	
	removal of gridpegs	item	1500	1500.00		0.00	includes removal offsite of all grid pegs in exploration area	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program if required	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
DOMAIN 7 TOTAL						$0.00		

NORTHERN TERRITORY GOVERNMENT

Domain 8: Access and Haul Roads

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Haul Roads	remove ARD material from road	m3/bcm	2.50-5.50	5.50		0.00	where haul road has been constructed with waste rock material that is leaching ARD removal and disposal in pit or similar will be required	
	reshape and deep rip	ha	2000-5000	3000.00	4	10800.00	windrows are pulled back and edges battered, area is deep ripped (road 12mwide)	
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required.	
						10800.00		
Access Roads	breaking and removal of bitumen	m3	12.00-17.00	17.00		0.00	Includes area of bitument in roads car parks etc which needs to be removed and disposed of appropriately	
	reshape and deep rip	ha	2000-5000	2500.00		0.00	windrows are pulled back and edges battered, area is deep ripped	
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required.	
						0.00		
Revegetation activities - all roads	source cart and spread topsoil	m^3	2.50-5.50	3.50	3600	12600.00	assume minimum of 10cm depth	
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	revegetation by direct seeding	ha	1200-2000	2000.00	4	7200.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions	
						19800.00		
DOMAIN 8 TOTAL						$30,600.00		

Domain 9: River Diversions

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Creek/River	channel maintenance	m	165.00	165.00		0.00	Includes earthwork repairs and stabilisation following flow events.	
	vegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)	
	vegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha	
	vegetation maintenance	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						0.00		
DOMAIN 9 TOTAL						$0.00		

Decommissioning & Post Closure Management

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	Comment (eg when $/UOM differs from DME)
Decommissioning and Closure	mobilisation/demobilisation	km	10.00-15.00	15.00	480	36,000.00	determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 5 pieces of machinery required per site. Adjust formula if necessary.	for one additional piece of earthworking equipment for increased size of project
	Contaminated site assessment	@	35000	35000.00		0.00	has a contaminated site assessment been undertaken? If not this should be included for large metalliferous mines.	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	15	3,850.00	Include total disturbed area , consider for minimum of 2 years during closure for larger sites only. Entry automated form 'Key Information' tab.	
	Contractor accommodation, messing and travel costs	man day	210-320	320.00	10	3,200.00	Assume 5-9 people required for 2-10 weeks (or more) depending on size of site *quantity = number of days X number of people (eg 9 persons for 50 days = 450 man days)	
	Closure management	yr	110,000 - 300,000	110000.00	1	55,000.00	This includes project manaement team assuming 1 - 3 persons based on the magnitude of the process salaries, oncosts, tender preparation and closure report and coordination of works. Consider part of year only for small sites.	
Post Closure	mobilisation/demobilisation	km	10.00-15.00	15.00		0.00	Determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 1 piece of machinery required per site.	prev included
	Post closure water monitoring	yr	adjust post closure worksheet - no entry required			156,300.00	Monitoring and measurement requirements that may be needed following the closure of the project - use the 'post closure worksheet' Estimated quanity refers to number of years required post closure	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	23	5,775.00	Include total rehabilitated area , assumed for minimum of 3 years post closure Entry automated form 'Key Information' tab.	
	Earthwork maintenance	ha	1,100	1100.00	2	1,804.00	Assume 20% failure rate for the total areas of contructed landforms (eg WRDS, TSF etc) for a period of 2 years (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Revegetation maintenance, monitoring & assessment	ha	1,250 - 2,500	2500.00	3	7,700.00	Assume a 20% failure rate for all disturbed areas for a period of 2 years. (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Project management	yr	20,000	20000.00	1	10,000.00	This includes tender preparation, financial reporting procurement, contractor management etc. Time frame assumed is 1-10 years depending upon the site & the complexity of the issues present	
	fire break maintenance	km	50-75	72.00		0.00	Grading of firebreaks during and after closure for a period of 1-10 years depending on site size *quantity = number km x number years	
						279,629.00		
POST CLOSURE TOTAL						279,629.00		

NORTHERN TERRITORY GOVERNMENT

POST CLOSURE WATER QUALITY MONITORING WORKSHEET

NOTE:
Operators must enter numbers in the blue boxes, to the appropriate timeframes and reflecting the structures present on individual sites.

SUMMARY

Item	Component	Cost ($)
1	Groundwater monitoring - Analytical	$25,000
2	Surface water monitoring - Analytical	$2,500
3	Field sampling and Expenses	$118,800
4	Water quality interpretation & reporting	$10,000
	TOTAL	$156,300

1 GROUNDWATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site structures	Size (ha)	Enter the number of structures	Sampling points	Sampling per year	Enter the number of years 0-10	Subtotal cost ($)	
Whole of site	All	1	5	2	10	25,000	
Extraction bores for use after closure			1	2	10	0	
Discrete infrastructure areas			3	2	10	0	
Underground fuel storage areas			1	2	10	0	
Pit voids/declines	All		3	2	10	0	*Denotes sampling of bores adjacent to structures*
Waste rock dump - oxide	<5		2	1	10	0	
	5 - 20		3	2	10	0	
	>20		4	2	10	0	
Waste rock dump - mixed or sulfide	<5		2	2	10	0	
	5 - 20		4	2	10	0	
	>20		6	2	10	0	
Tailings dam / residue disposal ponds	0 -20		3	2	10	0	
	21 - 100		4	2	10	0	
	100 - 150		6	2	10	0	
	>150		10	2	10	0	
Heap leach pad	<10		3	2	10	0	
	>10		5	2	10	0	
Water containment/retention ponds (water not suitable for passive release)	<10		2	1	10	0	
	10 - 20		3	2	10	0	
	>20		4	2	10	0	
Waste disposal areas			2	1	10	0	
Other						0	
Other						0	
Other						0	
					sub total	*$25,000*	

2 SURFACE WATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 1-10	Subtotal cost ($)
Water retaining structures with no discharge	1	1	1	10	2,500
Water retaining structures with possible discharge		1	2	10	0
Bioremediation structures		1	1	10	0

PLUS

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Perenial streams discharging from site		2	4	10	0
Ephemeral streams discharging from site		2	2	10	0

OR Please note: Fill out either the streams or the site operational complexity, size and climate section, but not both

Site operation complexity & size and climate	Default sampling sites	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Arid zone site - small to medium	5	1		0
Arid zone site - large	10	2		0
Wet/dry tropics site - small size, simple issues	10	2		0
Wet/dry tropics site - small size, moderate -complex issues	10	4		0
Wet/dry tropics site - medium size, simple issues	15	2		0
Wet/dry tropics site - medium size, moderate -complex issues	15	4		0
Wet/dry topics site - large size, moderate -simple issues	25	4		0
Wet/dry topics site - large size, moderate -complex issues	30	4		0
			sub total	*$2,500*

3 FIELD SAMPLING & EXPENSES

Assumptions:
Road travel <200km = day trip , 2 people, no accommodation, fuel (300km return) & expenses
Road travel 200 - 500km = minimum of 1 nights accom , 1 day travel + 1 night for each additional sampling day, 2 people , fuel (av 800km return)
Road travel >500km = minimum of 2 nights accom, 2 days travel + 1 night for each additional sampling day, 2 people, fuel (av 1600km return)
Fuel = $1.20/L @ 6km/L Accommodation & meals = $130 per person /per night Personnel = $800 per person per day Air travel = $2000 per person return Expenses (e.g. vehicle/consumables etc) $100/day

Travel and expenses	Enter No. of years 0-10	Distance from nearest centre eg Darwin	Quantity	Enter est. days each sampling trip	Subtotal cost ($)
Field trips - Road travel		<200km	4	1	0
		200 - 500km	4	1	0
	10	> 500km	2	1	118,800
Field trip - Air travel (Proof of availability & suitability required)			4	1	0
				sub total	*$118,800*

4 WATER QUALITY INTERPRETATION AND REPORTING

Item	Site size& water mgmt challenges	Quantity	Enter No. of yrs 0-10	Unit cost ($)	Subtotal cost ($)
Quaterly data collation & interpretation	small	3		2,500	0
	medium	3		5,000	0
	large	3		10,000	0
Annual data collation & interpretation	small	1	10	1,000	10,000
	medium	1		5,000	0
	large	1		20,000	0
Other reporting		1		5,000	0
				sub total	*$10,000*

NORTHERN TERRITORY GOVERNMENT

Assumptions

Ripping
deep rip low level disturbance - 14G grader or equivalent with multishank ripper to 3m width. At $180/hr and at 3km/hr with 0.83 efficiency will cover 7500m2/hr = $240/ha
Deep rip medium level disturbance- Cat D6 with triple shank rippers ripping to a depth of 0.3m and 3m width covered per pass. At $220/hr and 2km/hr with 0.83 efficiency will cover 4980m2/hr = $441/ha
deep rip high level of disturbance and compaction - using a Cat D9 with multishank
ripper to a width of 2.64m. At $300/hr and 1.6km/hr with 0.83 efficiency will cover 3320m2/hr = $900/ha

tracks
Assume D9 used to rip to depth of 0.3m, which can do 1.36km/hr. Assume $300/hr. Requires 2 passes on track ~5m wide = $440/km.
Windrows - 14G grader will grade in windrows at 3km/hr (2nd gear) and require two passes each side of road = 1500m of road/hr @ $180/hr =$120/km
two passes with grader to rip track <4m wide at 3km/hr =$120/km

grading firebreaks with 14G equivalent grader @$180/hr. Blade width of 14', travelling at ~5km/hr. Two passes required = 24minutes/km=$72/km

drillpads - major reshaping

using a Komatsu PC650 excavator or similar at $320/hr, can move 300bcm/hr assume one pad per hour

haul roads
haulroads assumed to be an average of 12m wide with an additional buffer of 5m each side of the road which has been cleared or significantly disturbed. Surfaces are heavily compacted and constructed of imported fill.
Road fill which may be ARD producing is removed using an excavator ($320/hr) and 3x50t dump truck ($750/hr), watercart @ $140/hr, dozer@$250/hr. Excavator will produce 300bcm/hr = $4.86/bcm

Stockpile/WRD removal/pit infill
Assume load and haul to pit using excavator and 3 dump trucks. Excavator ($320/hr) and 3 trucks ($840/hr total) as above = $3.87/bcm

bund - assume excavator and 3 dump trucks, with minimal haul distance (no greater than 1km.)
As per road fill above using and excavator and 3 trucks = $3.87/bcm. If bund is 5m wide and 2m high = 5m3/m then bund ~$19/m to construct

fertiliser - current (09/01/09) Landmark price per tonne for NPK fertiliser = $1487.50
fertiliser applied at 500kg/ha (best practice) = $743.75/ha
If applied at only 100kg/ha = $148.75/ha
application dependent on growth medium

RC drillpads assume average 10mx10m, DDH pads 10mx20m

post closure cost for pest, fire and weed management comes from contrators estimate for Woodcutters site

contractor costs for meals, accommodation, travel and supervision:
meals & accom @ $150/head/day
travel @$60/head/hr
supervision@$1000/day
so for 10.5hr day daily costs = $1845/hr/300bcm/hr of production = $6.15/bcm
This tool has assumed cost of $210-$320/man/day

AT3-010		last review: June 2009

DITT Security Calculation Form

Security Calculation Summary

Details: This calculation corresponds with section 6.3 of the MMP			
Assessment Date	16/05/2023	**Mining Officer**	JTyne
Project	Wonarah	**Authorisation #**	TBD
Operator	Avenira	**Operator Contact**	Steve Harrison
MMP reference	36:M2013/0039-0624~0001		

Calculation Trigger			
New Authorisation	**MMP Renewal/amendment**	**Audit Finding**	**Client Request**
☒			

Domains	Calculated Cost
1: Site Infrastructure	$0.00
2: Extractive Workings - Sand, Clay & Gravel	$0.00
3: Hard Rock Pits & Quarries	$0.00
4: Underground Workings	$0.00
5: Tailings Storage Facilities and Dams	$0.00
6: Stockpiles & Waste Rock Dumps	$0.00
7: Exploration	$137,380.00
8: Access and Haul Roads	$0.00
9: River Diversions	$0.00
Decommissioning & Post Closure Management	$55,237.50
Sub-Total - All Domains	$192,617.50
CONTINGENCY @15%	$28,892.63
TOTAL COST	$221,510.13

Departmental Assessment (to nearest $)	**$221,510**
10% Discount	**$22,151**
Amended amount	**$199,359**
1% levy	**$1,994**

Operator Assessment (as per MMP - remove cents)	

DISTURBANCE AREA INVENTORY				
Whole of site summary	**Total Area (ha)**	**Progressively rehabilitated area**	**Remaining area**	
Lease surface area				
Disturbed operational area				
Above grade landforms				
Waste rock dump #1				
Waste rock dump #2				
Waste rock dump #3				
Waste rock dump #4				
Waste rock dump #5				
Tailings Dam #1				
Tailings Dam #2				
Tailings Dam #3				
Tailings Dam #4				
Mining area #1				
Mining area #2				
Mining area #3				
Mining area #4				
Mining area #5				
Mining area #6				
Extractive areas				
haul roads				
access roads				
water ponds/dams				
Area of infrastructure				
camp area				
area of drill pads and sumps	9.35			779 drill pads
costeans/pits				
tracks/roads	15.2			38km of track
other				
TOTAL	**24.55**			

Domain 1: Infrastructure

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Process Plant, Mill, Crusher area	disconnect and terminate services	@	10000-27500	26700.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.
	demolish remove conveyor system	m	100-250	140.00		0.00	Enter the total length of conveyors
	demolish/remove crusher, process plant and mills	m^2	160-210	210.00		0.00	enter the total surface area of process plant and mills etc. If multi-story the area should be the sum of the surface area of all floors.
	remove concrete pads and footings	m^2	10-30	15.00		0.00	enter the total area of buildings, workshops etc. Cost dependent on thickness. Assume $10/m2 for <300mm thick, $30/m2 for >300mm thick. (default $15 if unknown)
	remove mobile plant	hr	140-300	200.00		0.00	consider distance to remove all mobile plant to the nearest centre or to Darwin.
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.
	deconstruct and remove large tanks - eg leach	@	35000-165000	35000.00		0.00	enter the number of tanks
	deconstruct and remove small tanks	@	10000-30000	10000.00		0.00	enter the number of tanks
						0.00	
Main Workshop and Stores area	disconnect and terminate services	@	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.
	demolish and remove small buildings	m^2	70-90	90.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area. Are there any remote or field based workshops to include
	remove concrete pads and footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. Include any areas of carpark and washdown pads, bulk fuel bunding and refuelling areas.
	remove contaminated material	m^3	3.00-5.00	5.00		0.00	enter volume of spillage and other contamination for removal to pit or WRD.
	underground tank removal - large hydrocarbon (>5000L)	@	48000-82500	60000.00		0.00	removal of underground tank and all pipework, bunds and any contamination
	underground tank removal - small hydrocarbon (up to 5000L)	@	20000-21000	20000.00		0.00	removal of underground tank and all pipework, bunds and any contamination
	above ground tank removal - hydrocarbon	@	200.00	200.00		0.00	enter number of tanks
	remove hydrocarbon contamination	m^3	3.00-5.00	5.00		0.00	enter the volume to be removed to pit void for appropriate rehabilitation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.
	remediation on site of hydrocarbon contamination	m^3	30-55	40.00		0.00	enter the volume of material requiring onsite remediation. If the volume is not known assume a volume of 3000m3 per fuel storage facility.
						0.00	
Administration	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and offices in the area, including demountables. It does not include workshops.
	demolish and remove industrial workshops and sheds	m^2	160-210	210.00		0.00	enter the total area of workshop facilities in the area.
	remove bitumen from sealed carparks etc	m^2	12.00-17.00	17.00		0.00	enter total area of carparks. Includes removal offsite to appropriate facility
	remove concrete pads, footings	m^2	10-30	10.00		0.00	enter the total area of workshops and buildings. (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)
	waste disposal offsite	@	650	650.00		0.00	assumes removal offsite to a waste disposal facility. Adjust if disposing at onsite facility
						0.00	
Sewerage/Water treatment plant	disconnect and terminate services	item	2500-5000	2500.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.
	remove contaminated soil	m^3	3.00-5.00	5.00		0.00	removal to pit void for appropriate rehabilitation
						0.00	
Accommodation Camp	disconnect and terminate services	item	5000-5500	5000.00		0.00	This item includes disconnecting all services such as power, water and sewer. This is a 'one off' cost for the area.
	demolish and remove small buildings	m^2	70-90	75.00		0.00	enter the total area of small buildings and tanks.
						0.00	
Airstrip, borefields, other	remove concrete pads footings and bitumen	m^2	10-30	10.00		0.00	enter total area (concrete <300mm @ $10/m2, concrete >300mm @ $30/m2)
	demolish and remove sheds and storage tanks	m^2	70-90	75.00		0.00	enter area of sheds and tanks
	production/dewatering bore closure	@	2000-3300	2000.00		0.00	sealing and rehabilitation
	observation bore closure	@	500	500.00		0.00	includes sealing and rehabilitation to make safe.

Domain 1: Infrastructure

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
						0.00	
Revegetation Activities - all infrastructure areas	Deep rip	ha	550-1100	1100.00		0.00	Enter all areas disturbed by infrasturcture from above, including laydown areas Assume highly disturbed and compacted areas - see assumptions.
	source cart and spread topsoil	m^3	2.50-5.50	5.50		0.00	assume minimum of 10cm depth
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
Other	remove powerlines	km	9800-15000	15000.00		0.00	include dismantling and removal of lines and poles from the site
	remove pipelines	km	1400-1800	1400.00		0.00	remove polypipe >300mm diameter. Assumes removal by 3 persons via truck to nearest location.
						0.00	
DOMAIN 1 TOTAL						$0.00	

Domain 2: Extractive Workings - Sand, Clay & Gravel

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Pits	Scaling, battering for stabilisation	m^2	1.21-3.00	3.00		0.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation
	backfilling of pits	m^3	4.00-5.00	5.00		0.00	enter volume of material to be backfilled into pit
	abandonment bund and pit access closed	m	20.00-63.25	50.00		0.00	required where final pit includes steep faces. Includes bund around pit and closure of ramp. Bund assumed to be 2m high and 5m wide at base
	structural works for drainage	ha	700-1500	1500.00		0.00	earthworks for banks and drains to manage surface water .
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that pit material is suitable as a growth medium
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program as required, dependent on material to be ripped eg sand, gravel, clay. Assume low to medium level disturbance - see assumtpions
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
	signage	@	50	50		0.00	enter number of warning signs as approriate
						0.00	
Sediment Management	sediment traps/dams	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material
Other						0.00	
						0.00	
DOMAIN 2 TOTAL						$0.00	

Domain 3: Hard Rock Pits and Quarries

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Stabilisation of Pits	Drill and blast faces to make safe OR	m^3	1.20-1.60	1.60		0.00	Volume is worked out be multiplying length of bench by width and height to reduce angle to make it safe.
	scaling, battering, pushing walls	m^3	1.21-3.00	3.00		0.00	volume requiring reshaping
	abandonment bund and pit access closed	m	19.00-63.25	30.00		0.00	required where final pit includes steep faces (>18o). Includes bund (2m high , 5m base) around pit and closure of ramp
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program around pit and pit floors as required
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water .
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program
	fencing	m	10.0-30.0	30.00		0.00	construct a standard stock fence around the site
	signage	@	50	50		0.00	enter number of warning signs as appropriate
						0.00	
Infill of pits	infill with tailings or waste rock	m^3	2.00-4.00	4.00		0.00	haul and dump of waste rock or tailings. Distance needs to be considered.
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping
	source cart and spread suitable material for growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium and only if does not require egineered capping design for ARD/metals mitigation. Assume min thickness of 0.5m
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over infilled pit as required
	structural works for drainage	ha	700-1540	1200.00		0.00	earthworks for banks and drains to manage surface water on top of capped pit area if required.
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
Sediment Management	sediment traps/dams	m^3	2.5-2.9	2.90		0.00	enter volume of dam required for sediment traps
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material
Other						0.00	
						0.00	
DOMAIN 3 TOTAL						$0.00	

Domain 4: Underground Workings

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Portals, Declines and Shafts	barricading portal/declines/adits	@	1500-2500	2500.00		0.00	barricading of portal with steel grill to make safe and ensure access cnnot be gained but will allow movement of bats
	sealing portal/decline	@	15000-25000	25000.00		0.00	OR sealing portal with concrete and backfill to make safe and ensure access cannot be gained
	capping/sealing shafts	@	10000-25000	10000.00		0.00	cap shafts using reinforced concrete slab. Dependent on size
	shaft infilling	m^3	8.00-20.0	10.00		0.00	filling of shafts using onsite material
	seal ventilation fans	@	27500	27500.00		0.00	seal and rehab ventilation fans to make safe.
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program in area as required
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
DOMAIN 4 TOTAL						$0.00	

Domain 5: Tailings Storage Facilities and Dams

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Water Dams, Ponds	clean water dams - stabilise and make safe	@	2000-2200	2000.00		0.00	minor earthworks
	or backfill to natural surface	m^3	2.00-5.00	5.00		0.00	backfilled with onsite material. Haul distance sliding scale from $2/m3 for up to 1km, up to $5/m3 for up to 5km or greater.
	dirty water dams - drain and remove sediment	m^3	5.00-7.50	7.50		0.00	includes draining the dam to the pit or other appropriate place, removing 500mm of potentially contaminated sediments to be buried in the pit or other disposal area. Must consider the distance from dam to disposal area.
	shaping or levelling	ha	550-1100	700.00		0.00	area requiring minor reshaping prior to deep ripping
	source cart and spread suitable material for capping/growth medium	m^3	2.00-5.00	5.00		0.00	required if it has not been demonstrated that infill material is suitable as a growth medium Assume min thickness of 0.5m
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program as required
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation be direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program
						0.00	
Tailings Dams	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the TSF. Must have appropriate chemical and physical properites. Required whether for engineered design or growth medium.
	apply capping design treatment as required eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from TSF. Capping layer assumed to be no less than 2m thick.
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program.
	reshape walls and surrounds	ha	1400-5500	1400.00		0.00	area requiring stabilisation and reshaping works around the walls of the emplacement
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program as required
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of capped dam area if required.
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation be direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
	seepage management - recovery and treatment	@	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.
	seepage management - wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning
Other						0.00	
						0.00	
DOMAIN 5 TOTAL						$0.00	

Domain 6: Stockpiles & Waste Rock Dumps

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Oxide waste rock dumps and extractive product stockpiles	Recontouring/battering for stabilisation	m^2	2.00-3.60	3.60		0.00	this includes the area requiring reshaping for stabilisation and preparation for revegetation
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00		0.00	enter the area requiring minor reshaping to 12-18° slopes and deep ripping to enhance revegetation
	unshaped requiring major earthworks, trim and deep rip	m^3	1.21-4.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° Or as specified in MMP) and deep ripping
	structural works for drainage	ha	700-1540	1500.00		0.00	earthworks for banks and drains to manage surface water on top of WRD.
	source cart and spread topsoil or growth medium	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that WRD material is suitable as a growth medium
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	carting of stockpiles offsite or WRD to pit. Consider carting distance
	trim, deep rip if required	ha	550-1600	1600.00		0.00	ripping stockpiles or surrounds if required.Assume ripping of waste rock dumps undertaken during reshaping.
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
Waste rock dumps with AMD or metals	unshaped requiring major earthworks, trim and deep rip	m^3	4.00-6.00	4.00		0.00	include volume of material requiring major reshaping to achieve approriate grades (<18° or as specified in MMP) and deep ripping
	unshaped requiring minor earthworks, trim and deep rip	ha	550-1600	1600.00		0.00	enter the are requiring minor reshaping and deep ripping to enhance revegetation
	source cart and spread suitable material for capping	m^3	2.00-5.00	5.00		0.00	volume of suitable material for capping the WRD. Must have appropriate chemical and physical properites.
	apply capping design treatment eg 'store and release'	ha	25000-49500	36500.00		0.00	required to manage AMD or metals leachate from WRD. Capping layer assumed to be no less than 2m thick.
	or removal of stockpiles	m3/bcm	3.00-5.00	5.00		0.00	removal to pit. Haulage distance needs to be considered at an additonal $1/km
	source cart and spread topsoil if appropriate	m^3	2.50-5.50	5.50		0.00	required if it has not been demonstrated that capping material is suitable as a growth medium
	final trim, deep rip	ha	550-1600	1600.00		0.00	to enhance vegetation program over WRD as required. Assume ripping may be undertaken during capping.
	structural works for drainage	ha	700-1540	700.00		0.00	earthworks for banks and drains to manage surface water on top of WRD area if required.
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
Leachate and sediment management	Active recovery treatment of problem leachate	item	20000-200000	20000.00		0.00	where seepage is at unacceptable levels and no wetland filter is in place and company has committed to recovery and treatment of seepage. Depends on size.
	Wetland filter	ha	5500	5500.00		0.00	assumes wetland filter is in place and functioning
	dams for sediment control	m^3	2.50-2.90	2.90		0.00	enter volume of dam required for sediment traps
	Rocks or coarse material lined sediment trap	m^3	1.00-5.00	5.00		0.00	condsider distance to cart material
Other						0.00	
						0.00	
DOMAIN 6 TOTAL						$0.00	

Domain 7: Exploration

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	
Drillholes, Pads, sumps, costeans	capping drillholes 30cm below ground	@	80-275	80.00	779.00	62320.00	Cut collar, insert plug and backfill. Assume using, concrete or plastic cone plugs or bridge (no 'occy' plugs) Depends on number of holes	
	grout with concrete	@	1250	1250.00		0.00	Assume total grouting of drillhole	
	empty and remove plastic sample bags	hole	25-235	100.00		0.00	return cuttings to hole and remove plastic bags to a waste disposal facility. Bags cannot be disposed of on site.	no plastic bags used
	ripping/scarifying pads	ha	440-2500	1600.00	9.35	14960.00	Minor ripping/scarifying of pads to depth of 0.3m to assist vegetation in areas of flat/gentle terrain, includes sump infilling. Sumps should not remain open for extended periods of time.	
	reshape drill pads	@	320	320.00		0.00	Required in steep terrain where earthworks required with excavator/dozer to return pad to slope and establish erosion control, includes sump infilling. Using PC650 excavator or equivalent assumes one pad per hour @$320/hr.	
	infilling costeans	m^3	2.00-3.00	3.00		0.00	Backfilling of all costeans/trenches. Assumes material does not have to be carted.	
	bulk sample pits	m^3	2.00-8.00	2.00		0.00	dependent on depth of pit and if battering of walls required to form to 18^o slope	
	contouring for erosion control	ha	700-1540	1500.00		0.00	minor pushing to construct water management structures such as contour banks and diversion drains as required.	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program. **this may be carried out when reshaping pads	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00	9.35	18700.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha if required. Required where area of disturbance is significant.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						95980.00		
Tracks and Gridlines	ripping/scarifying minor tracks and gridlines	km	120-500	250.00	38.00	9500.00	assume using grader or equivalent to rip to 0.3m and no windrows, establishing erosion control measures (eg bunds) as required	
	ripping major tracks and roads	km	550-1000	1000.00		0.00	pushing in windrows and ripping track and establishing erosion control measures (ie bunds) across tracks as required	
	removal of gridpegs	item	1500	1500.00	1.00	1500.00	includes removal offsite of all grid pegs in exploration area	
	topsoil replacement if applicable	m^3	2.50-5.50	5.50		0.00	includes min of 10cm of topsoil to assist revegetation program if required	
	revegetation by tube stock	ha	6000/ha (or 5/ea)	6000.00		0.00	includes acquisition of tubestock, fertiliser and guarding as necessary	
	revegetation by direct seeding	ha	1200-2000	2000.00	15.20	30400.00	includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha.	
	fertiliser applicataion	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program	
						41400.00		
DOMAIN 7 TOTAL						$137,380.00		

Domain 8: Access and Haul Roads

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Haul Roads	remove ARD material from road	m3/bcm	2.50-5.50	5.50		0.00	where haul road has been constructed with waste rock material that is leaching ARD removal and disposal in pit or similar will be required
	reshape and deep rip	ha	2000-5000	5000.00		0.00	windrows are pulled back and edges battered, area is deep ripped (road 12mwide)
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required. Diversion drains assumed to be every 100m and are ~10mx40m each.
						0.00	
Access Roads	breaking and removal of bitumen	m3	12.00-17.00	17.00		0.00	Includes area of bitument in roads car parks etc which needs to be removed and disposed of appropriately
	reshape and deep rip	ha	2000-5000	2500.00		0.00	windrows are pulled back and edges battered, area is deep ripped
	structural works for drainage	ha	700-1540	1500.00		0.00	pushing to construct water management structures such as contour banks and diversion drains as required. Diversion drains assumed to be every 100m and are ~10mx40m each.
						0.00	
Revegetation activities - all roads	source cart and spread topsoil	m^3	2.50-5.50	5.50		0.00	assume minimum of 10cm depth
	revegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)
	revegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha
	feriliser application	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program - see assumptions
						0.00	
DOMAIN 8 TOTAL						$0.00	

Domain 9: River Diversions

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes
Creek/River	channel maintenance	m	165.00	165.00		0.00	Includes earthwork repairs and stabilisation following flow events.
	vegetation by tubestock	ha	6000/ha (or 5/ea)	6000.00		0.00	enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha)
	vegetation by direct seeding	ha	1200-2000	2000.00		0.00	this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha
	vegetation maintenance	ha	140-744	140.00		0.00	includes a single application of fertiliser during the initial seeding program
						0.00	
DOMAIN 9 TOTAL						$0.00	

Decommissioning & Post Closure Management

Management Area	Technique	Unit of Measure (UOM)	Range per UOM ($)	Cost per UOM ($)	Estimated Quantity	Sub Total ($)	Technique Notes	
Decommissioning and Closure	mobilisation/demobilisation	km	10.00-15.00	15.00		0.00	determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 5 pieces of machinery required per site. Adjust formula if necessary.	accounted for in DSO calc
	Contaminated site assessment	@	35000	35000.00		0.00	has a contaminated site assessment been undertaken? If not this should be included for large metalliferous mines.	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	49.10	12,275.00	Include total disturbed area , consider for minimum of 2 years during closure for larger sites only. Entry automated form 'Key Information' tab.	
	Contractor accommodation, messing and travel costs	man day	210-320	320.00		0.00	Assume 5-9 people required for 2-10 weeks (or more) depending on size of site *quantity = number of days X number of people (eg 9 persons for 50 days = 450 man days)	
	Closure management	yr	110,000 - 300,000	110000.00		0.00	This includes project manaement team assuming 1 - 3 persons based on the magnitude of the process salaries, oncosts, tender preparation and closure report and coordination of works. Consider part of year only for small sites.	accounted for in DSO calc
Post Closure	mobilisation/demobilisation	km	10.00-15.00	15.00		0.00	Determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherwise stipulated & supported by the operator. Calculation assumes 1 piece of machinery required per site.	accounted for in DSO calc
	Post closure water monitoring	yr	adjust post closure worksheet - no entry required			0.00	Monitoring and measurement requirements that may be needed following the closure of the project - use the 'post closure worksheet' Estimated quanity refers to number of years required post closure	
	Pest and weed management, monitoring & assessment	ha	200 - 250	250.00	73.65	18,412.50	Include total rehabilitated area , assumed for minimum of 3 years post closure Entry automated form 'Key Information' tab.	
	Earthwork maintenance	ha	1,100	1100.00	0.00	0.00	Assume 20% failure rate for the total areas of contructed landforms (eg WRDS, TSF etc) for a period of 2 years (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Revegetation maintenance, monitoring & assessment	ha	1,250 - 2,500	2500.00	9.82	24,550.00	Assume a 20% failure rate for all disturbed areas for a period of 2 years. (if not stipulated otherwise) Entry automated form 'Key Information' tab.	
	Project management	yr	20,000	20000.00		0.00	This includes tender preparation, financial reporting procurement, contractor management etc. Time frame assumed is 1-10 years depending upon the site & the complexity of the issues present	accounted for in DSO calc
	fire break maintenance	km	50-75	72.00		0.00	Grading of firebreaks during and after closure for a period of 1-10 years depending on site size *quantity = number km x number years	
						55,237.50		
POST CLOSURE TOTAL						55,237.50		

POST CLOSURE WATER QUALITY MONITORING WORKSHEET

NOTE:
Mining Officers must adjust the numbers in the blue boxes only, to the appropriate timeframes and reflecting the structures present on individual sites.

SUMMARY

Item	Component	Cost ($)
1	Groundwater monitoring - Analytical	$0
2	Surface water monitoring - Analytical	$0
3	Field sampling and Expenses	$0
4	Water quality interpretation & reporting	$0
	TOTAL	$0

1 GROUNDWATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site structures	Size (ha)	Enter the number of structures	Sampling points	Sampling per year	Enter the number of years 0-10	Subtotal cost ($)	
Whole of site	All		3	2	10	0	
Extraction bores for use after closure			1	2	10	0	
Discrete infrastructure areas			3	2	10	0	
Underground fuel storage areas			1	2	10	0	
Pit voids/declines	All		3	2	10	0	*Denotes sampling of bores adjacent to structures*
Waste rock dump - oxide	<5		2	1	10	0	
	5 - 20		3	2	10	0	
	>20		4	2	10	0	
Waste rock dump - mixed or sulfide	<5		2	2	10	0	
	5 - 20		4	2	10	0	
	>20		6	2	10	0	
Tailings dam / residue disposal ponds	0 -20		3	2	10	0	
	21 - 100		4	2	10	0	
	100 - 150		6	2	10	0	
	>150		10	2	10	0	
Heap leach pad	<10		3	2	10	0	
	>10		5	2	10	0	
Water containment/retention ponds (water not suitable for passive release)	<10		2	1	10	0	
	10 - 20		3	2	10	0	
	>20		4	2	10	0	
Waste disposal areas			2	1	10	0	
Other						0	
Other						0	
Other						0	
					sub total	*$0*	

2 SURFACE WATER MONITORING - ANALYTICAL

Analytical & consumables
Assumptions: ICPMS, fields & laboratory consumables @ $250/sample

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 1-10	Subtotal cost ($)
Water retaining structures with no discharge		1	1	10	0
Water retaining structures with possible discharge		1	2	10	0
Bioremediation structures		1	1	10	0

PLUS

Mine site features	Number of features	Sampling points	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Perenial streams discharging from site		2	4	10	0
Ephemeral streams discharging from site		2	2	10	0

OR Please note: Fill out either the streams or the site operational complexity, size and climate section, but not both

Site operation complexity & size and climate	Default sampling sites	Sampling per year	Enter No. of years 0-10	Subtotal cost ($)
Arid zone site - small to medium	5	1		0
Arid zone site - large	10	2		0
Wet/dry tropics site - small size, simple issues	10	2		0
Wet/dry tropics site - small size, moderate -complex issues	10	4		0
Wet/dry tropics site - medium size, simple issues	15	2		0
Wet/dry tropics site - medium size, moderate -complex issues	15	4		0
Wet/dry topics site - large size, moderate -simple issues	25	4		0
Wet/dry topics site - large size, moderate -complex issues	30	4		0
			sub total	*$0*

3 FIELD SAMPLING & EXPENSES

Assumptions:
Road travel <200km = day trip , 2 people, no accommodation, fuel (300km return) & expenses
Road travel 200 - 500km = minimum of 1 nights accom , 1 day travel + 1 night for each additional sampling day, 2 people , fuel (av 800km return)
Road travel >500km = minimum of 2 nights accom, 2 days travel + 1 night for each additional sampling day, 2 people, fuel (av 1600km return)
Fuel = $1.20/L @ 6km/L Accommodation & meals = $130 per person /per night Personnel = $800 per person per day Air travel = $2000 per person return Expenses (e.g. vehicle/consumables etc) $100/day

Travel and expenses	Enter No. of years 0-10	Distance from nearest centre eg Darwin	Quantity	Enter est. days each sampling trip	Subtotal cost ($)
Field trips - Road travel		<200km	4	1	0
		200 - 500km	4	1	0
		> 500km	4	1	0
Field trip - Air travel (Proof of availability & suitability required)			4	1	0
				sub total	*$0*

4 WATER QUALITY INTERPRETATION AND REPORTING

Item	Site size& water mgmt challenges	Quantity	Enter No. of yrs 0-10	Unit cost ($)	Subtotal cost ($)
Quaterly data collation & interpretation	small	3		2,500	0
	medium	3		5,000	0
	large	3		10,000	0
Annual data collation & interpretation	small	1		1,000	0
	medium	1		5,000	0
	large	1		20,000	0
Other reporting		1		5,000	0
				sub total	*$0*

Assumptions

Ripping
deep rip low level disturbance - 14G grader or equivalent with multishank ripper to 3m width. At $180/hr and at 3km/hr with 0.83 efficiency will cover 7500m2/hr = $240/ha
Deep rip medium level disturbance- Cat D6 with triple shank rippers ripping to a depth of 0.3m and 3m width covered per pass. At $220/hr and 2km/hr with 0.83 efficiency will cover 4980m2/hr = $441/ha
deep rip high level of disturbance and compaction - using a Cat D9 with multishank ripper to a width of 2.64m. At $300/hr and 1.6km/hr with 0.83 efficiency will cover 3320m2/hr = $900/ha

tracks
Assume D9 used to rip to depth of 0.3m, which can do 1.36km/hr. Assume $300/hr. Requires 2 passes on track ~5m wide = $440/km.
Windrows - 14G grader will grade in windrows at 3km/hr (2nd gear) and require two passes each side of road = 1500m of road/hr @ $180/hr =$120/km
two passes with grader to rip track <4m wide at 3km/hr =$120/km

grading firebreaks with 14G equivalent grader @$180/hr. Blade width of 14', travelling at ~5km/hr. Two passes required = 24minutes/km=$72/km

drillpads - major reshaping
using a Komatsu PC650 excavator or similar at $320/hr, can move 300bcm/hr assume one pad per hour

haul roads
haulroads assumed to be an average of 12m wide with an additional buffer of 5m each side of the road which has been cleared or significantly disturbed. Surfaces are heavily compacted and constructed of imported fill.

Road fill which may be ARD producing is removed using an excavator ($320/hr) and 3x50t dump truck ($750/hr), watercart @ $140/hr, dozer@$250/hr. Excavator will produce 300bcm/hr = $4.86/bcm

Stockpile/WRD removal/pit infill
Assume load and haul to pit using excavator and 3 dump trucks. Excavator ($320/hr) and 3 trucks ($840/hr total) as above = $3.87/bcm

bund - assume excavator and 3 dump trucks, with minimal haul distance (no greater than 1km.)
As per road fill above using and excavator and 3 trucks = $3.87/bcm. If bund is 5m wide and 2m high = 5m3/m then bund ~$19/m to construct

fertiliser - current (09/01/09) Landmark price per tonne for NPK fertiliser = $1487.50
fertiliser applied at 500kg/ha (best practice) = $743.75/ha
If applied at only 100kg/ha = $148.75/ha
application dependent on growth medium

RC drillpads assume average 10mx10m, DDH pads 10mx20m

post closure cost for pest, fire and weed management comes from contrators estimate for Woodcutters site

contractor costs for meals, accommodation, travel and supervision:
meals & accom @ $150/head/day
travel @$60/head/hr
supervision@$1000/day
so for 10.5hr day daily costs = $1845/hr/300bcm/hr of production = $6.15/bcm
This tool has assumed cost of $210-$320/man/day

Future considerations

Treatment and removal of water from tailings dams and ponds prior to rehabilitation activities
Review requirements for contaminated site assessment against Australian Standard
The inclusion of additional category for mines with materials that require specific health and safety related management and rehabilitation eg radiological materials, asbestiform, maybe even ARD, heavy metals and sites with specific contaminants introduced as part of the process (e.g. arsenic, cyanide). In particular the case of radiological materials involves specialised management and costs. I have started jotting a few ideas down on this below: Special considerations for asbestiform or radioactive material removal (Eg licensing, Access control – security guard, lockable exclusion areas, health and safety equipment, Records management – recording of exposures, deliveries and removals, procedures for all crews, Radiation control – spill control and clean up, appropriate storage and sealing prior to transport, Training of staff, Monitoring and inspections, Monitoring equipment purchase, repairs & consumables (eg testing and calibration), Waste & scrap management of contaminated materials – is specialised clean up (and pre-disposal assessment) required? Is specific disposal taken into account by specialised contractors eg asbestos, PCBs, other additives)
Records collation, documentation and archiving costs for minimum 7 years to ensure capacity to manage the relevant information;
In lieu of estimating study (eg hydrological modelling, water balance, geochemical assessment etc) which would be hard to do, develop a checklist of items that, depending on the scale of the operation, we can use to will incrementally change the contingency applied to the security. I.e. the less they know the higher contingency is applied. This will discourage the trend of "this is all we know and therefore all we are liable for".
consideration of additional security where larger mines do not have a closure plan and agreed closure criteria?
consider council rates on authorised titles as closure/post closure cost.

APPENDIX J WEED MANAGEMENT PLAN

WONARAH PHOSPHATE PROJECT

Bulk Test Sample MMP
Weed Management Plan

Prepared for:

Avenira Limited
13/6-10 Duoro Rd
West Perth WA 6005

SLR Ref: 680.30199-R01
Version No: -v1.1
March 2023

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BASIS OF REPORT

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
680.30199-R01-v1.1	20 March 2023	Jill Woodworth	Emmanuelle Aliotti	
680.30199-R01-v1.0	17 March 2023	Jill Woodworth	Emmanuelle Aliotti	Jill Woodworth

CONTENTS

DOCUMENT REFERENCES

TABLES

CONTENTS

FIGURES

APPENDICES

1 Introduction

1.1 Purpose

The Weed Management Plan forms part of the Environmental Management System (EMS) for Avenira's Wonarah Phosphate Project Bulk Test Sample and is considered a working document. It has been developed to meet the requirements of the Department of Industry, Tourism and Trade (DITT) Document Review Comments received 9 March 2023 on the Bulk Test Sample Mine Management Plan (MMP).

Key activities during operations will disturb soils and vegetation, and have the potential to introduce or transfer weeds into or across the Wonarah Project area. This Weed Management Plan (WMP) will be implemented to reduce the risk of spreading existing weeds and introducing new weed species.

The purpose of the WMP is to:

- Identify key risks/hot spot areas within the project area, including declared and/or environmental weed species.
- Identify measures to control and/or eradicate declared weeds and Weeds of National Significance (WONS) before, during and after construction.
- Identify measures to minimise or avoid the spread of environmental weeds.
- Identify key responsibilities for construction and operational personnel.
- Detail a schedule for monitoring and evaluation, including review and update of the document and procedures.

1.2 Objective

The objective of the WMP is to guide the management of weeds throughout operations by:

- Comply with all legislated requirements and all relevant corporate requirements and policies.
- Leave the Wonarah Project area in a stable condition that minimises long-term environmental impacts, liabilities and maintenance.
- Rehabilitate disturbed land such that it is ecologically sustainable and generally reflects the surrounding ecology, or, where appropriate, the ecosystem relevant to an appropriate land use.
- Preventing the spread of declared weeds, Weeds of National Significance (WONS) and/or environmental weeds.
- Preventing the introduction of new weed species across the Wonarah Project area.
- Controlling or eradicating existing weed populations (where appropriate).
- Enhancing rehabilitation and landscaping success through weed management.

1.3 Definition of a weed

For the purposes of the WMP, a weed is defined as:

- A declared weed (i.e. weeds are declared under the NT Weeds Management Act 2001); or
- A Weed of National significance or WONS (these species are agreed by Australian governments based on an assessment process that prioritises these weeds based on their invasiveness, potential for spread and environmental, social and economic impacts); or
- An environmental weed (weeds that are not declared under the *Weeds Management Act 2001*, but represent a key threatening process for conservation values).

1.4 Legislation and Guidelines

All landholders must also meet the management requirements described in statutory weed management plans. A statutory weed management plan establishes and clearly articulates the objectives, management requirements and management actions to be achieved by landholders for a specific declared weed. The Minister responsible for the *Weeds Management Act 2001* approves statutory weed management plans and it is an offence not to comply with a statutory weed management plan.

There are 9 statutory weed management plans for the Northern Territory.

Under the Northern Territory *Weed Management Act* 2001, it is the responsibility of the owners and occupiers of land to manage weeds on their land. The landholder is required to:

- Take reasonable measures to prevent the land becoming infested with a declared weed.
- Take reasonable measures to prevent a declared weed spreading to other land.
- Follow a statutory weed management plan for any weeds on your land.
- Within 14 days after first becoming aware of a declared weed that has not previously been, or known to have been, present on the land, notify an officer of the presence of the declared weed.

There are three classes of declared weeds, based on the risk of harm they could cause and how difficult they are to control. They can be one class or a combination of these classes.

- Schedule Class A - To be Eradicated
- Schedule Class B – Growth and Spread to be Controlled
- Schedule Class C – Not to be Introduced into the NT

All Schedule Class A and B weeds in the Northern Territory are also Scheduled as Class C weeds. All weeds that fall into the three classes must be controlled. It is a requirement within the *Weeds Management Act 2001* that all land holders, land managers and land users must comply with the declaration classifications.

1.4.1 Other Legislation, guidelines and plans

- Environment Protection and Biodiversity Conservation Act 1999
- Territory Parks and Wildlife Conservation Act 2006
- Australian Weeds Committee – Weeds of National Significance 2012
- The Australian Weeds Strategy[1]
- Northern Territory Weed Management Handbook 2021[2]
- Northern Territory Weed Data Collection Manual 2015[3]
- Buffel Grass Management Guide for Central Australia 2018[4]
- Tennant Creek Regional Weeds Strategy 2021-2026[5]

[1] https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/pests-diseases-weeds/consultation/aws-final.pdf
[2] https://nt.gov.au/environment/weeds/how-to-manage-weeds/weed-management-handbook
[3] https://nt.gov.au/__data/assets/pdf_file/0007/233854/nt-weed-data-collection-manual-section-1.pdf
[4] https://nt.gov.au/__data/assets/pdf_file/0017/231416/buffel-grass-management-guide-2018.pdf
[5] https://depws.nt.gov.au/__data/assets/pdf_file/0006/258099/tennant-creek-regional-weeds-strategy.pdf

2 Existing Environment

Two weed species of environmental significance were recorded in the Project area, *Cenchrus ciliaris* (Buffel grass) and *Aerva javanica* (Kapok bush). Buffel grass was recorded in four isolated patches along the exploration track between the Main Zone and Arruwurra deposits, which are all low lying areas within the sand plains. Buffel grass occurs extensively outside the project area, especially along the Barkly Highway, where vehicles are major vectors spreading seed into the project area. Buffel grass is regarded as a significant pastoral grass, a dominant land use in the Barkly Tableland, and continues to be sown for pastoral use. Buffel grass has dramatically changed the vegetation structure and species composition of drainage systems in central Australia. As well as displacing native understorey species, Buffel grass increases the intensity of wildfires due to the high fuel loads it produces (Paltridge and McAlpin, 2002).

An individual Kapok bush was identified along the exploration track leading into the Arruwurra deposit in a shallow sand plain. Kapok bush is not considered a significant pest species on the Barkly Tablelands (Baker, 2005).

Four declared weeds have been recorded within a 50 km radius of the project area. Two of these weeds are also a WoNS (bolded):

- Bellyache Bush (*Jatropha gossypifolia*) (NT Class A and Class B)
- Parkinsonia (*Parkinsonia aculeata*) (NT Class B and Class C)
- Mossman River grass (*Cenchrus echinatus*)
- Noogoora Burr (*Xanthium strumarium*)

2.1 Environmental Impacts

The potential environmental impacts arising from the introduction and spread of weeds within the MTPA include:

- Modification of vegetation communities: weeds can prevent seed recruitment and out-compete native species for available resources. Changes to the floristics of communities can subsequently modify habitats for threatened fauna species and/or render the habitat less valuable to indigenous fauna.
- Alteration of fire regime: weeds can create additional fuel loads, which can lead to hotter and/or more frequent fire, which can in turn affect vegetation communities and threatened species habitat.
- Revegetation and landscaping success: if weeds become established and prolific in areas subject to revegetation they can out-compete other planted species and prevent the regrowth of native plants.

3 Weed Management

Avenira intends to operate the Wonarah Project to industry best practice or better and follow Australian standards and guidelines for its activities where applicable. To manage weeds on the Wonarah Project area, Avenira intends to undertake these following key activities:

- Weed Surveys
- Weed Monitoring
- Weed Mapping
- Weed Control (physical, mechanical and chemical)

Weed management measures will commence with the approval of the MMP through the implementation of this WMP. The critical focus of this WMP is early detection and control programs of the identified potentially occurring, declared weeds across the project area and to minimise weed seed propagation.

3.1 Weed Management Objectives

Weed management objectives (from Section 1.2) and targets have been established and are detailed in Table 1.

Table 1 Weed Management Objectives

Objective	Target	Indicator
No spread of existing Declared weeds within the Project area.	No significant change to the extent and distribution of Declared weeds within one year of completion of construction activities compared to the extent and distribution of weeds prior to construction.	Weed surveillance monitoring to show that existing Declared weeds have not proliferated through Project area or into adjoining vegetation.
Prevent the introduction of new Declared weed species across the Project area.	Zero occurrences of new weeds.	No new species of weeds recorded in the Project area.

Table 2 provides a summary of weed management at the Wonarah Project area.

Table 2 Summary of Weed Management Plan

Mitigations and Controls	Monitoring	Performance Indicators	Corrective Actions	Reporting and Record Keeping
Management of weeds in accordance with the NTG Weed Management Handbook and the Tenant Creek Regional Weed Strategy 2021-2026. Source off-site materials from sites that have been declared weed-free	Annual weed mapping Establish photo monitoring locations and undertake quarterly monitoring Quarterly surveying for the presence of weeds, focussing on:	No new declared weed species introduced into the project area No increase in declared weed infestations from baseline conditions No weed complaints	Review weed hygiene measures Implement weed controls appropriate to the species detected	Weed Monitoring - photos and weed control register Weed mapping data

Mitigations and Controls	Monitoring	Performance Indicators	Corrective Actions	Reporting and Record Keeping
Survey disturbance area for weeds prior to commencement of clearing/construction and control/eradicate existing infestations. Annual weed mapping to identify declared weed species location, abundance and distribution Clean, check and certify all earth-moving equipment and vehicles as weed-free before entering site Vehicle hygiene measures will be employed to prevent the introduction and spread of invasive species and pathogens when mobilising vehicles and equipment from one location to another: • Install wash bay facilities near Hwy entrance • Weed identification and management included in site induction and training	• Areas to be disturbed that are in the vicinity of any weed occurrence • Stockpiles • Areas that have soil, sand or gravel introduced • Access tracks • Drainages, particularly after floods			New occurrences of Weeds of National Significance (WoNS) to be reported to the NT Weeds Branch.

3.2 Employee Awareness and Training

The key to weed management is awareness, rapid detection, and response. To assist in this, adequate education and training needs to be provided.

Employees are required to understand and comply with the Avenira Environmental Policy, practices and objectives. Staff and contractors are advised of key environmental principles during inductions and ongoing training.

During the induction process, all employees will be informed of their obligations to report potential weeds sighted across the project area to the site supervisor and/or Environmental Officer. This may involve ‘suspicious or unfamiliar plants’ that will be investigated by the Environmental Officer. The Environmental Officer will record and obtain GPS coordinates of the weeds identified and the areas will be incorporated into the weed control program.

Avenira will engage a selection of specialist environmental consultants to assist if/when required (e.g. weed mapping and treatment). In the event that Avenira are required to assist with weed control measures (i.e. weed spraying or pest control), staff will first receive appropriate training to ensure they can complete the task safely and correctly.

3.3 Hygiene

Good hygiene practices are critical to prevent introduction and spread of declared weeds. The following hygiene practices will be implemented at the Wonarah Project area:

- All plant and equipment must be thoroughly cleaned prior to mobilisation to site and demobilisation from site at a designated wash-down area (Appendix A – Vehicle Inspection Checklist). Machinery used for clearing must be cleaned when moving between areas once on-site.
- Undertake daily plant and equipment inspections, including weed inspections.
- Vehicles to travel on designated tracks/cleared areas.
- Undertake weed monitoring and control of high-risk sites (i.e. wash-down areas, disturbance areas, drainage lines)
- Conduct weed control activities at suitable times of the year when the plant is actively growing and prior to seeding. Focus on outlier/isolated weeds and controlling the spread of declared weeds.
- During weed control, commence in clean areas (minimal weed occurrence) and finish in dirty areas (greater abundance/infestation). Ensure monitoring and treatment is undertaken prior to seeding.
- Inductions to include educational material such as weed alerts to efficiently detect and report declared weeds on-site.
- Topsoil stockpiles and disturbed area to be monitored frequently for weed seed germination and controlled immediately.
- Weed removal as required prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site.
- Before any additional clearing outside of existing disturbances, the boundaries of the new disturbances will be flagged to prevent over clearing of the new areas.

3.4 Trigger Action Response Plan

The Trigger, Action and Response Plan (TARP) outlines remedial actions and responses to the situation. The levels of incidents and TARP are provided in Table 3.

Table 3 Trigger, Action and Response Plan

<table>
<tr><th rowspan="3">Responsibility</th><th colspan="3">Situation</th></tr>
<tr><th>Standard</th><th>Level 1</th><th>Level 2</th></tr>
<tr><th>No introduction of weeds on the mine site or spread of weeds from current locations.</th><th>Triger: Spread of weeds to areas previously weed free.</th><th>Trigger: Introduction of Class A, B and C weeds and WONS to areas previous weed free</th></tr>
<tr><td>Site personnel</td><td colspan="3">Comply with:
• Site Induction requirements.
• Personnel, Vehicle and Equipment Hygiene Procedures.
• Ground Disturbance Permit Procedures.</td></tr>
<tr><td>Environmental Officer</td><td>• Ensure all employees and contractors are aware of all required procedures and systems for weed management and are provided with all required resources to implement the requirements effectively.
• Assessment of compliance with Ground Disturbance Permits.
• Weed surveillance monitoring and application of chemical control.
• Ensure all employees and contractors are provided with appropriate clearance approvals and on-ground guidance prior to giving any ground disturbance instructions.
• Complete weed surveillance monitoring and control by an appropriately experienced and qualified person as required.</td><td>• Undertake additional chemical control as required and increase frequency of surveillance monitoring.
• Record monitoring and application of chemical control in the Weed Register (Appendix B).</td><td>• Undertake additional chemical control as required and increase frequency to monthly surveillance monitoring.
• Record monitoring and application of chemical control in the Weed Register (Appendix B).
• Commission an appropriately experienced and qualified person to undertake weed surveillance survey and control across the mine site.
• Revise the Weed Management Plan following Environmental Manager approval of additional mitigation measures.
• Reportable to NT Weed Management Branch</td></tr>
</table>

Responsibility	Situation		
	Standard	Level 1	Level 2
	No introduction of weeds on the mine site or spread of weeds from current locations.	Triger: Spread of weeds to areas previously weed free.	Trigger: Introduction of Class A, B and C weeds and WONS to areas previous weed free
Environmental Officer and Subcontractor	Annual weed surveillance monitoring by an appropriately experienced and qualified person. Weed surveillance to be summarised within a report detailing controls, spread and additional management measures (if any).		Undertake weed surveillance monitoring, assessment of Project activities and existing weed mitigation measures. Determine additional mitigation measures and provide a summary report.
Environmental Manager	Ensure that the Weed Management Plan is implemented by all Site Personnel.		• Assess and implement Quarterly Surveillance Report mitigation measures. • Facilitate the revision of the Weed Management Plan.
	Clearing undertaken in accordance with Ground Disturbance Permit.	Trigger: Clearing undertaken outside of established Ground Disturbance Permit approval but outside of sensitive areas (i.e restricted works areas).	Trigger: Clearing undertaken outside of established Ground Disturbance Permit approval and within sensitive areas (i.e restricted works areas).
Environmental Officer and Environmental Manager	Daily assessment of compliance with Ground Disturbance Permits.	• Commence investigation into the clearing works to determine root cause of over clearing. • Establish the significance of over clearing and determine rehabilitation measures. • Produce summary report within 1 week of the incident occurring.	• Commence investigation into the clearing works to determine root cause of over clearing. • Establish the level/area of impact within the sensitive area. • Produce summary report within 24 hours of the incident occurring.

Responsibility	Situation		
	Standard	Level 1	Level 2
	No introduction of weeds on the mine site or spread of weeds from current locations.	Triger: Spread of weeds to areas previously weed free.	Trigger: Introduction of Class A, B and C weeds and WONS to areas previous weed free
Environmental Manager and General Manager	Ensure that the Weed Management Plan is implemented by all Site Personnel.	Review summary report and undertake debriefing with site personnel.	• Review summary report and inform relevant stakeholders regarding over clearance. • Review contractor / personnel performance and implement management measures.

3.5 Monitoring Program

Weed inspection involves a field survey of the project area, identifying weed species, occurrence, distribution, abundance, growth stage, treatment.

Monitoring is an essential component of any WMP as it provides a means of identifying the following:

- Changes in the extent of weed populations.
- Changes in the cover density of weed populations.
- Any new weed species that may become established.

Documentation of any unexpected impacts of weed control activities (i.e. unplanned damage to native vegetation);

- Changes in the extent and condition of native vegetation.
- Changes in any conditions that have the potential to impact on site restoration works.
- How well control methods are working.

The WMP will be adapted as needed to improve results and accommodate changing circumstances or changes in the local environment.

Ongoing monitoring and management of weeds, particularly in disturbed areas is a high priority. It is recommended that monitoring of the Wonarah Project area be undertaken throughout the year, especially after rain periods. The monitoring program will involve mapping the Wonarah Project area for the presence of weeds and revisiting information to evaluate if the weed management program is effective and any changes are required.

Weed data will be captured on the inspection checklist (Appendix B) and then transferred to the site's weed database. This information will be GIS compatible so that distribution maps can be generated for reporting requirements or control work if required. Avenira or a designated subcontractor will undertake weed surveys of the site and produce a report and maps showing site weed infestations, which will provide a guide for weed control work for the coming season.

Each weed species or area is marked with a GPS location so follow up treatment and monitoring can be achieved.

3.6 Integrated Management Approach

An integrated weed management approach will be implemented for the most effective outcome. This may involve chemical application (herbicides), physical removal (hand pulling), mechanical removal (slashing, brush-cutting etc) and no-go zones (restricted access areas).

Weed management focus will be in all areas of disturbance, access tracks, infrastructure (including wash down / brush down facilities) and areas of elevation (areas exposed to wind has the potential to carry weed seeds long distances).

3.6.1 Growth Cycles of Potentially Occurring Declared Weeds

It is important to note the growth and reproductive cycles of each specific weed when carrying out control techniques such as foliar spraying, as this will have a bearing on both short- and long-term management success. Treatments should generally occur before flowering and seeding and after germination to have an effect on the weed infestation.

- Bellyache Bush (*Jatropha gossypifolia*) (NT Class A and Class B)
- Parkinsonia (*Parkinsonia aculeata*) (NT Class B and Class C)

3.6.2 Management Timing for Potentially Occurring Declared Weeds

It is important to note the growth and reproductive cycles of each of the species of weeds when carrying out control techniques such as foliar spraying, as this will have a bearing on both short- and long-term management success. Treatments should generally occur following germination when the plant if actively growing and not under stressful conditions for the most effective uptake of the herbicide. Treatment should also occur prior to the plant flowering to ensure treatment occurs before the plant has an opportunity to seed, this preventing seed dispersal. Figure 1 shows the management options for the Bellyache bush if occurring in the project area. The darker green colour indicates the preferred treatment time, with the lighted colour still acceptable for treatment depending on the individual plant's growth stage at the time of treatment. Additional information on the chemicals, application rate and frequency can be found at:

Bellyache bush: https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT/bellyache-bush

Parkinsonia: https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT/parkinsonia

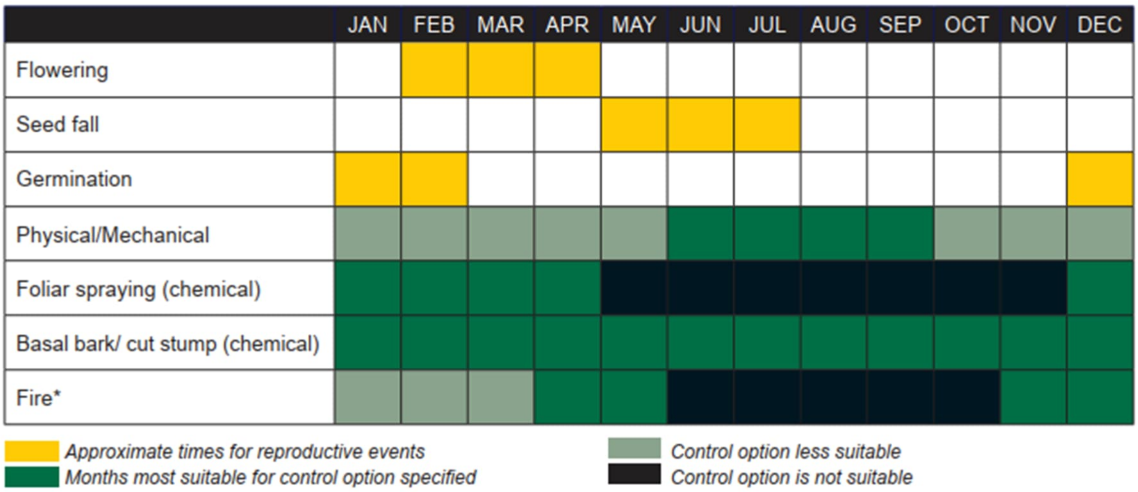

Figure 1 Guide to the management of Bellyache Bush[6]

[6] https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT/bellyache-bush

Table 4 Guide to the Management for Parkinsonia[7],[8]

Parkinsonia	Optimal Treatment Time											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Flowering												
Seed fall												
Germination												
Physical/ mechanical												
Foliar spraying (chemical)												
Basal bark /cut stump (Chemical)												
Approximate times for reproduction events						Most suitable for control options						
Control option less suitable						Control option not suitable						

3.7 Chemical Application Rates for Potentially Occurring Declared Weeds

Chemical control is recommended as part of the integrated weed management plan for as per the preferred treatment time in Figure 1 above for the Bellyache bush and Table 4 for Parkinsonia, with further information the recommended chemical, concentrations, application rate and application method obtained at the websites shown above.

Foliar spraying is a technique used to apply herbicide diluted with water onto targeted foliage, which allows the leaves to directly absorb the active ingredients. Foliar spraying can be carried out in several different ways depending on the size of the infestation. According to the NT Weed Management Handbook[9], foliar spraying is an efficient and cost-effective method, however the use of this technique may result in potential spray drift and off-target damage. It is important to undertake herbicide application in calm or low wind conditions to prevent potential drift. It is also that follow-up treatment is carried out (approximately one month post the initial application) to control seedling recruitment and regrowth after the site has been treated.

A person who uses a chemical product has a duty of care to ensure the use does not result in harm to health of the general public, animals, the environment or domestic or export trade in agricultural produce. The Australian Pesticides and Veterinary Medicines Authority (APVMA) registers pesticides and herbicides for use in Australian States and Territories according to the provisions of the *Agricultural and Veterinary Chemicals (Northern Territory) Act 2004*. Herbicides must be used according to the directions for use on the APVMA registered label.

[7] https://profiles.ala.org.au/opus/weeds-australia/profile/Parkinsonia%20aculeata
[8] https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT/parkinsonia
[9] https://nt.gov.au/environment/weeds/how-to-manage-weeds/weed-management-handbook

4 Reporting and Review

4.1 Weed Mapping and Monitoring

Monitoring of the Wonarah project area will be undertaken as required to:

- Identify new or re-establishing weed infestations at an early stage, so follow up control can be undertaken quickly.
- Determine the effectiveness of control methods, enabling improvements to future weed management.

Annual weed mapping will be conducted during February to March to coincide with weed emergence following the commencement of the wet season. Flowering of some weeds will occur during this time, assisting with positive plant identification and ensure monitoring is conducted prior to seeding to prevent spread. The focus will be areas of disturbance/earth works, access tracks, fire breaks, areas of previous treatment, areas disturbed by fire and heavy grazing.

A weed inspection checklist template is provided in Appendix B. Weed inspection involves a field survey of the project area, identifying weed species, occurrence, distribution, abundance, growth stage, treatment. Each weed species or area is marked with a GPS location so follow up treatment and monitoring can be achieved.

4.2 Maintaining Records

Keeping all weed management records up to date will enable an assessment of the previous year's management measures undertaken, effectiveness of controls and expenditure. Weed contractors/field staff should keep a record of control works and weed surveys as they are conducted. This information should include the timing, resources and control methods. A weed treatment record template is provided in Appendix C. Photo records also provide a useful form of monitoring and assessment of treatment.

4.3 Follow-up Control

Weed management is to be conducted prior to seeding. The areas controlled with chemical use must be revisited to assess if further herbicide application is required for complete success. The secondary treatment can occur approximately one month following the initial treatment, to allow the initial effect of the herbicide to take place and assess regrowth and/or missed areas. Plant seeds may remain viable in the ground for a number of years, thus it is critical that monitoring is a long-term process.

4.4 Review

The Weed Management Plan will be reviewed and updated consequent to a material change in risk, legal requirements or an incident relevant to weed management.

Field and reporting systems and processes may be reviewed if non-conformances continue to be recorded.

Appendix A:
Vehicle Checklist

Machinery and Vehicle Weed Inspection Checklist

PROJECT NAME/NUMBER:					DATE:		NAME CONDUCTING INSPECTION:		
Equipment type	Number Plate	Has the equipment come from Interstate? Y/N	Has the Equipment been washed prior to entering the site? Y/N	Any Evidence of Weed Seeds? (Include inspection underneath equipment and Radiator) Y/N If Yes, the equipment MUST be washed again prior to entering the site.	Any Mud Present on the Equipment? Y/N If Yes, the equipment MUST be washed again prior to entering the site.	Has the Equipment been washed prior to leaving site? Y/N	Name of person conducting inspection	Date of inspection	Comments

Appendix B:

Weed Inspection Checklist

Weed Inspection Checklist

PROJECT NAME/NUMBER:			**DATE:**				**PERSON CONDUCTING INSPECTION:**	
Your reference	*Common name*	*20, 50, 100*	*2,3,4,5*	*0, 25, 50, 75, 100 (3 columns add up to 100%)*				
GPS Coordinates	**Weed name**	**Size**	**Density category**	**Seedling**	**Juveniles**	**Adults**	**Actions to be taken**	**Photos**
Example	*G, WP, H*	*100*	*2*	*40*	*20*	*40*		

Appendix C:

Weed Treatment Record

Weed Treatment Record

PROJECT NAME/NUMBER:							
Date of Application	Treatment Type	Chemical Treatment	Application Rate (mL/L)	Extent (area) (m2)	Location (GPS coordinates)	Weather details (temperature, wind speed/direction)	Person applying treatment

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CAIRNS
Level 1, Suite 1.06
Boland's Centre
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
1/25 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Level 1, 500 Hay Street
Subiaco WA 6008
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SUNSHINE COAST
Suite 2, 14-20 Aerodrome Rd
Maroochydore QLD 4558
Australia
T: +61 7 3858 4800

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
201 Victoria Street West
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX K EROSION AND SEDIMENT CONTROL PLAN

WONARAH PHOSPHATE PROJECT

Bulk Test Sample MMP
Erosion and Sediment Control Plan

Prepared for:

Avenira
13/6 - 10 Duoro Rd
West Perth WA 6005

SLR Ref: 860.30199-R02
Version No: -v1.0
March 2023

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
860.30199-R02-v1.0	17 March 2023	Jill Woodworth	Emmanuelle Aliotti	Jill Woodworth

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

1.1 Background and Purpose

This Erosion and Sediment Control Plan (ESCP) forms part of the Mining Management Plan (MMP) for the Wonarah Phosphate Project located approximately 240 km east of Tenant Creek. This project seeks to undertake a bulk test sample within the existing Arruwurra test pit on the current Mineral Lease (ML) application ML33344.

The purpose of the ESCP is to prevent adverse impacts on the surrounding environment (noting that here are no waterways on the ML, see Figure 4-1 in the MMP and that all mining will occur during the 2023 dry season[1]) and prevent pollution of the downslope environment. Erosion and Sediment Control (ESC) measures and monitoring programs documented in this ESCP will be implemented through the operation of the bulk test sample pit. This ESCP is applicable to employees, contractors and all personnel associated with the planning, construction and operation of the pit.

1.2 Scope and Objectives

The scope of this document is to outline the ESC management protocols for the Wonarah Bulk Test Pit construction and operation works to provide the contractor/operators with a baseline set of management strategies to assist with effectively managing water/runoff in the unlikely event that it occurs. The ESCP will be used by all personnel (including contractors) involved in project activities.

The objectives of this ESCP are to:

- Comply with the requirements detailed within the 'Best Practice Erosion and Sediment Control guideline' (IECA, 2018).
- Comply with all applicable legislation, regulations and conditions.
- Provide controls for construction activities to prevent adverse impacts to the surrounding environment and the general public.
- Minimise soil erosion from the site.
- Avoid unnecessary ground disturbances.
- Detail monitoring and maintenance requirements.

1.3 Construction and Mining Activities with Potential Impacts

This ESCP specifically addresses the following activities associated with the proposed Wonarah Project Bulk Test Sample construction and operation works that have the potential to cause environmental impacts unless controlled:

- Stripping of vegetation, subsoil and topsoil.
- Construction and establishment of infrastructure.
- Vehicle and machinery movements.
- Ground disturbances including extraction works.

[1] The site has a well defined wet and dry season with nearly all the rain falling between November and March. Light rains sometimes occur during the dry season, but the period between April and September is frequently rainless as determined by 62 years of data with median rainfall of 0 mm.

- Liquid waste, fuel and oil spills.
- Rehabilitation areas.

All works listed above will be undertaken within the approved disturbance footprint in accordance with the MMP approval.

2 Existing Environment

2.1 Soil Types

Four soil types were classified using the Australian Soil Classification system (Isbell, 1996) based upon the wet season 2009 survey - Kandosols, Vertosols, Calcarosols and Rudosols. Soil classifications were found to correlate with land units, although many land units contained similar soil types and were thus grouped for mapping purposes, as mapped in Figure 1. Kandosols and Rudosols dominate the sand plains and rocky rises within the project area; Vertosols are restricted to areas subject to inundation (e.g. ephemeral lakes) and Calcarosols are restricted to two localities in the southern end of the lease area.

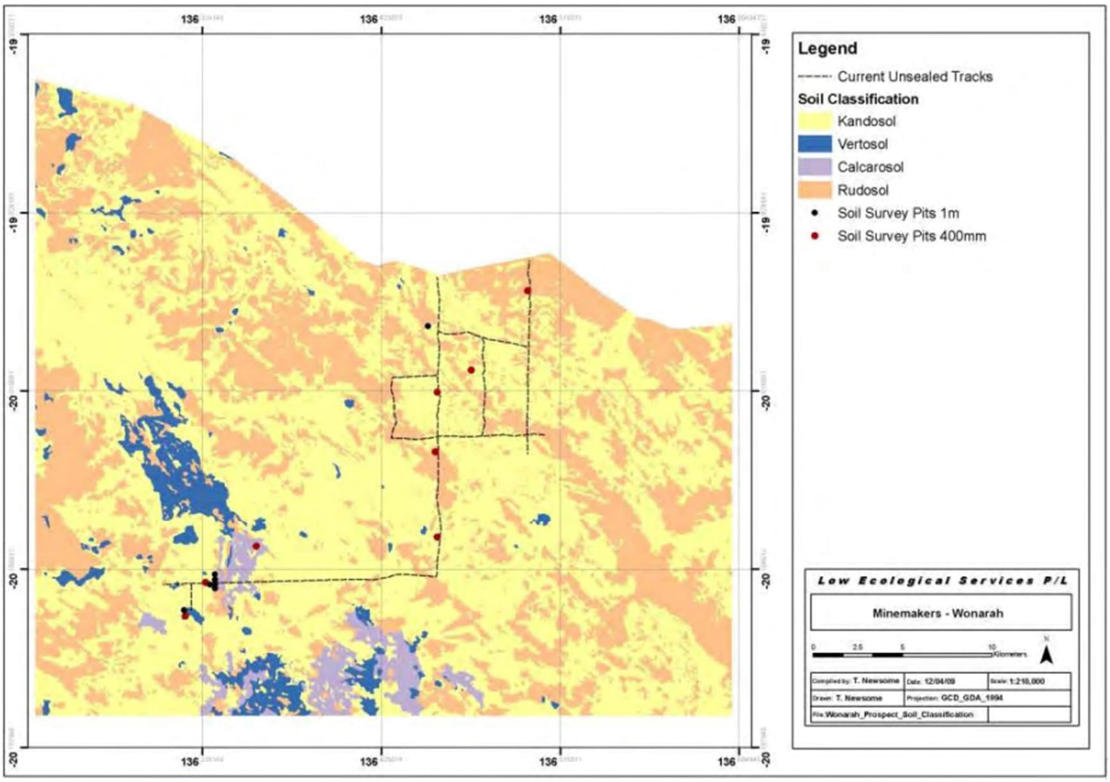


Figure 1 Soil Map for Wonarah Project Area

2.1.1 Soil Erosion

Erodibility of soils was assessed through combining erosivity potentials of classified soils in accordance with descriptions of arid land soils and topography. Most soils were found to have low erodibility potentials, except deep soils (mostly Rudosols with loose rock aggregations) on sloping terrains overlain by deep clayey sands. These soils can be at risk from road construction, and road building techniques to mitigate erosion are provided in Appendix Forty-four within Appendix E of the MMP.

The Preliminary Flood Assessment for the DSO MMP is located in Appendix C.

3 Control Measures to be Implemented

3.1 Soil and Water Management Principles

Standard drawings of the proposed ESC measures are provided in Appendix A. The proposed ESC measures have been designed to minimise the potential impact on soil erosion. The Bulk Test Sample operation will be conducted in the Dry Season when minimal rain (if any) is expected on site. There are no waterways on site, therefore impacts to waterways from erosion and subsequent siltation will not occur and are not discussed in this ESCP. However, erosion due to wind and rainfall from disturbance areas cannot be eliminated completely, however the following measures will be undertaken to minimise their impact (in accordance with the IECA guidelines):

- Minimising the disturbance footprint.
- Undertaking ground disturbance and construction works outside of the wet season.
- Construction of a sediment fence compliant with the required treatment standards around the low side of the pit and any topsoil stockpiles to provide a reasonable measure for sediment control.
- Minimising soil erosion (i.e. rehabilitation, drainage and erosion control measures) at the source, rather than trapping resultant sediment. Where this is not practicable, upslope and downslope ESC measures shall be installed prior to any ground disturbance (refer to Appendix A).
- Conducting best practice land clearing procedures for all proposed disturbance areas.
- Soil stockpiles will be placed in areas away from roadways and other drainage lines. Suitable sediment control measures will be installed downslope of soil stockpiles and upslope clean water runoff diverted (where possible).
- Sealing or revegetation of disturbed areas as soon as possible. Any plant/vegetation species used are to be appropriate for the site conditions, including compatibility with local environmental values, and anticipated erosive forces.
- Effective dust suppression measures (where required).
- Implementing an effective monitoring and maintenance program for the site.

3.2 ESC Program

Ground disturbance and excavation works shall be conducted during the 2023 Dry Season. The Contractor shall remove temporary ESC measures (if required) when permanent measures are in place and / or site stabilisation has occurred.

Any areas used for ESC management will be rehabilitated to the satisfaction of the appropriate Regulators.

Future flood mitigations for the DSO Project are located in Appendix C. Note: The future flood mitigation measures are not applied to the Bulk Test Sample as all activities will be conducted in the dry season.

4 Monitoring and Maintenance

4.1 Monitoring

The performance of ESC devices will decline if they are not maintained. All staff are responsible for reporting ESC issue observations. ESC devices will be inspected weekly and following significant rainfall events (i.e. >10mm in a 24hr period). As such weather forecasts are required to be monitored daily. However, these are not expected to occur during the Project construction and operations in the 2023 Dry Season.

Regular visual inspections of rehabilitated areas will be undertaken to ensure runoff is safely conveyed from the areas and that a stable landform is being created. The inspections will also include assessing vegetation cover to ensure that erosion potential is minimised.

An "ESC Inspection Checklist[2]" is provided in Appendix B.

4.2 Maintenance

All erosion and sediment control measures will be maintained in a functioning condition until individual areas have been deemed "successfully" sealed, rehabilitated or no longer required due to excavation works. Where controls are observed to not be functioning correctly, they will be restored to meet the required standard. Sediment build up within temporary sediment control measures (i.e. sediment fencing) will be regularly removed. If this sediment is not suitable for reuse then it shall be disposed of in a suitable manner. Where significant erosion is observed to be occurring on a regular basis, additional controls will be implemented.

Regular visual inspections of rehabilitated areas will be undertaken to ensure water is safely conveyed from the areas and that a stable landform is being created. The inspections will also include assessing vegetation cover to ensure that erosion potential is minimised. Where required, bald or patchy areas are either scarified and seeded, or have a maintenance application of fertiliser to encourage growth.

5 Roles and Responsibility

All staff must comply with this ESCP. Other responsibilities are detailed in Table 1.

Table 1 Responsibilities relating to ESC Management

Position	Responsibility
Site Manager	Establishment of best practice culture and monitoring Enforcement of the requirements of this ESCP
HSE Manager	Monitoring and maintenance of ESC structures in accordance with this ESCP
All Construction Personnel	Undergo appropriate inductions and training. Comply with the relevant Acts, Regulations and Standards. Compliance with this ESCP Promptly report to management on any non-conformances or breaches of the system.

[2] IECA Australasia 2008

5.1 Training

All construction staff and sub-contractors will be inducted prior to commencing works. The induction will include an explanation of this ESCP. All personnel (company and contractors) must be inducted to the requirements of the ESCP. Specific training will also be provided to operators and site contractors prior to soil stripping and stockpiling to ensure effective management of soils.

6 Reporting

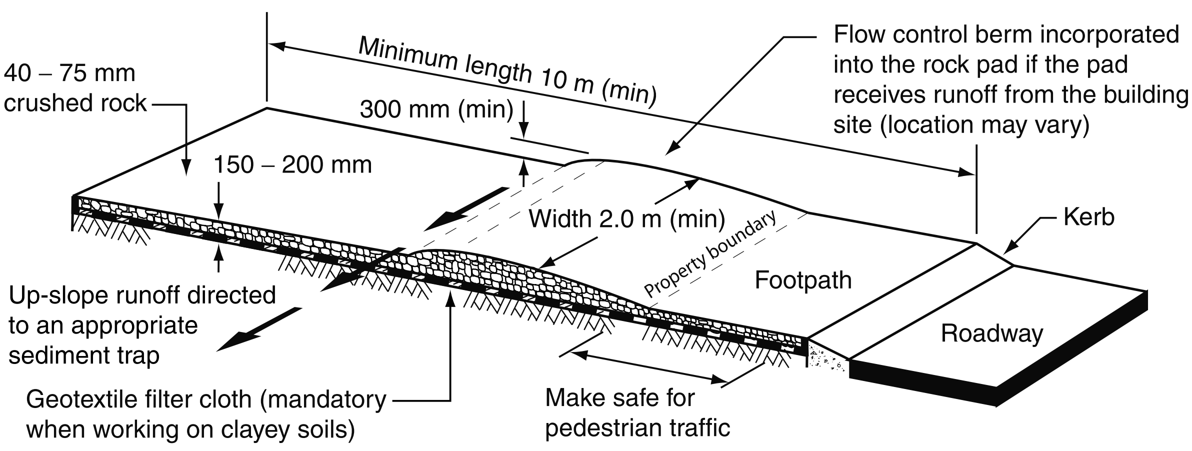
The *Waste Management and Pollution Control Act 1998* and Regulations and the *Water Act 1992* and Regulations controls water pollution matters. Where a water pollution incident causes or threatens to cause damage, DITT will be informed as soon as practicable in accordance with the *Mining Management Act 2001* and the DEPWS will be informed as soon as practicable (and in any case within 24 hours after) under *the Waste Management and Pollution Control Act 1998.*

7 Limitations of this report

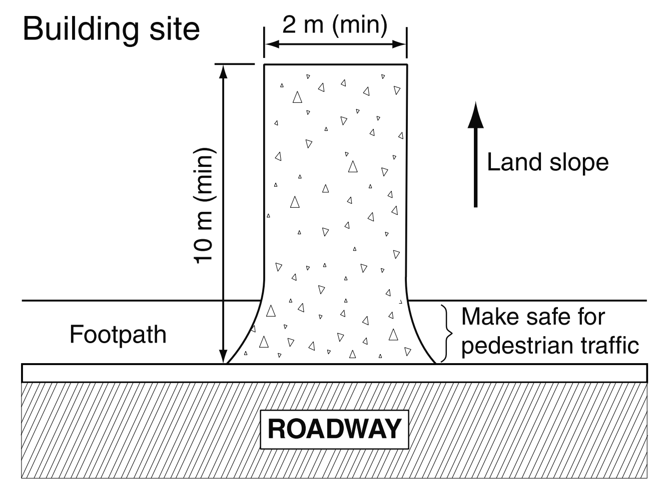
This ESCP is intended for the proposed Wonarah Bulk Test Sample Project construction / mining works and sets out minimum requirements. The Principal Contractor will need to review the appropriateness of ESC measures on site at each stage of construction / mining, and may be required to adjust measures to ensure that they are appropriate at all times to prevent harm to the environment as site conditions change over time.

Appendix A:

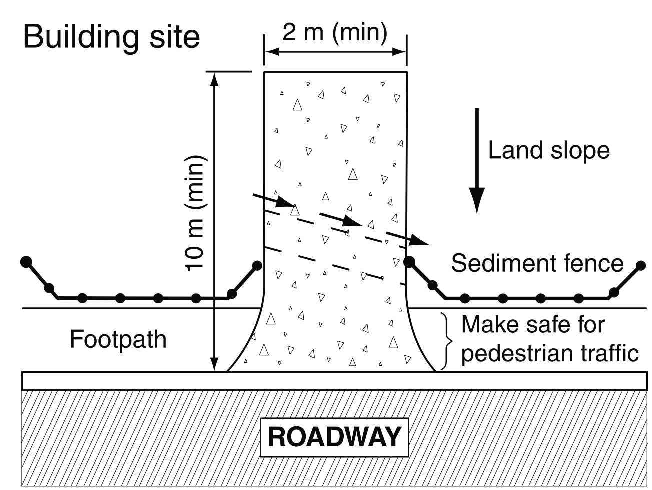
ESC Standard Drawings



(a) Rock entry/exit pad for building sites



(b) Rock pad sloping away from road



(c) Rock pad sloping towards the road

CONSTRUCTION NOTES:

MATERIALS

ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 40 TO 75mm.

FOOTPATH STABILISING AGGREGATE: 25 TO 50mm GRAVEL OR AGGREGATE (IF REQUIRED).

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).

INSTALLATION

1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.

2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.

3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.

4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.

5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITION.

6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

Drawn:	Date:		
GMW	May-10	Rock Pads for Building Sites	ESC-01

MATERIALS

ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 50 TO 75mm (SMALL DISTURBANCES) OR 100 TO 150mm (LARGE DISTURBANCES). ALL REASONABLE MEASURES MUST BE TAKEN TO OBTAIN ROCK OF NEAR UNIFORM SIZE.

FOOTPATH STABILISING AGGREGATE: 25 TO 50mm GRAVEL OR AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION OF THE ROCK PAD, REMOVING STUMPS, ROOTS AND OTHER VEGETATION TO PROVIDE A FIRM FOUNDATION SO THAT THE ROCK IS NOT PRESSED INTO SOFT GROUND. CLEAR SUFFICIENT WIDTH TO ALLOW PASSAGE OF LARGE VEHICLES, BUT CLEAR ONLY THAT NECESSARY FOR THE EXIT. DO NOT CLEAR ADJACENT AREAS UNTIL THE REQUIRED EROSION AND SEDIMENT CONTROL DEVICES ARE IN PLACE.

3. IF THE EXPOSED SOIL IS SOFT, PLASTIC OR CLAYEY, PLACE A SUB-BASE OF CRUSHED ROCK OR A LAYER OF HEAVY-DUTY FILTER CLOTH TO PROVIDE A FIRM FOUNDATION.

4. PLACE THE ROCK PAD FORMING A MINIMUM 200mm THICK LAYER OF CLEAN, OPEN-VOID ROCK.

5. IF THE ASSOCIATED CONSTRUCTION SITE IS UP-SLOPE OF THE ROCK PAD, THUS CAUSING STORMWATER RUNOFF TO FLOW TOWARDS THE ROCK PAD, THEN FORM A MINIMUM 300mm HIGH FLOW CONTROL BERM ACROSS THE ROCK PAD TO DIVERT SUCH RUNOFF TO A SUITABLE SEDIMENT TRAP.

6. THE LENGTH OF THE ROCK PAD SHOULD BE AT LEAST 15m WHERE PRACTICABLE, AND AS WIDE AS THE FULL WIDTH OF THE ENTRY OR EXIT AND AT LEAST 3m. THE ROCK PAD SHOULD COMMENCE AT THE EDGE OF THE OFF-SITE SEALED ROAD OR PAVEMENT.

7. FLARE THE END OF THE ROCK PAD WHERE IT MEETS THE PAVEMENT SO THAT THE WHEELS OF TURNING VEHICLES DO NOT TRAVEL OVER UNPROTECTED SOIL.

8. IF THE FOOTPATH IS OPEN TO PEDESTRIAN MOVEMENT, THEN COVER THE COARSE ROCK WITH FINE AGGREGATE OR GRAVEL, OR OTHERWISE TAKE WHATEVER MEASURES ARE NEEDED TO MAKE THE AREA SAFE.

MAINTENANCE

1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.

2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MATERIAL MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.

3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.

4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.

5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITIONS.

6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. THE ROCK PAD SHOULD BE REMOVED ONLY AFTER IT IS NO LONGER NEEDED AS A SEDIMENT TRAP.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.
3. RE-GRADE AND STABILISE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	Apr-10	Construction Exit - Rock Pad (construction sites only)	Exit-02

INSTALLATION (EARTH-LINED)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF REQUIRED CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. SPECIFICALLY, ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE TEMPORARY DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED SITE REHABILITATION PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Earth Lined	CD-02

MATERIALS

ROCK: 150 TO 300mm NOMINAL DIAMETER, HARD, EROSION RESISTANT ROCK. SMALLER ROCK MAY BE USED IF SUITABLE LARGE ROCK IS NOT AVAILABLE.

SANDBAGS: GEOTEXTILE BAGS (WOVEN SYNTHETIC, OR NON-WOVEN BIODEGRADABLE) FILLED WITH CLEAN COARSE SAND, CLEAN AGGREGATE, STRAW OR COMPOST.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. PRIOR TO PLACEMENT OF THE CHECK DAMS, ENSURE THE TYPE AND SIZE OF EACH CHECK DAMS WILL NOT CAUSE A SAFETY HAZARD OR CAUSE WATER TO SPILL OUT OF THE DRAIN.

3. LOCATE THE FIRST CHECK DAM AT THE DOWNSTREAM END OF THE SECTION OF CHANNEL BEING PROTECTED. LOCATE EACH SUCCESSIVE CHECK DAM SUCH THAT THE CREST OF THE IMMEDIATE DOWNSTREAM DAM IS LEVEL WITH THE TOE OF THE CHECK DAM BEING INSTALLED.

4. ENSURE THE CHANNEL SLOPE IS NO STEEPER THAN 10:1 (H:V). OTHERWISE CONSIDER THE USE OF A SUITABLE CHANNEL LINER INSTEAD OF THE CHECK DAMS.

5. CONSTRUCT THE CHECK DAM TO THE DIMENSIONS AND PROFILE SHOWN WITHIN THE APPROVED PLAN.

6. WHERE SPECIFIED, THE CHECK DAMS SHALL BE CONSTRUCTED ON A SHEET OF GEOTEXTILE FABRIC USED AS A DOWNSTREAM SPLASH PAD.

7. EACH CHECK DAM SHALL BE EXTENDED UP THE CHANNEL BANK (WHERE PRACTICABLE) TO AN ELEVATION AT LEAST 150mm ABOVE THE CREST LEVEL OF THE DAM.

MAINTENANCE

1. INSPECT EACH CHECK DAM AND THE DRAINAGE CHANNEL AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CORRECT ALL DAMAGE IMMEDIATELY. IF SIGNIFICANT EROSION OCCURS BETWEEN ANY OF THE CHECK DAMS, THEN CHECK THE SPACING OF DAMS AND WHERE NECESSARY INSTALL INTERMEDIATE CHECK DAMS OR A SUITABLE CHANNEL LINER.

3. CHECK FOR DISPLACEMENT OF THE CHECK DAMS

4. CHECK FOR SOIL SCOUR AROUND THE ENDS OF EACH CHECK DAM. IF SUCH EROSION IS OCCURRING, CONSIDER EXTENDING THE WIDTH OF THE CHECK DAM TO AVOID SUCH PROBLEMS.

5. IF SEVERE SOIL EROSION OCCURS EITHER UNDER OR AROUND THE CHECK DAMS, THEN SEEK EXPERT ADVICE ON AN ALTERNATIVE TREATMENT MEASURE.

6. REMOVE ANY SEDIMENT ACCUMULATED BY THE CHECK DAMS, UNLESS IT IS INTENDED THAT THIS SEDIMENT WILL REMAIN WITHIN THE CHANNEL.

7. DISPOSE OF COLLECTED SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN CONSTRUCTION WORK WITHIN THE DRAINAGE AREA ABOVE THE CHECK DAMS HAS BEEN COMPLETED, AND THE DISTURBED AREAS AND THE DRAINAGE CHANNEL ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, ALL TEMPORARY CHECK DAMS MUST BE REMOVED.

2. REMOVE THE CHECK DAMS AND ASSOCIATED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

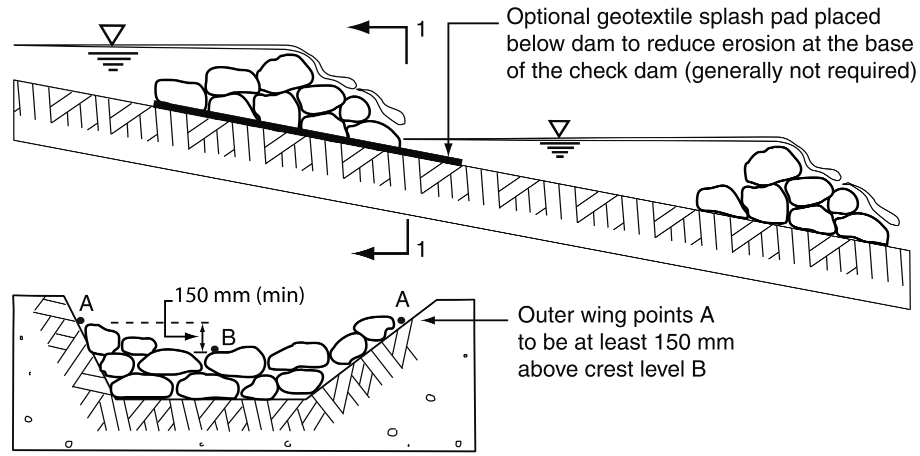


Figure 1 - Layout and profile of check dams (rock check dams shown)

Drawn:	Date:		
GMW	Dec-09	Check Dams	RCD-01

MATERIALS

SOCKS: MINIMUM 200mm DIAMETER SYNTHETIC OR BIODEGRADABLE TUBES MANUFACTURED FROM NON-WOVEN OR COMPOSITE FABRIC SUITABLE FOR THE ‘FILTRATION’ OF COARSE SEDIMENTS.

FILL MATERIAL: STRAW, CANE MULCH, COMPOSTED MATERIAL (AS4454), COARSE SAND, OR CLEAN AGGREGATE.

STAKES: MINIMUM 25 x 25mm TIMBER.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN PLACED ACROSS NON-VEGETATED OR NEWLY SEEDED SLOPES, THE FILTER SOCKS MUST BE PLACED ALONG THE CONTOUR.

3. IF PLACED ON OPEN OR LOOSE SOIL, ENSURE THE FILTER SOCKS ARE TRENCHED 50 TO 100mm INTO THE GROUND.

4. ENSURE THE OUTER MOST ENDS OF EACH FILTER SOCK OR CONTINUOUS ROW OF FILTER SOCKS ARE TURNED UP THE SLOPE TO ALLOW WATER TO ADEQUATELY POND UP-SLOPE OF THE SOCKS, AND TO MINIMISE FLOW BYPASSING.

5. ENSURE THE ANCHORING STAKES ARE DRIVEN INTO THE END OF EACH SOCK AND ALONG THE LENGTH OF EACH SOCK AT A SPACING NOT EXCEEDING 1.2m OR SIX TIMES THE SOCK DIAMETER (WHICHEVER IS THE LESSER).

7. ADJOINING SOCKS MUST BE OVERLAPPED AT LEAST 450mm, NOT ABUTTED.

MAINTENANCE

1. INSPECT ALL FILTER SOCKS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORMS OR OTHERWISE AT WEEKLY INTERVALS.

2. REPAIR OR REPLACE DAMAGED FILTER SOCKS.

3. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. ALL EXCESSIVE SEDIMENT TRAPPED BY THE FILTER SOCKS MUST BE REMOVED FROM THE DRAIN OR SLOPE IF SUCH SEDIMENT IS LIKELY TO BE WASHED AWAY BY EXPECTED FLOWS.

2. DISPOSE OF COLLECTED SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. ALL SYNTHETIC (PLASTIC) MESH OR OTHER NON READILY BIODEGRADABLE MATERIAL MUST BE REMOVED FROM THE SITE ONCE THE SLOPE OR DRAIN IS STABILISED, OR THE SOCKS HAVE DETERIORATED TO A POINT WHERE THEY ARE NO LONGER PROVIDING THEIR INTENDED DRAINAGE OR SEDIMENT CONTROL FUNCTION.

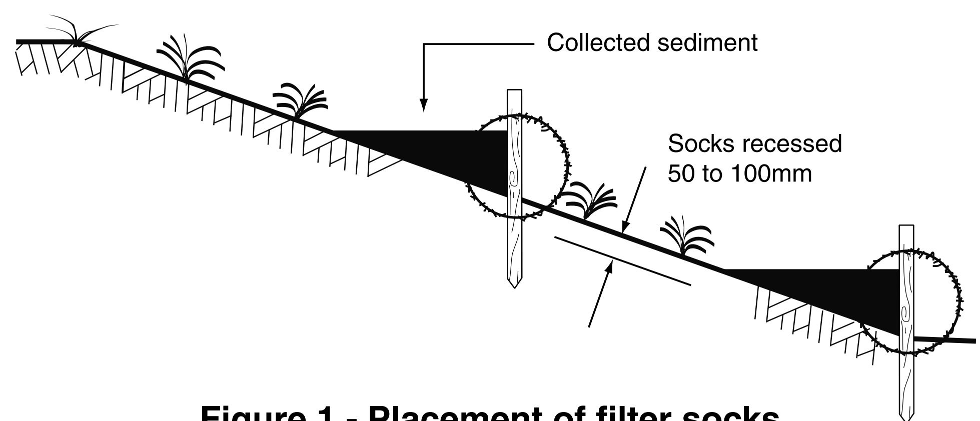
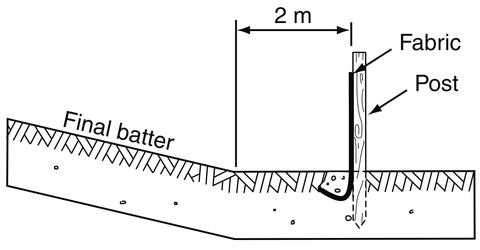
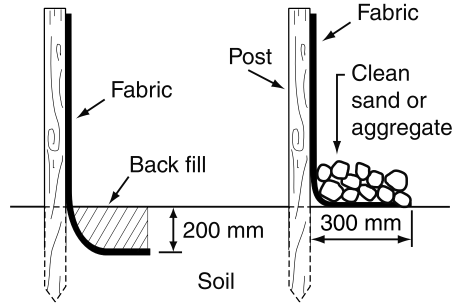


Figure 1 - Placement of filter socks

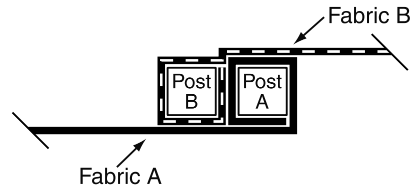
Drawn:	Date:		
GMW	Dec-09	Filter Socks - Sheet Flow	FS-02



(a) Location of fence relative to base of slope

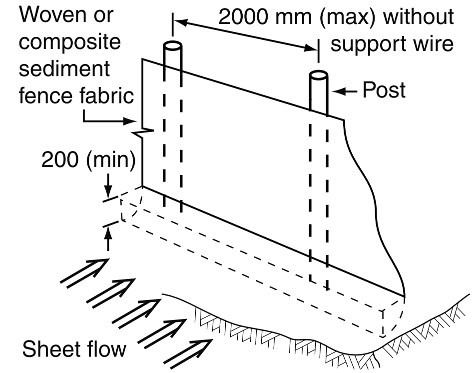


(b) Anchoring base of fabric

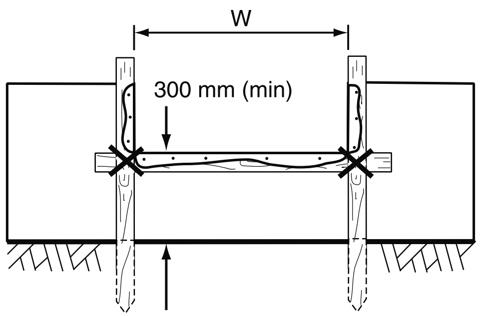


Fabric to fold around each stake one full turn.
Stake B to be drive tightly against Stake A.
The tops of both stakes to be secured with wire.

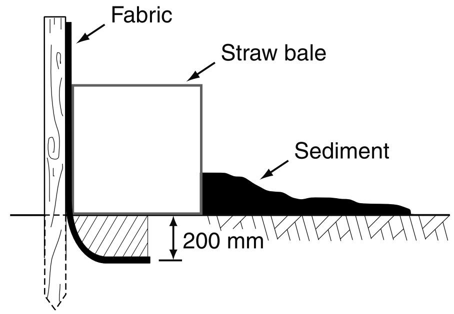
(c) Joining fabric - Method 1



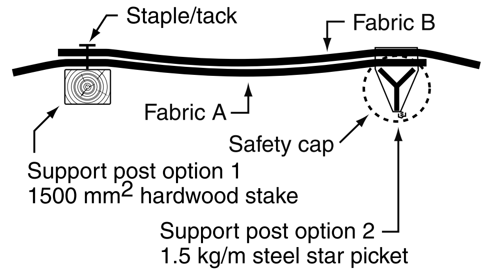
(d) Installation without backing support



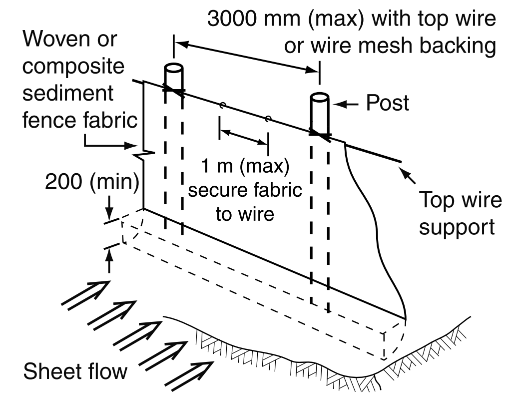
(e) Spill-through weir



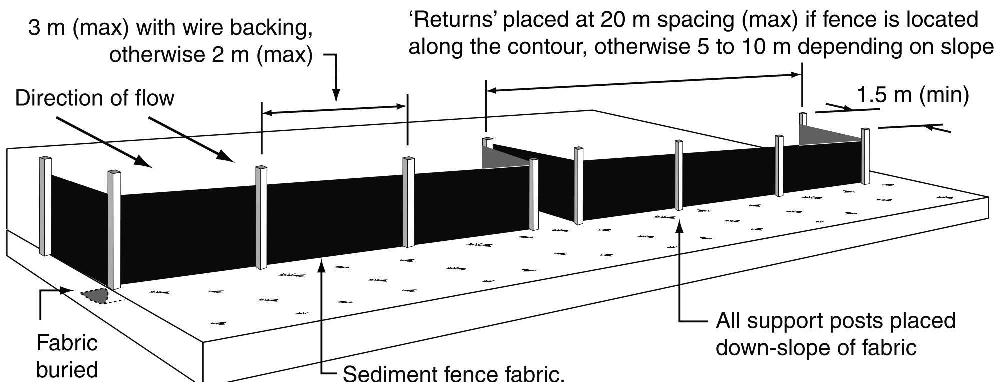
(f) Placement of up-slope straw bale



(g) Joining fabric - Method 2



(h) Installation with top wire support



(i) Installation of sediment fence

Notes:

1. Sediment fence to be installed along a line of constant ground elevation wherever practical.
2. Both end of the sediment fence to extend up the slope at least 1m.
3. Support post to be spaced a maximum 2m unless the fence is supported by a top wire or wire mesh backing, in which case 3m maximum spacing.
4. Fence 'returns' shall be installed at maximum 20m spacing if fence is installed along the contour, otherwise 5 to 10m maximum spacing.
5. Minimum 4 staples or tie wires per stake.

Drawn:	Date:		
GMW	Dec-09	Sediment Fence	ESC-04

MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140g/m^2. ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND REQUIRED TYPE OF FABRIC (IF SPECIFIED). IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, FABRIC TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TO THE MAXIMUM DEGREE PRACTICAL, AND WHERE THE PLANS ALLOW, ENSURE THE FENCE IS LOCATED:
(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;
(ii) ALONG A LINE OF CONSTANT ELEVATION WHEREVER PRACTICAL;
(iii) AT LEAST 2m FROM THE TOE OF ANY FILLING OPERATIONS THAT MAY RESULT IN SHIFTING SOIL/FILL DAMAGING THE FENCE.

3. INSTALL RETURNS WITHIN THE FENCE AT MAXIMUM 20m INTERVALS IF THE FENCE IS INSTALLED ALONG THE CONTOUR, OR 5 TO 10m MAXIMUM SPACING (DEPENDING ON SLOPE) IF THE FENCE IS INSTALLED AT AN ANGLE TO THE CONTOUR. THE 'RETURNS' SHALL CONSIST OF EITHER:
(i) V-SHAPED SECTION EXTENDING AT LEAST 1.5m UP THE SLOPE; OR
(ii) SANDBAG OR ROCK/AGGREGATE CHECK DAM A MINIMUM 1/3 AND MAXIMUM 1/2 FENCE HEIGHT, AND EXTENDING AT LEAST 1.5m UP THE SLOPE.

4. ENSURE THE EXTREME ENDS OF THE FENCE ARE TURNED UP THE SLOPE AT LEAST 1.5m, OR AS NECESSARY, TO MINIMISE WATER BYPASSING AROUND THE FENCE.

5. ENSURE THE SEDIMENT FENCE IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE FENCE, AND THE UNDESIRABLE DISCHARGE OF WATER AROUND THE ENDS OF THE FENCE.

6. IF THE SEDIMENT FENCE IS TO BE INSTALLED ALONG THE EDGE OF EXISTING TREES, ENSURE CARE IS TAKEN TO PROTECT THE TREES AND THEIR ROOT SYSTEMS DURING INSTALLATION OF THE FENCE. DO NOT ATTACH THE FABRIC TO THE TREES.

7. UNLESS DIRECTED BY THE SITE SUPERVISOR OR THE APPROVED PLANS, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE PROPOSED FENCE LINE, PLACING THE EXCAVATED MATERIAL ON THE UP-SLOPE SIDE OF THE TRENCH.

8. ALONG THE LOWER SIDE OF THE TRENCH, APPROPRIATELY SECURE THE STAKES INTO THE GROUND SPACED NO GREATER THAN 3m IF SUPPORTED BY A TOP SUPPORT WIRE OR WEIR MESH BACKING, OTHERWISE NO GREATER THAN 2m.

9. IF SPECIFIED, SECURELY ATTACH THE SUPPORT WIRE OR MESH TO THE UP-SLOPE SIDE OF THE STAKES WITH THE MESH EXTENDING AT LEAST 200mm INTO THE EXCAVATED TRENCH. ENSURE THE MESH AND FABRIC IS ATTACHED TO THE UP-SLOPE SIDE OF THE STAKES EVEN WHEN DIRECTING A FENCE AROUND A CORNER OR SHARP CHANGE OF DIRECTION.

10. WHEREVER POSSIBLE, CONSTRUCT THE SEDIMENT FENCE FROM A CONTINUOUS ROLL OF FABRIC. TO JOIN FABRIC EITHER:
(i) ATTACH EACH END TO TWO OVERLAPPING STAKES WITH THE FABRIC FOLDING AROUND THE ASSOCIATED STAKE ONE TURN, AND WITH THE TWO STAKES TIED TOGETHER WITH WIRE; OR
(ii) OVERLAP THE FABRIC TO THE NEXT ADJACENT SUPPORT POST.

11. SECURELY ATTACH THE FABRIC TO THE SUPPORT POSTS USING 25 X 12.5mm STAPLES, OR TIE WIRE AT MAXIMUM 150mm SPACING.

12. SECURELY ATTACH THE FABRIC TO THE SUPPORT WIRE/MESH (IF ANY) AT A MAXIMUM SPACING OF 1m.

13. ENSURE THE COMPLETED SEDIMENT FENCE IS AT LEAST 450mm, BUT NOT MORE THAN 700mm HIGH. IF A SPILL-THOUGH WEIR IS INSTALLED, ENSURE THE CREST OF THE WEIR IS AT LEAST 300mm ABOVE GROUND LEVEL.

14. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC AND MESH TO PREVENT WATER FROM FLOWING UNDER THE FENCE.

ADDITIONAL REQUIREMENTS FOR THE INSTALLATION OF A SPILL-THROUGH WEIR

1. LOCATE THE SPILL-THROUGH WEIR SUCH THAT THE WEIR CREST WILL BE LOWER THAN THE GROUND LEVEL AT EACH END OF THE FENCE.

2. ENSURE THE CREST OF THE SPILL-THROUGH WEIR IS AT LEAST 300mm THE GROUND ELEVATION.

3. SECURELY TIE A HORIZONTAL CROSS MEMBER (WEIR) TO THE SUPPORT POSTS/ STAKES EACH SIDE OF THE WEIR. CUT THE FABRIC DOWN THE SIDE OF EACH POST AND FOLD THE FABRIC OVER THE CROSS MEMBER AND APPROPRIATELY SECURE THE FABRIC.

4. INSTALL A SUITABLE SPLASH PAD AND/OR CHUTE IMMEDIATELY DOWN-SLOPE OF THE SPILL-THROUGH WEIR TO CONTROL SOIL EROSION AND APPROPRIATELY DISCHARGE THE CONCENTRATED FLOW PASSING OVER THE WEIR.

MAINTENANCE

1. INSPECT THE SEDIMENT FENCE AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. IF THE FENCE IS SAGGING BETWEEN STAKES, INSTALL ADDITIONAL SUPPORT POSTS.

5. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 1/3 THE HEIGHT OF THE FENCE.

6. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. REPLACE THE FABRIC IF THE SERVICE LIFE OF THE EXISTING FABRIC EXCEEDS 6-MONTHS.

REMOVAL

1. WHEN DISTURBED AREAS UP-SLOPE OF THE SEDIMENT FENCE ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE FENCE MUST BE REMOVED.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	May-10	Sediment Fence	ESC-05

Appendix B:

ESC Inspection Checklist

Weekly Site Inspection

LOCATION ....

INSPECTION OFFICER ....**DATE** ....

SIGNATURE ....

Legend: ✔ OK ✗ Not OK N/A Not applicable

Item	Consideration	Assessment
1	Public roadways clear of sediment.	....
2	Entry/exit pads clear of excessive sediment deposition.	....
3	Entry/exit pads have adequate void spacing to trap sediment.	....
4	The construction site is clear of litter and unconfined rubbish.	....
5	Adequate stockpiles of emergency ESC materials exist on site.	....
6	Site dust is being adequately controlled.	....
7	Appropriate drainage and sediment controls have been installed prior to new areas being cleared or disturbed.	....
8	Up-slope "clean" water is being appropriately diverted around/through the site.	....
9	Drainage lines are free of soil scour and sediment deposition.	....
10	No areas of exposed soil are in need of erosion control.	....
11	Earth batters are free of "rill" erosion.	....
12	Erosion control mulch is not being displaced by wind or water.	....
13	Long-term soil stockpiles are protected from wind, rain and stormwater flow with appropriate drainage and erosion controls.	....
14	Sediment fences are free from damage.	....
15	Sediment-laden stormwater is not simply flowing "around" the sediment fences or other sediment traps.	....
16	Sediment controls placed up-slope/around stormwater inlets are appropriate for the type of inlet structure.	....
17	All sediment traps are free of excessive sediment deposition.	....
18	The settled sediment layer within a sediment basin is clearly visible through the supernatant prior to discharge such water.	....
19	All reasonable and practicable measures are being taken to control sediment runoff from the site.	....
20	All soil surfaces are being appropriately prepared (i.e. pH, nutrients, roughness and density) prior to revegetation.	....
21	Stabilised surfaces have a minimum 70% soil coverage.	....
22	The site is adequately prepared for imminent storms.	....
23	All ESC measures are in proper working order.	....

Appendix C:

Preliminary Flood Assessment

Memorandum

Date	16 March 2023	Pages	11
Attention	Steve Harrison		
Company	Avenira Ltd		
Job No.	1919-01-C_DRAFT		
Subject	Arruwurra Mine Area: Preliminary flood assessment of proposed flood protection levees and drains		

Dear Steve,

Overview

This memorandum describes proposed drain and levee structures designed to protect the Arruwurra Mine Area (AMA) from flooding and overland flow during mining operations. Four key structures are proposed:

- East Drain – a drain and bund to protect the northeast pit from overland flow;
- East Levee - a levee to protect the eastern pits from flooding;
- West Drain - a drain and bund to protect the operational mine area from overland flow;
- West Levee - a levee to protect the southern dump from flooding.

Figure 1 shows the location of the four proposed structures.

Structure details

Figure 2 to Figure 5 show longitudinal sections along the alignment of the proposed structures. The structures were sized to convey the 1% AEP design flood event. Details of the structures are as follows:

- East Drain:
  - Embankment crest: 258.2 - 261.7 mAHD
  - Freeboard for 1% AEP water level: 0.1 – 0.7 m
  - Embankment crest width: 3 m
  - Embankment batter slopes: 1V:3H
  - Channel gradient: 0.4% to 0.7%
  - Drain batter slope: 1V:10H

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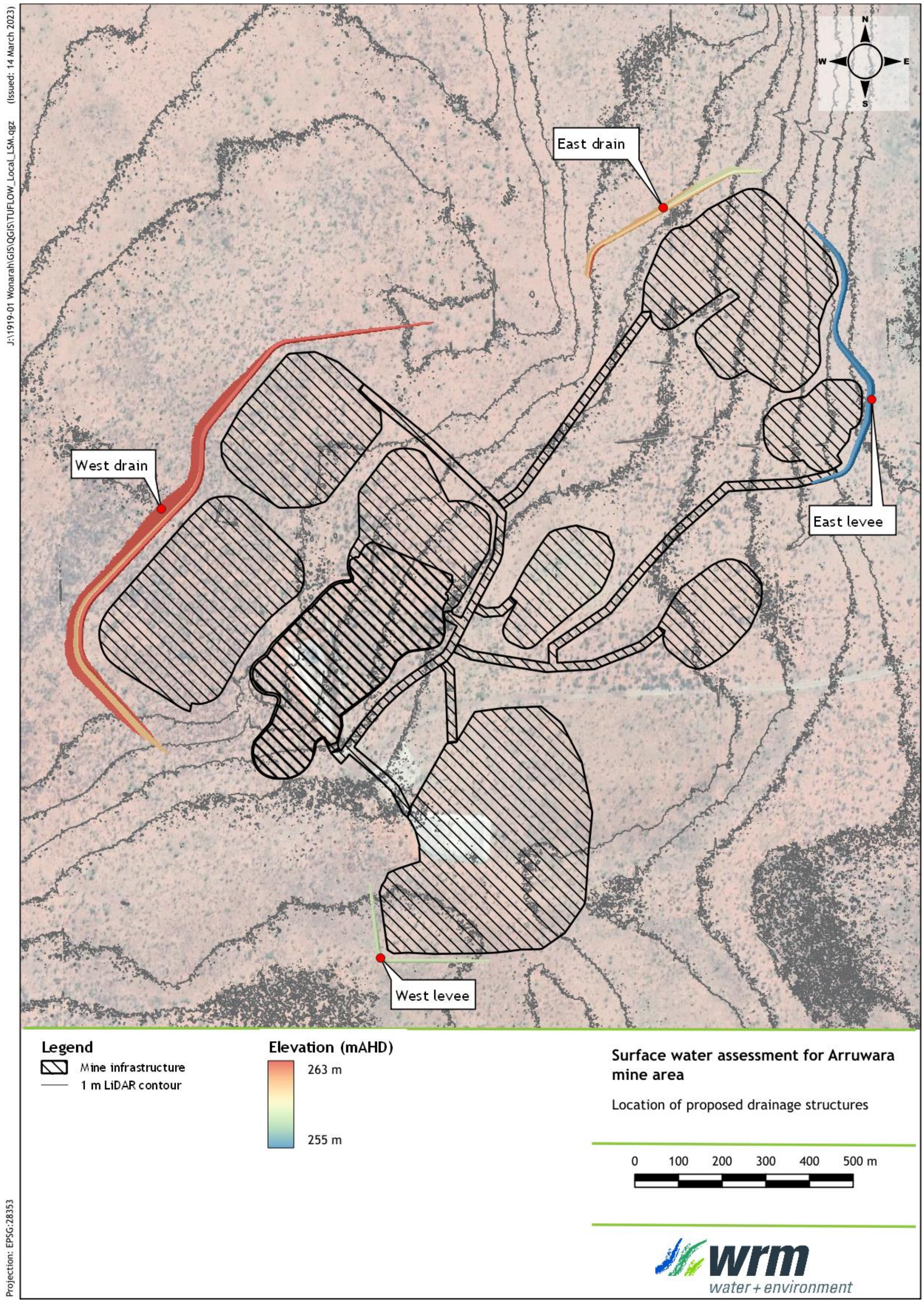

Figure 1 – Location of proposed drainage structures

- East Levee:
  - Embankment crest: 256.2 mAHD (min)
  - Peak water level (1% AEP): 255.6 mAHD
  - Design freeboard: 0.5 m
  - Embankment crest width: 5 m
  - Batter slopes: 1V:3H
- West Levee:
  - Embankment crest: 258.5 mAHD (min)
  - Peak water level (1% AEP): 258.0 mAHD
  - Design freeboard: 0.5 m
  - Embankment crest width: 5 m
  - Batter slopes: 1V:3H
- West Drain:
  - Embankment crest: 260.6 – 263.5 mAHD
  - Peak water level (1% AEP): 263.0 mAHD
  - Freeboard: 0.1 to 0.9 m
  - Embankment crest width: 3 m
  - Embankment batter slopes: 1V:3H
  - Channel gradient: 0.1% to 0.3%
  - Drain batter slope: 1V:10H

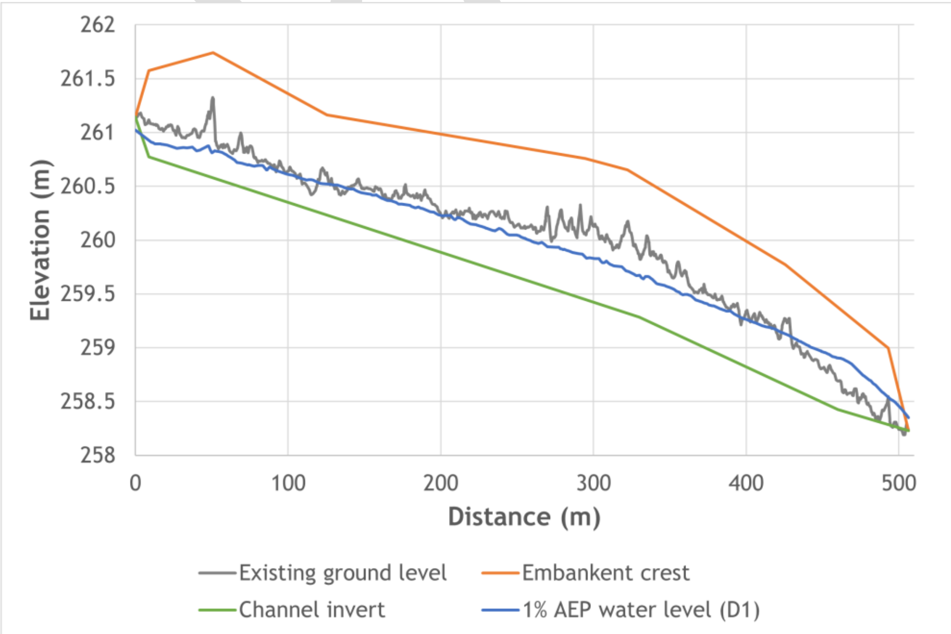

Figure 2 – East Drain longitudinal section

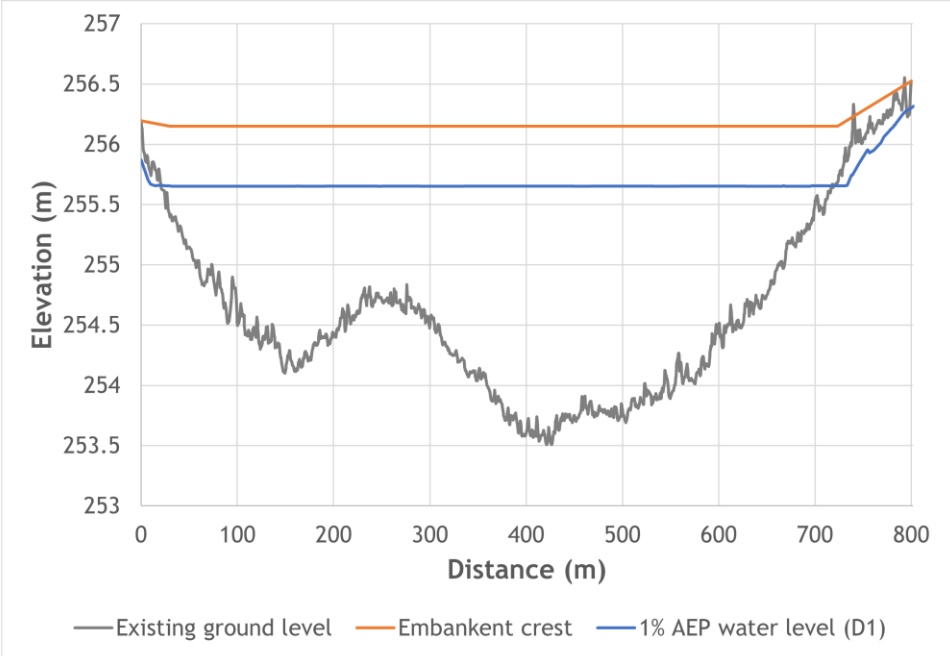

Figure 3 - East Levee longitudinal section

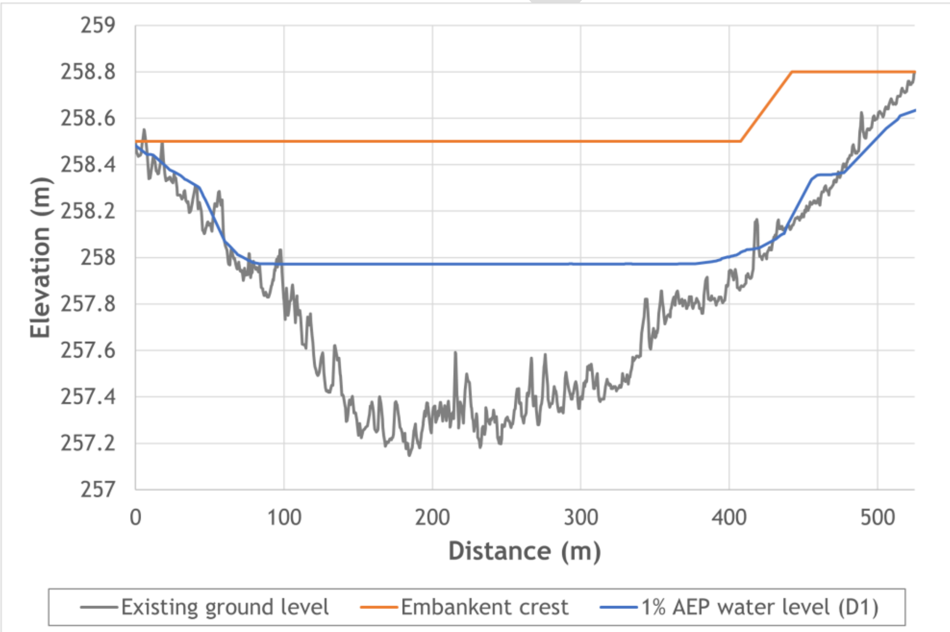

Figure 4 - West Levee longitudinal section

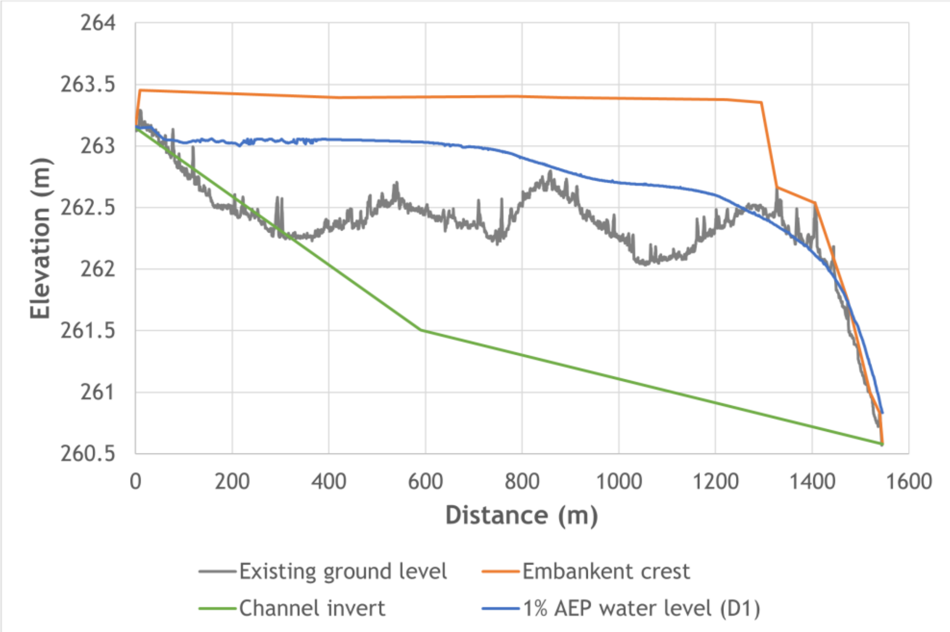

Figure 5 - West Drain longitudinal section

Earthworks volumes

Table 1 shows the cut and fill volumes for the proposed structures. This assessment provides volumes only and does not consider suitability of cut material for use as fill or a bulking factor of excavated material.

Table 1 - Cut and fill balance

Structure		Cut Volume (m^3)	Fill Volume (m^3)	Balance (m^3)
East drain	Embankment	0	1,766	1,766
	Drainage channel	-1,283	0	-1,283
	Total	***-1,283***	***1,766***	***483***
East levee	Embankment	0	13,341	13,341
	Total	***0***	***13,341***	***13,341***
West levee	Embankment	0	*3,087*	*3,087*
	Total	***0***	***3,087***	***3,087***
West drain	Embankment	0	*7,535*	*7,535*
	Drainage channel	*-18,361*	0	*-18,361*
	Total	***-18,361***	***7,535***	***-10,826***
	Total for 4 structures	**-19,644**	**25,729**	**6,085**

Memorandum

Flood Impact Assessment - Methodology

A fine-scale TUFLOW hydraulic model of the local hillslope catchment was used to confirm the effectiveness of the proposed flood protection infrastructure and assess impacts on local catchment runoff.

Figure 6 shows the fine-scale TUFLOW hydrodynamic model used to simulate the flow behaviour in the project area under developed conditions (D1). In addition to the proposed drainage infrastructure design, the following changes were made to the model:

- A model grid size of 5 m was adopted for the entire model extent;
- Two (2) water level vs. time (HT) boundaries and two (2) initial water levels were included in the model to represent the lake water levels of the regional model;
- Four (4) 'stage-discharge' (HQ) downstream outflow boundaries with a fixed slope of 0.2% were included to allow local runoff to leave the model extent.

Flood Impact Assessment - Results

Figure 7 and Figure 8 show the modelled developed conditions (D1) 1% AEP peak flood levels. Figure 9 shows the changes in the flood levels and flood extents between the existing conditions and D1 conditions.

The model results show that for 1% AEP event flooding:

- The proposed drainage structures are not overtopped and protect the operational mining area from flooding;
- Flood levels increase by up to 0.3 m to the north of the West Drain due to the flat gradient;
- The West Drain diverts water to the west of the operational mining area, resulting in water level increase up to 0.2 m in this area.

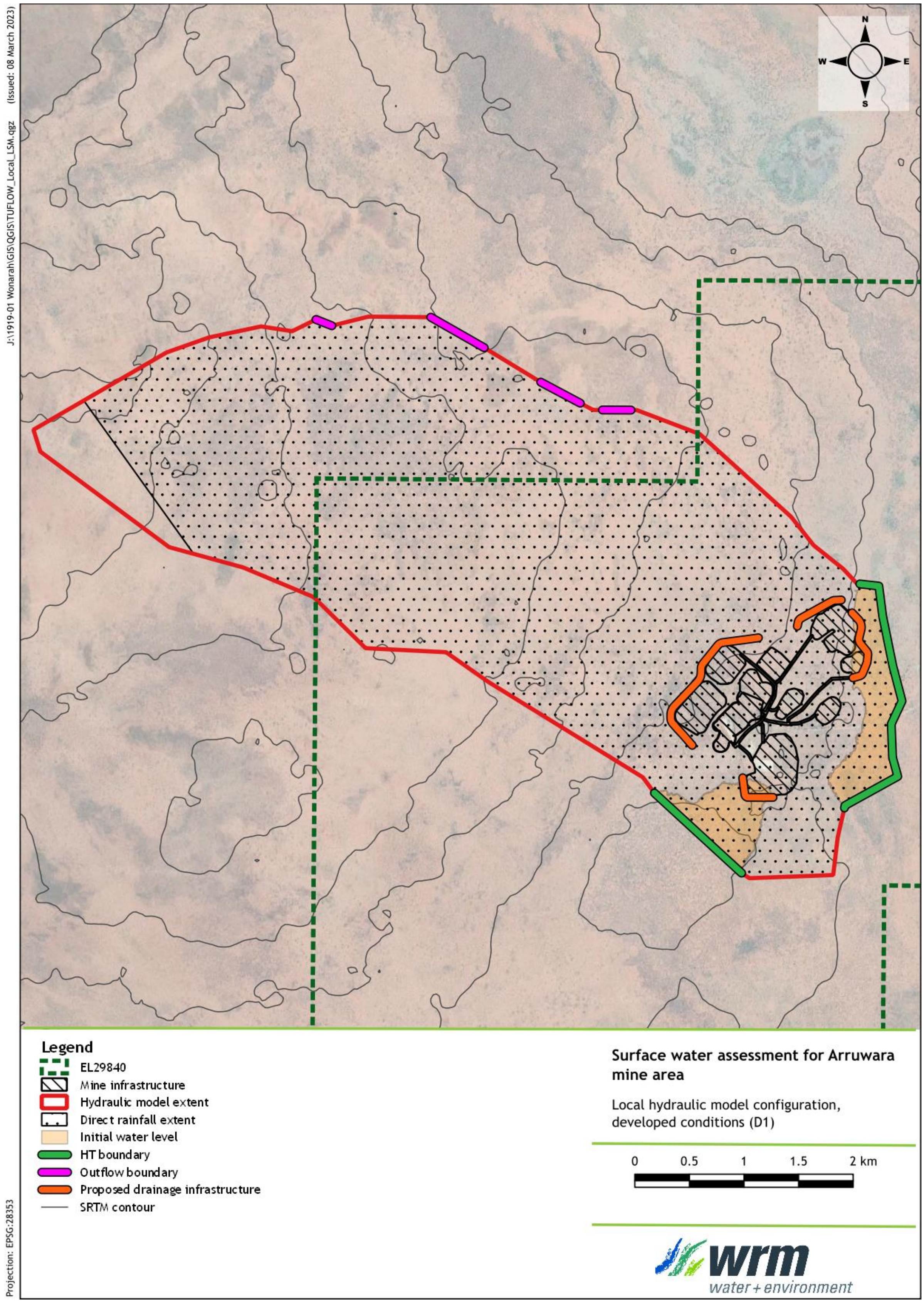

Figure 6 – Local hydraulic model configuration, developed conditions (D1)

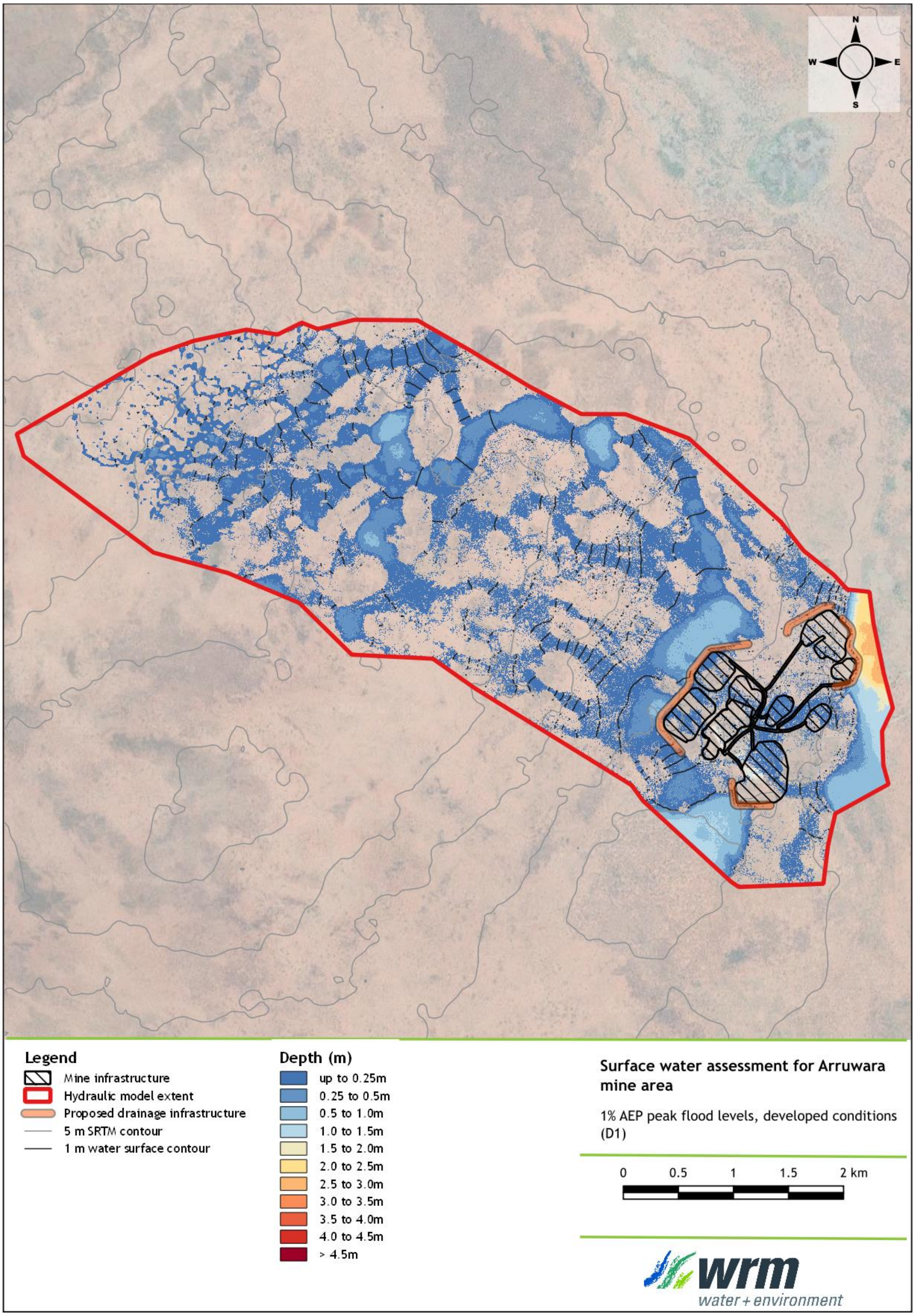

Figure 7 – Predicted peak flood levels for 1% AEP, developed conditions (D1)

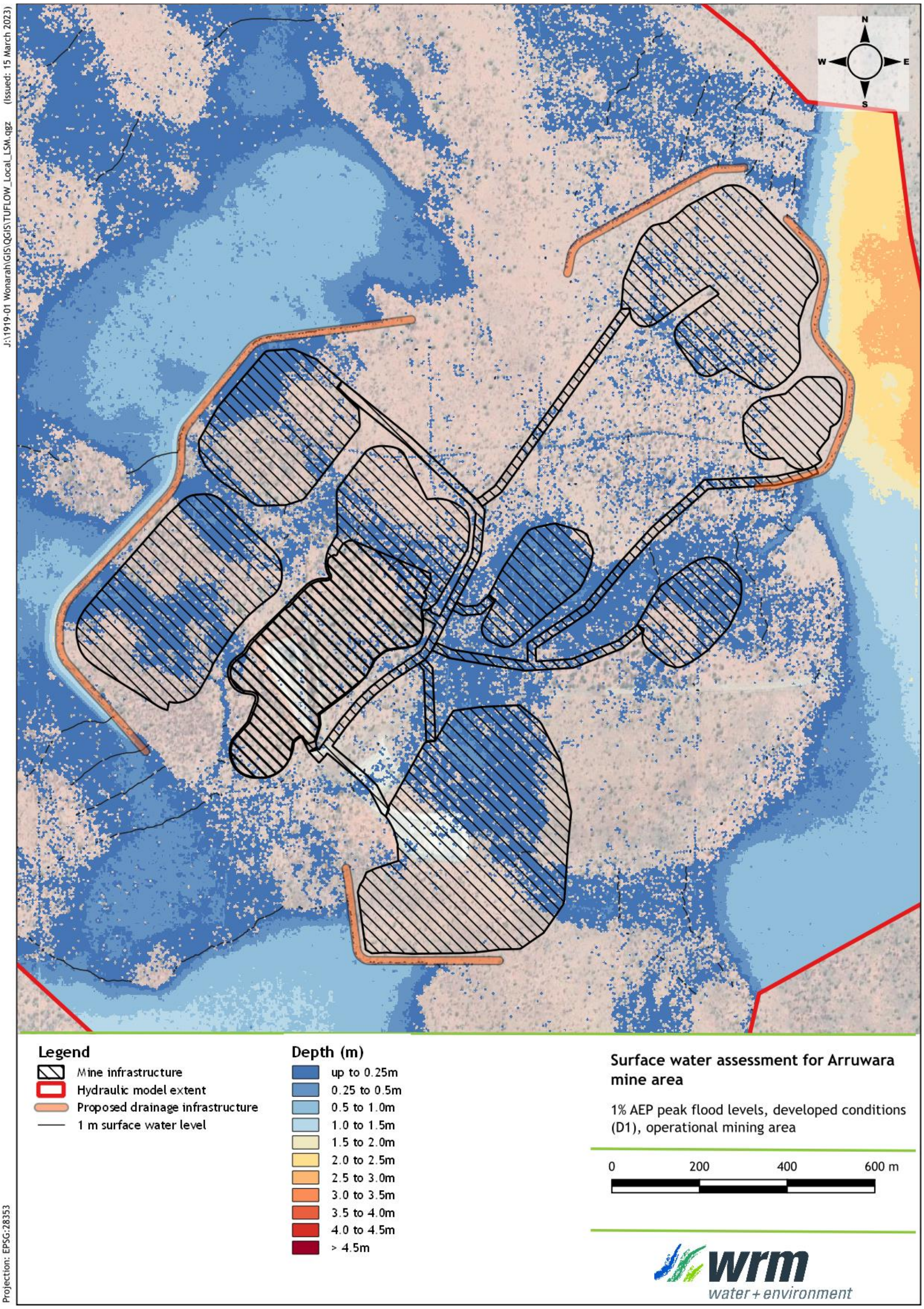

Figure 8 – Predicted peak flood levels for 1% AEP, developed conditions (D1), operational mining area

Memorandum

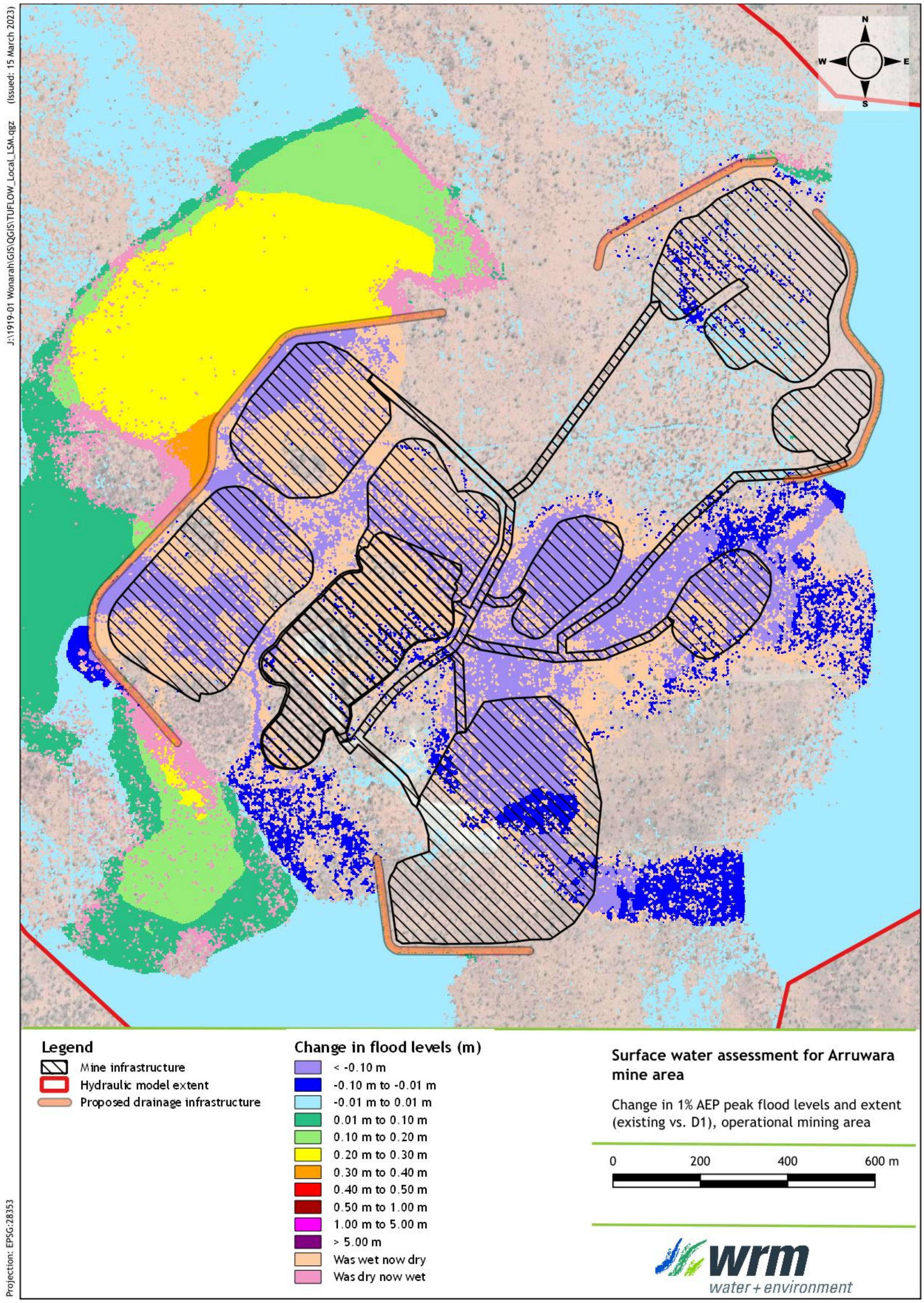

Figure 9 – Change in flood levels and extents between existing and D1 conditions for 1% AEP

Conclusions

The information and results provided above are preliminary only and may be subject to change. This information is intended to provide a high-level indication of major drainage infrastructure requirements and should not be relied upon for detailed design or costing.

Can you please review the above details and provide any comments.

Please do not hesitate to contact me if you have any queries.

For and on behalf of
WRM Water & Environment Pty Ltd

Julian Orth

Principal Engineer

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APPENDIX L PRE-CLEARANCE CHECKLIST

Pre-clearance checklist – Wonarah Bulk Test Sample

Area : Date : Observer :			
Identifying the work area	YES	NO	N/A
Are the proposed locations for clearing consistent with the approved Mining Management Plan? (refer to attached map)			
Identify the vegetation	YES	NO	N/A
Are there any flora species of conservation significance (e.g. *Bergia barklyana, Hibiscus brachychlaenus*) present along the access track and/or in the working areas? (refer to the 'flora species of conservation significance' in the provided supplementary list for species identification)			
Are there trees with a trunk diameter at breast height (DBH) over 12.5 cm (circumference of 125 cm) and greater than 1.5m along the area due for clearing[1]?			
If you have ticked yes to any of the above criteria, have you flagged the vegetation(s) or tree(s) to ensure it is avoided and communicated it to the team members?			
Comments on observations: Specify species, number trees with a DBH over 12.5 cm and height greater than 1.5 m, record the trees encountered and any other relevant information such as avoidance measures, take as many photos as possible along with GPS coordinates of any environmental value that has to be avoided and refer the photos and GPS coordinates back to a description of that environmental value:			
Are there any listed weeds under NT Weeds Management Act (e.g., Gamba grass, Mesquite, prickly acacia) or weeds of national significance (bellyache bush, Parkinsonia) present along the access tracks or in the working area? (refer to the 'Listed weeds under NT Weeds Management Act' in the provided supplementary list for species identification)			
If yes, have you implemented appropriate control measures as outlined in the Weed Management Plan? (E.g., equipment inspection, etc.)			
Comments on observations (take as many photos as possible along with GPS coordinates of any weed infestation and refer them back to a description including species names and relevant control/ avoidance information):			

[1] These trees require approval from the Traditional Owners prior to removal.

Area :			
Date :			
Observer :			
Identify active fauna breeding places/areas of high environmental value for fauna	YES	NO	N/A
Have you encountered any animals you suspect may be near threatened species? e.g., long haired rat, woma python, Australian bustard or Northern nail-tailed wallaby. (refer to the 'Threatened fauna species' in the provided supplementary list for species identification)			
Are there any bird nests present in working area? (Specify whether active or not)			
Are there any trees with hollows present in the working area?			
Are there any burrows present in the working area? (Specify whether active or not)			
Are there any termite mounds with associated burrows or hollows present in the working area?			
Are there large amounts of coarse woody debris/ fallen hollow logs present in the working area?			
Did you identify any caves or sheltered overhangs?			
Did you locate any rocky outcrops, boulders or slab formation?			
If you have ticked yes to any of the above criteria, have you flagged the fauna habitat, ensured avoidance of the fauna/fauna habitat and communicated it to the team members?			
Do you identify any pest species? (e.g., feral pig, cat, cane toad, swamp buffalo)			
Comments on observations: specify species and/or habitat encountered and any relevant information, take as many photos as possible along with GPS locations of any environmental value/ fauna habitat found and has to be avoided and refer back to the description of the environmental value, for trees with hollows if present, record the estimated diameter of the hollow entrance and its height off the ground:			

Pre-clearance checklist – Supplementary list of potentially occurring threatened flora, threatened fauna and listed weed species under NT *Weeds Management Act*

Threatened, near-threatened and data deficient flora species

No flora species of conservation significance listed under the *EPBC Act* were recorded in the project area, and none are considered likely to be present.

Eight flora species of conservation significance listed under the *Territory Parks and Wildlife Conservation Act 1976* (*TPWC Act)* have been recorded inside the Wonarah Phosphate Project area during on-site investigations.

Species	Description
Bergia barklyana  *Bergia* sp. Atlas of Living Australia	Listed as near threatened. *B. barklyana* plants were recorded at one survey site within low lying alluvial sand plain supporting open eucalypt woodland over hummock grassland. Dominant species were coolibah and bloodwood over spinifex. This area is within an Indigenous cultural exclusion zone. The plant is a perennial herb with dry capsule fruit types.

Species	Description
Bonomia alatisemina.  *Florabase.dpaw.wa.gov*	Listed as data deficient. A single plant has been recorded in the NT Parks and Wildlife Flora Atlas within Arruwurra deposit. No specimens were recorded during site surveys.
Heliotropium ballii.  *Atlas of Living Australia*	Listed as data deficient. A search of the NT Parks and Wildlife Flora Atlas identified one record of *H. ballii* just inside of the main zone deposit, alongside the Barkly Highway. No specimens were recorded during site surveys.

Pre-clearance checklist – Supplementary list of potentially occurring threatened flora, threatened fauna and listed weed species under NT *Weeds Management Act*

Species	Description
Heliotropium pulvinum  *Atlas of Living Australia*	Listed as data deficient. The NT Parks and Wildlife Flora Atlas records eight specimens of *H. pulvinum* in the project area surrounds. Records are scattered around the area with the closest record along the Barkly Highway. The March 2009 survey identified specimens within the Acacia shrubland.
Hibiscus brachychlaenus  *Florabase.dpaw.wa.gov*	Listed as near threatened. The March 2009 survey identified *H. brachychleanus* plants within the Arruwurra deposit. Specimens were found within the Acacia shrubland vegetation community. This species has not been recorded in the area before. Upright, spreading perennial, herb or shrub, 0.4-1.8 m high, to 1 m wide. Fl. blue-purple-pink, Mar to Apr or Aug to Nov. Sandy & loamy soils, sandstone. Sandplains, dunes

Species	Description
Sporobolus latzii  *NT Government*[1]	Listed as vulnerable. One record of *S. latzii* is listed in the NT Parks and Wildlife Flora Atlas and this record is within an Indigenous cultural exclusion zone. This is the only known collection site of this species in Australia. Although targeted searches were performed as part of the surveys no specimens were identified. *Sporobolus latzii* is a fairly robust erect tufted perennial grass with flowering stems to almost 1 m high from a short rhizome. The leaves are minutely roughened, flat and to 16 cm long and 3.5 mm wide. Spikelets are 2-2.3 mm long and arranged in a panicle 11-13 cm long. The main branches of the inflorescence are solitary and spikelet-bearing throughout1. Flowering: recorded in May1
Triumfetta deserticola  *Florabase.dpaw.wa.gov*	Listed as data deficient. A single record of *T. deserticola* has been recorded within the proposed Arruwurra pit; however, no plants were recorded as part of the June 2008 or March 2009 surveys. Slender shrub, 0.5-1.5 m high. Flowers are yellow, April to May. Red sandy soils, gravelly loam2

[1] https://nt.gov.au/__data/assets/pdf_file/0007/208492/sporobolus-latzii.pdf

[2] https://florabase.dpaw.wa.gov.au/browse/profile/16306

Threatened and near-threatened fauna species

Three species listed as near threatened have been recorded in the Project area (long haired rat, woma python and Northern nail-tail wallaby) and one species listed as vulnerable under the TPWC Act (Australian bustard).

Species	Description
Long haired rat (*Rattus villosissimus*)  *Atlas of Living Australia*	The long-haired rat can be distinguished by its very long, coarse guard hairs that form an outer layer to protect the softer underfur. The species is generally a light grey colour with the black guard hairs giving and overall greyish speckled appearance. This distinguishes them from the tan or brown colouration of many other rat species. A male long-haired rat can grow to an average size of 187 mm with a tail length of approximately 150 mm while a female can grow to an average of 167 mm with an approximate tail length of 141 mm. The average weight for males is 156 g and for females is 112 g[3].
Woma python (*Aspidites ramsayi*)  	This python can grow to 2.7 metres in total length and weigh up to 5.8 kg. It is thick set and muscular with a smoothly rounded snout when viewed from above. The body is a yellowish brown to yellowish white with many wavy brownish bands that join along the back into an irregular brown midline. Juveniles are more prominently patterned and coloured than older animals. Woma Pythons are found in desert dunefields and on sandy plains, usually with hummock grasses but also other natural vegetation.

[3] https://bie.ala.org.au/species/https://biodiversity.org.au/afd/taxa/bc623514-ce79-4ba8-bb9c-41cb5767dcc1

Species	Description
Australian bustard *(Ardeotis Australis)*  *Australian Museum*	The Australian Bustard is one of Australia's largest birds and it is ground dwelling bird which is common in grassland, woodland and open agricultural country across northern Australia. It stands at about one metre high, and its wingspan is around twice that length. It is a mainly grey-brown bird, speckled with dark markings, with a pale neck and black crown, with a slight crest and a white eye-brow. There are bold black and white markings on the wing. The female is slightly smaller than the male.
Northern nail-tailed wallaby (*Onychogalea unguifera)*  Alamy	Northern nail-tail wallabies have a horny spur like a fingernail beneath a crest of fur at the end of the tail. No one knows what this nail is for. The northern nail-tail wallaby is sandy coloured with a paler head and neck, brown flanks and a white stripe near the leg, and long ears. It's habitat includes acacia woodlands and shrublands with tussock grasses or spinifex, especially at the edges of black soil plains.

Pre-clearance checklist – Supplementary list of potentially occurring threatened flora, threatened fauna and listed weed species under NT *Weeds Management Act*

Listed weeds under NT Weeds Management Act

Species		Description
Bellyache Bush (*Jatropha gossypiifolia*) *NT Government* 		Bellyache bush is declared a Class A weed in the NT. Bellyache bush is targeted for eradication in the Tennant Creek Region and is the subject of a statutory weed management plan. Bellyache bush is being monitoring within Tennant Creek and Elliott townships Bellyache bush is a perennial, erect shrub or small tree usually about 2.5 m tall but which can exceed 4 m in some areas (P. Jeffrey, pers. comm. 1998). Some specimens have a single stem, whereas others can have two or more stems. The stems are thick, rather soft, coarsely hairy, 1-2 m long. Stems rise from a herbaceous crown.
Parkinsonia (*Parkinsonia aculeata*) 		Parkinsonia is declared a Class B weed in the NT. Parkinsonia is a large shrub or small tree growing up to eight metres high. It sometimes has only a single stem but it usually branches close to the base following mechanical damage. The trunk and branches have bright green bark. Leaves: Light green, narrow, very thin and up to 30 centimetres long, with numerous minute leaflets on both edges. Stiff spines about 12 millimetres long are formed on the branches at the base of each leaf. Flowers: Bright yellow and fragrant. They are one to two centimetres wide and are borne in loose bundles on long flower stalks hanging near the ends of the branches. Parkinsonia flowers mainly in May and June, but individual plants may flower throughout the year

Species		Description
Mossman River (buffel) grass *(Cenchrus echinatus)* 		Mossman River grass is declared a Class B weed in the NT. It is a slightly-tufted, short-lived grass usually growing 25-60 cm tall. Its stem bases and lower leaf sheaths often have a reddish or purplish-coloured tinge. Its seed-heads are spike-like with numerous, almost stalkless, burr-like structures (4-10 mm in size). The 'burrs' contain several flower spikelets enclosed in numerous spine-tipped bracts and hairy bristles. The 'burrs' are reddish or purplish-green when young, but turn straw-coloured or dark brown as they mature
Noogoora Burr *(Xanthium strumarium)* 		Noogoora burr is declared a Class C weed in the NT. Noogoora is a branched annual plant up to 2m tall with fleshy stems, green to purplish in colour with rough texture. Dark green, alternate leaves 10 to 15cm in diameter. Flowers are pale green small and inconspicuous that grow in leaf axils and produce clusters of burrs on short stalks. Burrs are 1.5 to 2cm long and 0.5 to 0.8cm wide green and oval shaped, drying to dark brown, covered in small woody spines. Two seeds are contained inside the burr in separate sections

Species	Description
Gamba grass (*Andropogon gayanus*)  	Gamba grass is declared a Class A weed in the NT. Erect tussock grass. Robust stems covered in dense soft white hairs. Broad leaves with a distinctive white midrib. Leaves broad and softly hairy. Seed heads are 'v' shaped and fluffy. Occurrences of gamba grass have been recorded on the Stuart Highway south of Elliott and on the Adelaide to Darwin Railway line south of Elliott. All known occurrences have been controlled and are currently under monitoring.
Athel pine (*Tamarix aphylla*) 	Athel pine is declared a Class A and Class B weed in the NT. Athel pine is a spreading tree to 15 m with pendulous, jointed branches. Immature trees have light grey trunks and stems. Mature trees have a thick, rough, dark grey to black bark, and grey-brown stems, and can be up to 1 m in diameter. The minute, dull green leaves superficially resemble pine tree 'needles'. However, athel pine is misleadingly named as it is a flowering plant, not closely related to true pine trees (conifers). Its small flowers are pinkish-white without stalks, growing on 30–40 mm long spikes from the ends of the previous year's branches. The fruit is bell shaped with a hairy tuft, and contains numerous small cylindrical seeds. The seeds have a tuft of fine hairs which assists wind dispersal. The trees have strong woody roots which penetrate and spread deeply throughout the soil.4

[4] https://weeds.dpi.nsw.gov.au/Weeds/Athelpine

Pre-clearance checklist – Supplementary list of potentially occurring threatened flora, threatened fauna and listed weed species under NT *Weeds Management Act*

Species		Description
Mesquite (Prosopis spp.)  	 	Mesquite is declared a Class A weed in the NT. Mesquite is targeted for eradication in the Northern Territory and is the subject of a statutory weed management plan. Mesquite infestations in the Tennant Creek Region are a priority for control and monitoring. Mesquite has a persistent seed bank. Species vary in growth characteristics. Mesquite can occur as a multi-stemmed shrub with branches drooping to the ground, around 3–5 m high, or as a single-stemmed tree with a spreading canopy growing to 15 m. Leaves are fern-like in appearance. Each leaf has 1–4 pairs of leaf branches (pinnae), with each 'branch' having 6–18 pairs of individual leaflets. Leaflets vary from oval-shaped to long and narrow depending on the species. Foliage is usually dark green but can vary to bluish green. Paired thorns usually occur just above each leaf axil. Flowers are small greenish-cream 'lamb's tail' shaped that grow near the ends of branches in wattle-like spikes, 5–12 cm long. Seed pods are 10–20 cm long, straight to slightly curved, smooth, with slight constrictions between the seeds. When ripe the pods are straw-coloured, or purplish in some species. Each pod contains between 5–20 hard seeds

Species		Description
Prickly acacia (*Vachellia nilotica*) 		Prickly acacia is declared a Class A weed in the NT. Prickly acacia is targeted for eradication in the Northern Territory and is the subject of a statutory weed management plan. Prickly acacia is predominantly found on pastoral leases and poses a significant risk to the Tennant Creek's Mitchell Grass bioregion. Prickly acacia is a thorny, spreading tree. It usually grows to 4–5 m but occasionally is up to 10 m tall. The leaves are fern-like with 3–10 pairs of primary leaf segments which are further divided into 10–25 pairs of leaflets. The leaflets are green, oblong 3–6 mm long and 0.5–1.5 mm wide. The flowers are bright yellow fluffy balls that look like wattle flowers 10–12 mm in diameter in groups of 2–6 flower heads at the base of each leaf joint5.
Neem (*Azadirachta indica*) 		Neem is declared a Class B weed in the NT. Neem is a medium sized tree growing to a height of 15 meters. It has dark red-brown bark that cracks and flakes when aged and small white honey scented flowers.

[5] https://weeds.dpi.nsw.gov.au/Weeds/Pricklyacacia

Species		Description
Prickly pear (*Opuntia spp)* 		Prickly pear is declared a Class A weed in the NT. Prickly pear range from low growing shrubs to erect trees up to 8m tall most commonly around 2m tall and covered with spines small to large flattened stem fragments commonly referred to as pads, most are covered with spines 1cm to 5cm long flowers more commonly yellow, red and orange in colour.
Rope cactus (*Austrocylindropuntia spp.*, *Cylindropuntia* spp.) 		Rope cactus is declared a Class A weed in the NT. Rope cactus range from low growing shrubs to erect trees up to 8m tall, usually around 0.5m to 2m tall and are covered with spines. Some have small or large club-shaped segments, some have smaller cylindrical segments that look like ropes. All are covered with spines 1cm to 5cm long flower colours vary from red or pink to yellow.

APPENDIX M FAUNA MANAGEMENT

WONARAH PHOSPHATE PROJECT

Bulk Test Sample MMP
Fauna Management Plan

Prepared for:

Avenira Limited
13/6-10 Duoro Rd
West Perth WA 6005

SLR Ref: 680.30199-R03
Version No: -v0.2
March 2023

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
680.30199-R03-v0.2	20 March 2023	Jill Woodworth	Emmanuelle Aliotti	Jill Woodworth
680.-R03-v0.1	17 March 2023	Jill Woodworth	Emmanuelle Aliotti	

CONTENTS

DOCUMENT REFERENCES

TABLES

APPENDICES

1 Introduction

1.1 Background and Purpose

This Fauna Management Plan (FMP) forms part of the Mining Management Plan (MMP) for the Wonarah Phosphate Project located approximately 240 km east of Tenant Creek. This project seeks to undertake a bulk test sample within the existing Arruwurra test pit on the current Mineral Lease (ML) application ML33344.

The purpose of this FMP is to prevent adverse impact on native fauna and road users and prevention of native fauna deaths. A vehicular collision with any larger species can result serious injury and even death for not just wildlife, but driver of the vehicle themselves. This FMP is applicable to employees, contractors and all personnel associated with the planning, construction and operation of the Project.

1.2 Scope and Objectives

This Fauna Management Plan has been developed for the management of fauna road-strikes to fully address animal-welfare and safety objectives, including:

- Risk of leaving large animal carcasses on the road, which presents risks of causing further accidents for other road users, particularly at night, on un-lit highways.
- Risk of attracting scavenger fauna, such as eagles, and kites onto the highways risking further fauna strikes, and further accidents for other road users.
- Avoiding preventable fauna deaths by providing effective procedures for rescue of injured wildlife, and /or recovery and care of orphaned wildlife that may still be present in the pouch of a freshly killed or injured parent.

1.3 Legislation and Guidelines

1.3.1 Commonwealth Legislation

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*

1.3.2 Northern Territory Legislation

- *Mining Management Act 2001*
- *National Environment Protection Council (Northern Territory) Act 1994*
- *Territory Parks and Wildlife Conservation Act 2006 (TPWC Act)*

1.3.3 Guidelines

Rescuing Wildlife Information Sheet. Parks and Wildlife Commission of the Northern Territory (Appendix A)

2 Existing Environment

2.1 Fauna

The protected matters report and search of the NT Parks and Wildlife Fauna Atlas identified 693 records of 163 species within the project surrounds. Twelve species were identified that are listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), including:

- *Rostratula australis* (painted snipe), listed as vulnerable.
- *Dasycercus cristicauda* (mulgara), listed as vulnerable.
- *Macrotis lagotis* (bilby), listed as vulnerable.
- *Epthianura crocea* (yellow chat), listed as vulnerable; however, it is the northern subspecies, *Epthianura crocea tunneyi*, which is listed. The inland species, *Epthianura crocea crocea,* recorded in the surrounding area, is not listed under the EPBC Act and is of least concern under the Territory Parks and Wildlife Conservation Act (TPWC Act).
- Eight migratory bird species were identified as potentially present.

None of these species were recorded during field surveys.

A further eight species listed under the TPWC Act have been recorded within the project surrounds; two species (both listed as near threatened) have been recorded in the Project area, *Rattus villosissimus* (long haired rat) and *Aspidites ramsayi* (woma python).

Field surveys identified no habitats of ecological importance. In general, the area does not exhibit any special features for biodiversity; however, two species of conservation significance were recorded during the field surveys, *Ardeotis Australis* (Australian bustard) (listed as vulnerable under the TPWC Act) and *Onychogalea unguifera* (northern nail-tailed wallaby) (listed as near threatened under the TPWC Act). Surveys for species of conservation significance were conducted, particularly targeting the bilby (*Macrotis lagotis*) and mulgara (*Dasycercus cristicauda* or *D.blythi*) where suitable habitat was identified, but no evidence was found.

2.2 Fauna of Indigenous Conservation Significance

Traditional Owners identified local fauna of cultural significance for their utilitarian values. Larger fauna species such as kangaroo, Australian bustard, sand goanna and other large dragons are still hunted by the Traditional Owners. The ephemeral lakes within the cultural exclusion zones (located outside of the MLs) are considered as an important hunting ground as they provide seasonal refuge to larger species. The Traditional Owners consulted during the March 2009 survey identified no species of mythical significance.

3 Fauna Management

3.1 Background

Many animals prefer to be on the move at night or at dusk. Care must be taken, and speed reduced at these times of the day. Poor visibility increases the risk of accidents; therefore, adjust your speed to the conditions.

Drivers should be aware of the danger sign 'Wildlife Crossing', reduce their speed and keep an eye on the edge of the road. As soon as an animal comes into view, drivers should switch to dipped headlights so that the animals are not blinded.

It is important to note that many animals travel in groups; therefore, if one kangaroo appears, it should be expected that more kangaroos are present. It is important that you do not accelerate again immediately after an animal has crossed the road. Further, to ensure your own safety do not swerve or take any risky evasive manoeuvres. Slow down and brake to avoid endangering yourself and other road users.

3.2 Management and Mitigation

General management objectives for fauna pertaining to management of fauna road strikes are detailed in Table 1. Management and mitigation measures are shown in Table 2.

Table 1 Fauna Management Objectives

Objective	Target	Indicator
Avoid injury or death to native fauna from mine activities.	All vehicles to adhere to established mine speed limits.	Number of incidents of speeding.
	Zero incidents of native fauna injury or death from mine activities	Number of incidents involving native fauna injury or death from mine activities.
Avoid injury or death to drivers due to collision with native or non-native fauna	All vehicles to adhere to established mine speed limits.	Number of incidents of speeding.
	Zero incidents of driver/passenger injury or death from mine activities	Number of incidents involving mine vehicles and native/non-native fauna.

Table 2 Management and Mitigation Measures

Mitigation Measures	Timing	Responsibility
Vehicle driving policies will be implemented (including speed restrictions) to minimise risk to fauna.	At all times	All personnel
Use of pooled vehicles such as buses and work vehicles (to minimise exposure) where appropriate.	At all times	All personnel
“Wildlife crossing” signs to be erected at locations that wildlife has been observed or signs of activity is evident (Native and non-native)	At all times	All personnel
Minimal driving at dawn and dusk (if possible)	Between dawn and dusk	All personnel
Reduce speed limits between dawn and dusk		All personnel

3.3 Management after Wildlife Collision

It can be difficult to know what to do if an animal is injured or in need of help. Basic first steps are outlined below for how to assess a situation. However, animal groups highly recommend that if you do find a sick or injured wild animal, contact your nearest veterinarian or wildlife carer organisation as soon as possible.

- If you're involved in an accident with an animal, stop and secure the site.
- Before rescuing injured wildlife you must make sure you and your party are safe from possible danger from road and traffic, other animals or the injured animal itself.
- If it's safe to do so, check the animal's well-being. If the animal is alive and injured, call RSPCA, WIRES or your local wildlife rescue service[1]. Contact details below and in Appendix A.
- It is strongly advised not to rescue the animal on your own, unless otherwise advised by the wildlife rescue service or the vet.
- If you have spoken with a rescue group for advice, and it is safe to do so, then, while wearing gloves, you can gently wrap the animal loosely in a towel. Then place them in a ventilated box with a lid and place the box in a dark, quiet, and cool place before going to your nearest veterinarian/ wildlife rescue or while waiting for the carer to arrive.
- Wildlife can carry a variety of diseases. Extra precautions include wearing a mask and long-sleeved shirt to prevent injuries, for instance in the case of possums.
- Wild animals become very stressed with handling and exposure to people and loud noises. Keep handling to a minimum, place the animal in the box, and put the box in a quiet area away from people and other animals.
- Check dead kangaroo and possum pouches for joeys.
- Do not handle bats and do not approach snakes, monitor lizards, large macropods, bats (flying foxes or microbats) or birds of prey (falcons, hawks etc) [2]. These animals require specialist handling and MUST be rescued by trained wildlife rescuers. Please monitor the animal from a safe distance and call for rescue assistance.
- Take note of where you found the animal, as they may need to be released back at the same location.
- Do not feed or treat the animal, unless instructed to by the veterinarian or wildlife rescue group.

3.3.1 Reporting Injured Wildlife

Appendix A has a complete list of contact details for wildlife rescue organisations. Some useful contact details are shown below.

- Northern Territory Wildcare: Ph: 08 8988 6121 or Mob: 0408 885 341
- Katherine Wildcare: Ph: 0412 955 336
- Alice Springs Wildcare: Ph: 0419 221 128
- Tennant Creek Barkly Veterinary Practice: 0447 471 399

[1] https://www.four-paws.org.au/our-stories/publications-guides/avoiding-wildlife-accidents
[2] https://www.wires.org.au/rescue/emergency-advice

Appendix A:

Rescuing Wildlife Information Sheet

INFORMATION SHEET

Rescuing Wildlife

What to do if you encounter injured or orphaned wildlife in the Northern Territory

What should I do if I find injured or orphaned wildlife?

The basic information outlined below is applicable to most wildlife rescue situations. It is important to bring any injured or orphaned animal to your nearest vet or wildlife rescue group as soon as possible. Please remember Wildlife Care groups are mostly staffed by volunteers who also work full time jobs and may not be able to answer the phone on the first call.

Remember, your safety always comes first!

- Ensure the animal needs rescuing.
- If working near roadways, be aware of traffic hazards.
- Minimize handling.
- Keep pets and children away from wildlife.
- Minimize Noise. Turn the radio off and keep voices down.
- Do not try to feed injured wildlife. Providing water is OK, but do not force an animal to drink.
- Try and move any road kill at least 10m off the road.
- Check dead kangaroo and possum pouches for joeys.
- Bring the animal to the nearest Veterinarian or Wildlife care group.
- Wildlife can carry a variety of diseases. Where possible wear gloves and always wash your hands after handling wildlife.

Who is my local wildlife rescue organisation?

Darwin Wildlife Sanctuary - 0473 992 581

Katherine Wildcare Inc - 0412 955 336

Alice Springs Wildcare Inc - 0419 221 128

Or visit www.dwsnt.com.au or www.wildcareasp.org.au for more information.

Alternatively local vets are affiliated with care groups and you can drop wildlife off during business hours at the following locations:

Darwin Area:

All Pets Vet Hospital - Rapid Creek - (08) 8948 0056

Ark Animal Hospital - Yarrawonga - (08) 8932 9738

Darwin My Vet Service - Wulagi - (08) 8927 3657

Darwin Wildcare Inc - 0408 885 341

Howard Spring Veterinary Clinic - Howard Springs - (08) 8983 1458

Humpty Doo Vets – Humpty Doo – (08) 8988 3340

Litchfield Veterinary Hospital - Coolalinga - (08) 8983 2838

Parap Veterinary Hospital - Parap - (08) 8981 9767

Paul Arnold Bush Photos - Darwin - (08) 8941 6062

Territory Wildlife Park - (08) 8988 7200

University Ave. Veterinary Hospital - Durack - (08) 8931 0455

Katherine Area:

Katherine Vet Care Centre - (08) 8972 2752

Katherine Veterinary Clinic - (08) 8972 2893

Tennant Creek Area:

Barkly Veterinary Practice - 0447 471 399

Alice Springs Area:

Alice Springs Reptile Centre - (08) 8952 8900 - reptiles only

Alice Springs Veterinary Centre - (08) 8952 4353

Alice Springs Veterinary Hospital - (08) 8952 9899

Desert Oaks Veterinary Clinic (08) 8953 4936

Parks & Wildlife Commission of the Northern Territory

Head Office - Darwin
Level 1 JHV 2,
Jape Homemaker Village
356 Bagot Rd, Millner, NT, 0810
Ph: (08) 8999 4555

Regional Offices
Alice Springs - Arid Zone Research Institute
Sth Sturart Hwy, Ph: (08) 8951 8250
Katherine - Giles St, Katherine
Ph: (08) 8973 8888

NORTHERN TERRITORY GOVERNMENT

Rescuing Wildlife

Caring for wildlife requires specialised knowledge and experience.

Wildlife care groups are always looking for volunteers and are able to provide mentorship and training for new wildlife carers. All wildlife in the NT is protected under law, and rescued wildlife may not be kept permanently. In order to become a wildlife carer, you must obtain a permit from the NT Parks and Wildlife Commission.

Please contact your local wildlife care group for more information, or visit www.parksandwildlife.nt.gov.au

Bird Rescue

Birds come into care for a number of reasons; often they have been hit by cars or attacked by domestic pets. If you find an injured bird follow these steps.

1.Try to determine what sort of bird it is and any potential risks to you before handling it. Talons and beaks can cause serious injury if birds are not handled correctly.

2.If the bird is young, and appears to be having trouble flying, it may be a fledgling bird that is learning to fly. Before approaching, look for adult birds that may be nearby as they are likely still caring for the young. Only rescue the bird if there are immediate threats present such as dogs, cats or traffic. If a nest is visible and within reach, you can try placing the bird back in the nest or on a branch nearby.

3. If the bird needs to be rescued, to restrain a bird, place a towel or shirt over the birds head. This helps calm the bird and may prevent it from biting. Wrap the towel around the bird securing the wings to its side. Place the bird in a cardboard box with air holes, or in a pet carrier. Drape a towel over the box to keep it dark. Bring the bird to the nearest veterinarian or Wildlife care group as soon as possible.

Bat Rescue

All bats are potential carriers of Australian Bat Lyssavirus disease, so it is important that ***only people vaccinated for the disease handle bats.*** If you are scratched or bitten by a bat, you should seek advice from a doctor immediately. Contact a wildlife care group for assistance with rescuing bats.

Mammal Rescue

Mammals such as Kangaroos, Wallabies, Possums, Gliders and native rats come into care primarily as victims of road accidents, attacks by domestic pets, or as orphans.

Many Australian mammals such as Kangaroos, Wallabies and Possums are marsupials, which mean they carry their young (joeys) in a pouch. If you find a joey, put it in a pillowcase or a pouch fashioned from breathable material. Place some padding inside which will also act as insulation. A furred joey should be kept at around 28 – 30°C, furless joeys should be kept at around 32 – 34°C. Keeping it close to your body can provide that heat, or you can place a warm (not hot) water bottle in the pouch, provided it is not in direct contact with the joey.

Most mammals have sharp claws and teeth and will bite and scratch in defence. Handling should be quick, as they stress easily and can overheat during the heat of the day. Small mammals can be scooped up in a large thick towel or blanket and placed in a ventilated box. Large macropod joeys should be handled/picked up from the base of the tail.

Rescuing a full grown adult macropod requires specialised training and equipment as they can be very dangerous. Call the wildlife care group nearest you, who can arrange a rescue.

Reptile Rescue

Often reptiles that are found near the roadways do not need rescuing at all. Many reptiles lay motionless on the road to absorb the suns heat or heat from the roadway. If the reptile doesn't have any visible wounds, and it is able to move on its own, it likely does not need any help. Simply encouraging it to get off the road may be all that is required.

If a lizard is visibly wounded, take care when handling it. Larger lizards like monitors can cause injury and wounds can become infected. Grip the lizard firmly at the base of the head and grab the base of the tail where it meets the body with the other hand. Place the lizard inside a well ventilated box. Secure with a lid as many lizards can climb and possibly escape.

For smaller or medium lizards, the same techniques as above are useful. Alternatively you can try scooping them into cupped hands or picking them up directly by the body. They can then be placed in a box or crate

If you come across a snake, leave it alone. Pick up the phone not the snake. Local snake collectors can be contacted at:

Darwin: 1800 453 210

Katherine: 1800 453 210

Tennant Creek: 0418 856 969

Alice Springs: 1800 453 210

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CAIRNS
Level 1, Suite 1.06
Boland's Centre
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
1/25 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Level 1, 500 Hay Street
Subiaco WA 6008
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SUNSHINE COAST
Suite 2, 14-20 Aerodrome Rd
Maroochydore QLD 4558
Australia
T: +61 7 3858 4800

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
201 Victoria Street West
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX N TRAFFIC MANAGEMENT PLAN

Traffic Management Plan

Wonarah Phosphate DSO Project

Avenira Limited

Unit 13/6 Duoro Rd
West Perth WA 6005

Prepared by:

SLR Consulting Australia Pty Ltd

Level 16, 175 Eagle Street, Brisbane QLD 4000,
Australia

SLR Project No.: 680.V13432

20 September 2023

Revision: v4

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
v1	14 June 2023	A. Parmenter	K. Sammons	
v2	25 July 2023	A. Parmenter	K. Sammons	J. Woodworth
v3	8 September 2023	J. Woodworth	S. Buxton, S. Harris	J. Woodworth
v4	19 September 2023	B. Rheinberger	J. Woodworth	B. Rheinberger
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables in Text

Figures in Text

Appendices

1.0 Introduction

1.1 Context

SLR Consulting Australia Pty Ltd (**SLR**) has been engaged by Avenira Pty Ltd (**Avenira**) to prepare a Traffic Management Plan (**TMP**) for the construction of the Wonarah Phosphate DSO Project, located in the Barkly Tableland of the Northern Territory (**NT**).

This TMP describes measures to be implemented to facilitate construction activities and the haulage of crushed and screened phosphate rock safely with consideration of safety for the community. Consideration has been given to all users of the subject road network, along with worker safety in proximity to the planned works.

This TMP has been prepared by Brendyn Rheinberger, who is a suitably qualified and experienced person. Brendyn holds the following accreditation:

- Institute of Engineers Australia, Chartered Professional Engineer (**CPEng**).
- Board of Professional Engineers Queensland, Registered Professional Engineer of Queensland (**RPEQ**).
- Queensland Department of Transport and Main Roads, Traffic Management Design (**TMD**), Number: OP 951.
- Queensland Department of Transport and Main Roads, Road Safety Auditor (**RSA**).
- Transport for NSW, Prepare a Workzone Traffic Management Plan (**PWZTMP**), Licence No: TCT1044529.
- Business Licensing Authority, Registered Professional Engineer of Victoria, Registration No: PE0009941.

1.2 Reference Documents

Reference is made to the following documents which have been referenced during the preparation of this Traffic Management Plan:

- Wonarah Phosphate Project, Operations Safety Management Plan, prepared by Avenira dated 31 May 2023.
- Wonarah Mine Site, Traffic Impact Assessment, prepared by ARCCOS dated 14 March 2023.
- Austroads Guide to Temporary Traffic Management document suite.

1.3 NT EPA Recommendations

The following recommendations relating to topsoil management were made by the NT EPA after review of the Wonarah DSO Project EIS submitted in 2010 and listed in Assessment Report 64.

Recommendation 21

Minemakers (Avenira) shall formulate a traffic management plan, identifying risks, potential scenarios, monitoring and contingency management measures to be applied.

Minemakers (Avenira) shall consult with Road Network Division, Department of Lands and Planning to resolve any road related issues associated with the Project. Consultation should clarify appropriate:

- *Procedures for responding to significant traffic incidents.*
- *Procedures for reporting of significant incidents.*
- *Detail for the Traffic Awareness Program, prior to its delivery to members of Indigenous communities.*
- *Liability for repairs or preventative maintenance of road degradation.*
- *Requirements for, and design of any upgrades of road infrastructure, such as lighting of intersections.*
- *Safe interaction of the haul trucks with tourist traffic, such as slower vehicles towing caravans, or vehicles wishing to overtake.*
- *Management of driver fatigue and distraction.*

Any other road or traffic related issues for the Project. Minemakers (Avenira) shall include the Traffic Management Plan in the Mining Management Plan for the Project.

1.4 Stakeholder Consultation

In response to EPA's recommendations as per **Section 1.3**, this TMP will be submitted to the Department of Infrastructure, Planning and Logistics (**DIPL**) (formerly Department of Lands and Planning) for resolution of any foreseeable road related issues associated with the project. This TMP, being Version 4.0, shall be considered as a live document and will be updated accordingly with advice and recommendations provided by DIPL.

1.5 Legislative Requirements

Avenira is committed to fulfilling its obligations under the Work Health and Safety (National Uniform Legislation) Act 2011 (NT), Work Health, Safety (National Uniform Legislation) Regulations (NT) and protecting workers and other persons against harm from its operations.

1.5.1 Control of Roads Act 1953

The *Control of Roads Act 1953* provides that, subject to the *Planning Act 1999* and the *Local Government Act 2019*, the control, care, and management of all public roads in the Northern Territory vests with the Minister. This *Act* outlines the process by which public roads can be opened and closed. Any public or gazetted roads that are required to be opened or closed because of construction or operation in the Project Area would be required to follow the provisions of the *Act*.

1.5.2 Traffic Act 1987

The objective of this *Act* is to regulate traffic, which includes provisions in relation to the erection and operation of traffic control devices. Traffic control devices refer to signals, signs or markings displayed for the purpose of regulating, warning, or guiding traffic. Under the *Act*, consent from the applicable competent authority is required prior to the erection and operation of traffic control devices.

1.5.3 Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2010

The object of this *Act* and associated regulations is to regulate the transport of dangerous goods on land in order to promote public safety and protect property and the environment, achieved within a nationally consistent context.

The provisions of this Regulation reflect, with minor modifications, the provisions of the Model Subordinate Law on the Transport of Dangerous Goods by Road or Rail 2007 prepared by the National Transport Commission. The Regulation establishes a system of standards and licensing for the transport of dangerous goods by road and rail and applies the Australian Code for the Transport of Dangerous Goods by Road and Rail to such transport.

This *Act* makes provision for safety in the transport of dangerous goods by road and rail. Involvement in the transport of dangerous goods by road or rail includes, but is not limited to, being the consignee of dangerous goods, loading or unloading dangerous goods that have been transported or the importation or arrangement to import dangerous goods.

1.5.4 Work Health and Safety (National Uniform Legislation) Act 2011

The Northern Territory *Work Health and Safety (National Uniform Legislation) Act* 2011 commenced on 1 March 2012, and represents a movement by state and territory governments towards harmonising work health and safety legislation across Australia. Under the *Act*, approved codes of practice provide practical guidance to meeting legislative obligations.

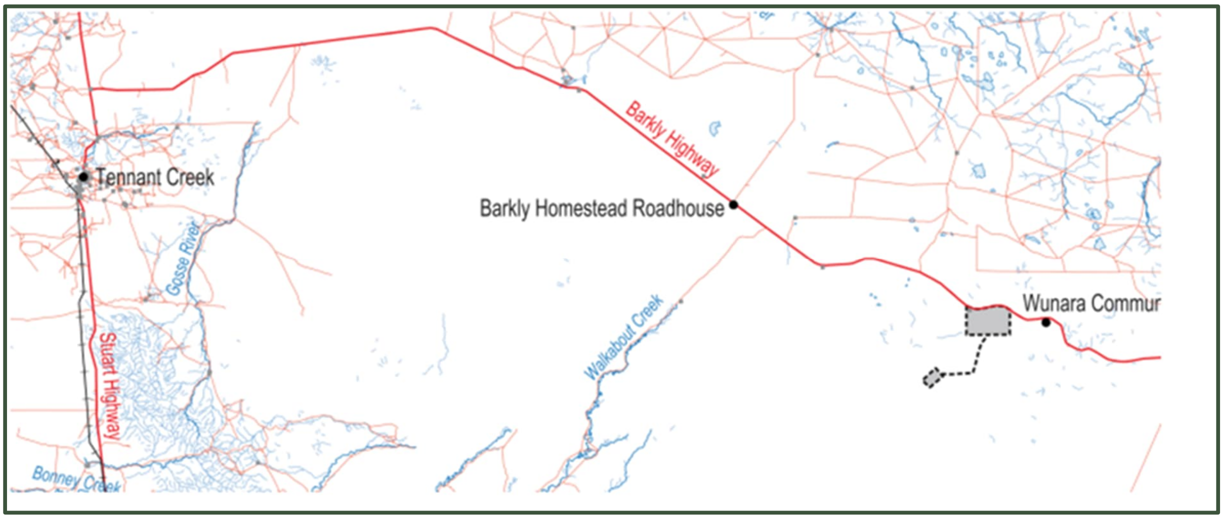
2.0 Project Overview

2.1 Site Location

The Wonarah Project area is located approximately 260km east of Tennant Creek. The proposed haulage route is along the Barkly Highway, Stuart Highway and Warrego Road.

The site is shown in the context of the surrounding area on **Figure 1**

Figure 1 Site location



(Source: ARCCOS TIA Report)

2.2 Surrounding Road Network

Details of the key roads surrounding the subject site are provided in **Table 1**.

Table 1 Key Roads

Road Name	Classification	Authority	Existing Form	Posted Speed
Stuart Hwy (A87)	State Road	DIPL	Two lane, two-way single carriageway.	130km/h
Barkly Hwy (R66)	State Road	DIPL	Two lane, two-way single carriageway.	130km/h
Warrego Road	Rural Road	DIPL	Two lanes, two-way single carriageway.	Un-posted

2.3 Approved Project

As shown in **Figure 1** the Wonarah Phosphate DSO Project is located approximately 260 km east of Tenant Creek and directly south of the Barkly Highway on the current Mineral Lease (ML) application ML33344 (the Site).

Key activities associated with the Project are:

- Construction of mine infrastructure involving clearing.

- Infrastructure maintenance including road maintenance.
- Mining (drilling, blasting and extracting), crushing and screening of phosphate rock ore at the Site.
- Transport of the crushed and screened phosphate rock along the Barkly Highway to the Stuart Highway then north to the Threeway intersection and rail siding.

2.4 Existing Traffic Volumes

The ARCCOS TIA report documented traffic volumes obtained from the DIPL Annual Traffic Report from 2021 for the Barkly Highway, Stuart Highway and Warrego Road. In 2021, the following Annual Average Daily Traffic (**AADT**) volumes recorded for each road were as follows:

- Barkly Highway:
  - Traffic counter: RTVDC004 (10km East of Stuart Highway) = 295 vpd two-way.
  - Traffic counter: RTVDC029 (10km West of Ranken Road) = 323 vpd two-way.
- Stuart Highway:
  - Traffic counter: RTVDP001 (10km North of Barkly Highway) = 446 vpd two-way.
  - Traffic counter: RTVDP003 (5km South of Barkly Highway) = 466 vpd two-way.
- Warrego Road:
  - Traffic counter: UTVDC017 (1.5km West of Stuart Highway) = 58 vpd two-way.

As anticipated, traffic volumes along each of these roads are low, with the Stuart Highway experiencing the highest two-way volume with 466 vehicles per day (**vpd**) just south of the Barkly Highway intersection. This AADT volume is approximately the equivalent of 47 vehicles within the peak 1-hour period, or one vehicle every 77 seconds. As stated within the ARCCOS TIA report, these traffic volumes are well within the theoretical capacity for each carriageway.

3.0 Operational Phase Overview

3.1 Ore Transport

This TMP addresses the transport component of the project. On-site construction activities are considered within the Operational Safety Management Plan prepared by Avenira dated 31 May 2023. Described within the Operational SMP is a requirement to prepare site specific Traffic Management Plans as the need arises.

In regard to ore transport, once the ore is processed through the crushing and screening plant, it will be stored within a designated stockpile area on the mine site prior to transport to the rail siding to the north of Tennant Creek. Ore will be transported from the mine site to the rail siding by triple side tipper and quad road trains along the routes as shown in **Figure 2**. The ore will be transported by rail to the Darwin Port for shipping to the customer.

The primary mode of transportation for ore will be along the Barkly Highway and Stuart Highway to the rail siding (**Figure 2**). There are two routes that are proposed to be used. Route 1 is proposed to be used only until such time as the multi-user hub off Warrego Road is active. Route 2 will be undertaken only once others have undertaken agreed intersection upgrades at the rail siding intersection with Warrego Road for the multi-user hub.

The two routes for transporting the ore will be as follows:

Route 1: from the site to the Barkly Highway and Stuart Highway, and finally to the rail siding (site -> Stuart Highway -> rail siding):

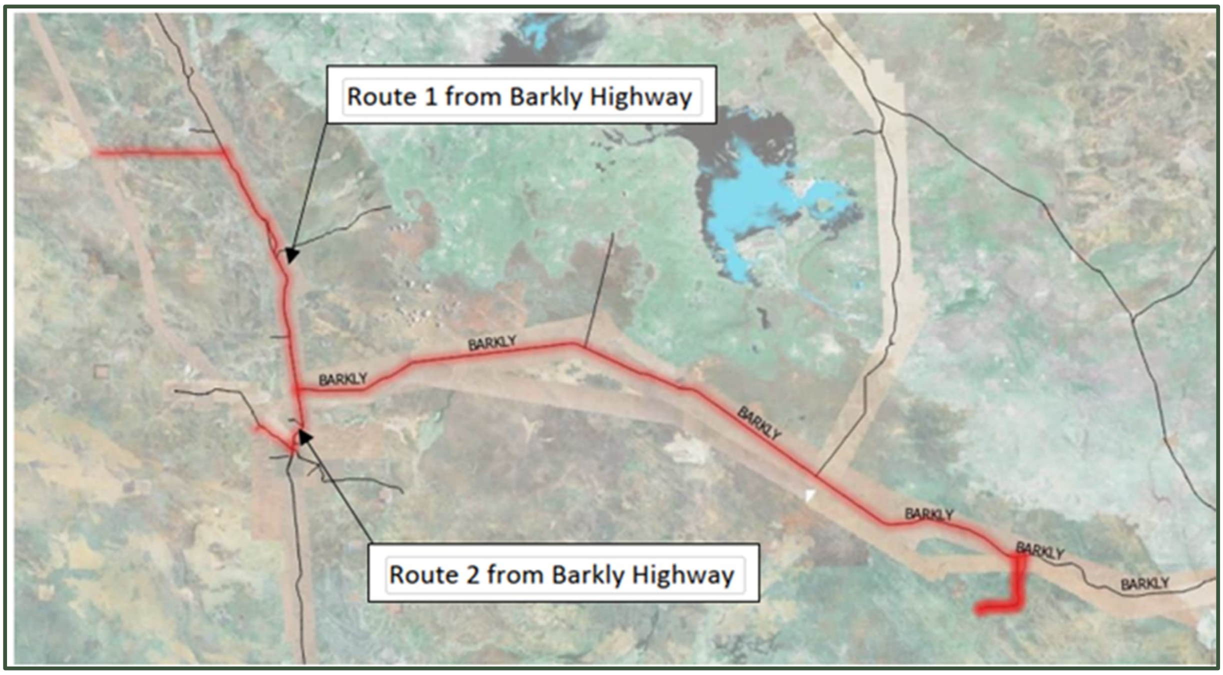
- 8.5 km access road from the ore stockpile to the Barkly Highway.
- 260 km along the Barkly Highway to the intersection with the Stuart Highway at Threeways.
- Approximately 77 km north along the Stuart Highway to the Bootu Creek Mine Road.
- Approximately 40 km to the rail siding along Bootu Creek Mine Road.

Route 2: from the site to the Barkly Highway, then to the Stuart Highway, and finally to Warrego Road and the Multi-user hub rail siding (site -> Barkly Highway -> Stuart Highway -> Warrego Road -> Multi-user hub rail siding):

- 8.5 km access road from the ore stockpile to the Barkly Highway.
- 260 km along the Barkly Highway to the intersection with the Stuart Highway at Threeways.
- 22 km south along the Stuart Highway to the intersection with the Warrego Road.
- 16 km along the Warrego Road to the multi-user hub rail siding.

Route 2, once it becomes available for use, represents a shorter distance to travel from the ore stockpile to the rail siding by approximately 79 km.

Figure 2 Ore Transport Routes



(Source: ARCCOS TIA Report)

3.2 Projected Traffic

Transport of ore will be carried out 24-hours per day with truck movements anticipated to be 17 round trips per day as the mine is planned to operate at 600kt per annum, or 50kt per month. This equates to approximately one truck every 85 minutes, during peak operations, in either direction. Ore will be transported 365-days a year; however, an allowance for two weeks of road closures due to flooding or other reasons has been made when calculating the expected ore transport requirements.

3.3 Mine Site Contact Details

The nominated contact person during the mining activities is as follows:

- Chief Geologist: Steve Harrison
    - Mobile No.: 0438 100 350
    - Email: sharrison @avenira.com

4.0 Barkly Highway / Site Access Intersection

The current access to the site is via an unsealed road from the Barkly Highway (**Figure 3**). It is recommended that the Barkly Highway/Site Access Road intersection be upgraded to a standard suitable to accommodating haulage vehicles including sealing the Site Access Road in proximity to the Barkly Highway to avoid loose material being dragged onto the surface of the Barkly Highway.

The new intersection will also provide safe access for workers and delivery vehicles to the mine site. The proposed access road will be on the same alignment as an existing track with minor realignment over the 200 m immediately adjacent to the Barkly Highway to meet DIPL requirements to form a perpendicular t-junction intersection.

Figure 3 Existing Condition of Barkly Hwy/Site Access Intersection

(Source: ARCCOS TIA Report)

4.1 Sight Distance Assessment

According to the sight distance assessment undertaken by ARCCOS and presented within the Traffic Impact Assessment report dated 14 March 2023, Safe Intersection Sight Distance (**SISD**) is achieved in both directions. For the Barkly Highway, the design speed is 140 km/h (posted speed limit plus 10km/h). This assessment adopted a design speed of 140km/h and a reaction time of 2 seconds, resulting in an SISD requirement of 409 m. **Figure 4** and **Figure 5** illustrate the available sight distance looking in both directions along the Barkly Highway from the Site Access Road.

Figure 4 Available Visibility Looking to the East

(Source: ARCCOS TIA Report)

Figure 5 Available Visibility Looking to the West

(Source: ARCCOS TIA Report)

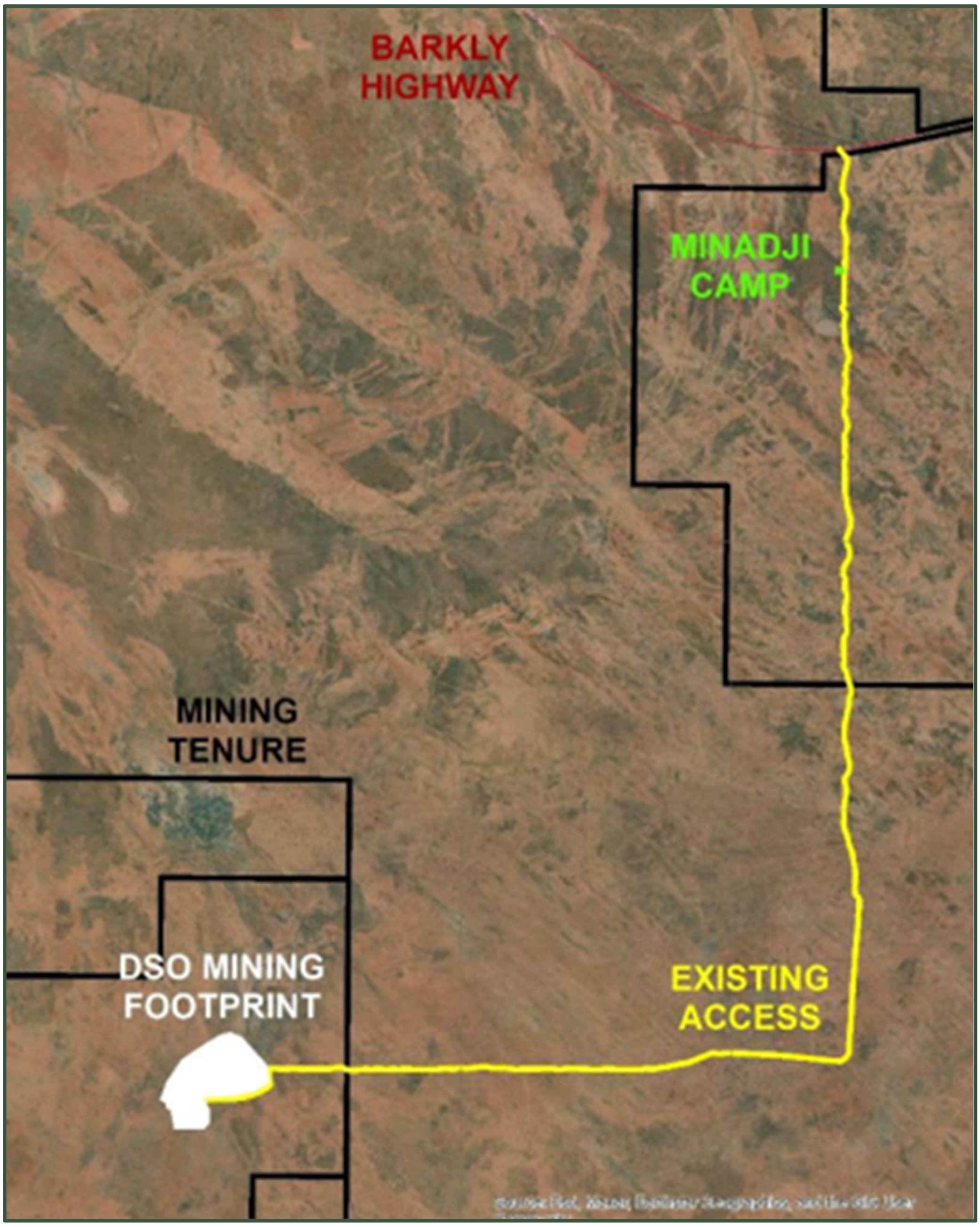
5.0 Site Access Arrangements

5.1 DSO Mining Footprint & Location

The Wonarah phosphate project is located in a remote area off the Barkly Highway and involves the extraction of ore through open pit mining, as well as the operation of a crushing and screening plant and associated necessary mine facilities.

The access road will provide a direct connection between the mine site and the Barkly Highway, ensuring efficient transportation of mined materials. The existing access road is 30.4 km and of various widths with a total area of 23.7 ha. Figure 6 depicts the DSO mining footprint along with the site access route between the Barkly Highway and the Project.

Figure 6 DSO Mining Footprint & Site Access Route



(Source: ARCCOS TIA Report)

6.0 Safety Assessment

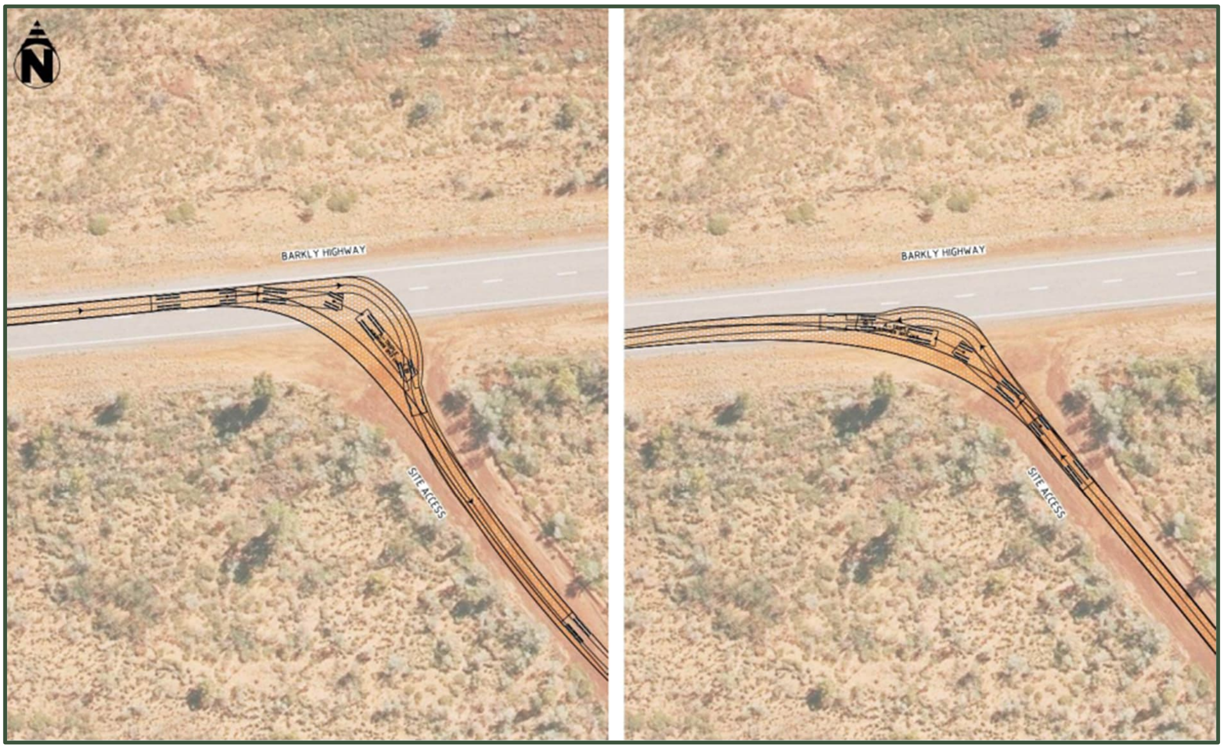
6.1 Haulage Route Swept Paths

It is understood that the largest vehicle likely to be utilised for transporting ore material is a 53.4m quad road train. However, the ARCCOS TIA report provides a swept path assessment at each key manoeuvring location using a triple road train, as this provides a slightly more conservative swept path. The documented triple road train swept paths are provided within the subsequent Sections for key turning locations.

6.1.1 Barkly Highway / Site Access Road Intersection

The triple road train swept paths for the right turn movement into the Site Access Road and for the left turn movement from the Site Access Road are provided at **Figure 7**.

Figure 7 Barkly Hwy/Site Access Rd – Triple Road Train Swept Paths



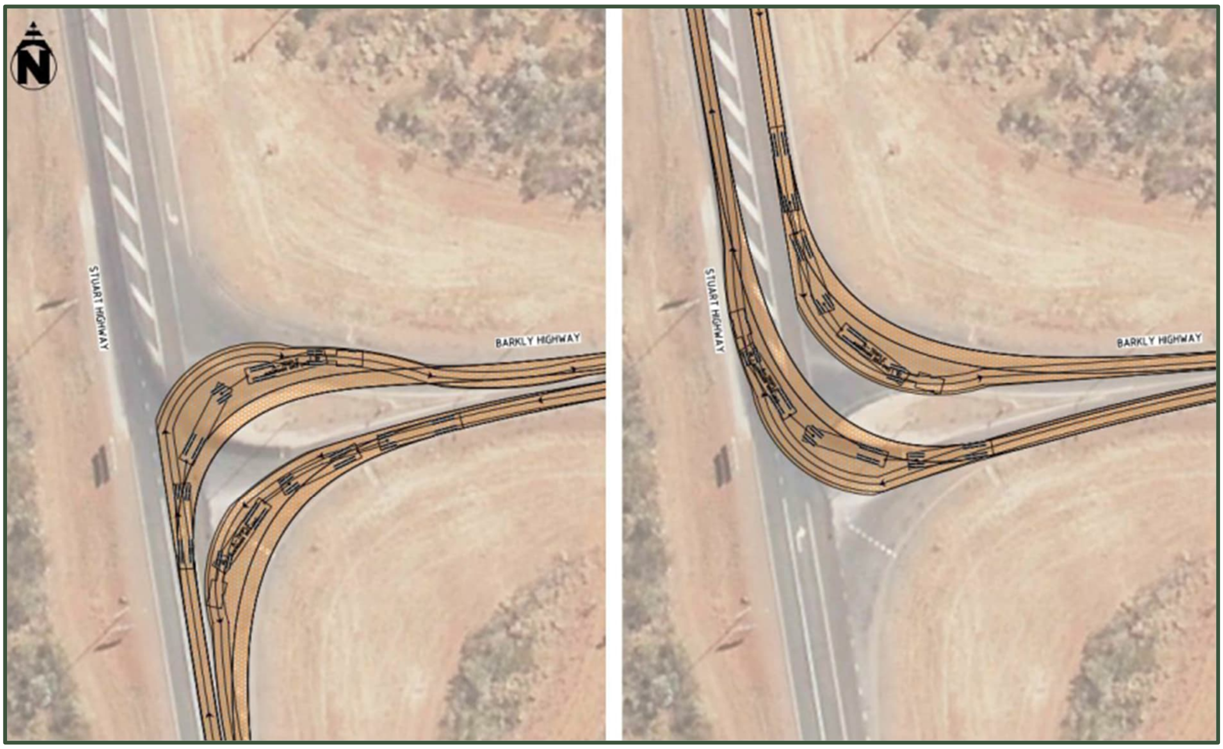
(Source: ARCCOS TIA Report)

Figure 7 demonstrates that the spatial requirements to accommodate haulage vehicles can be readily accommodated. As stated previously, upgrade works to formalise this intersection into a sealed T-junction are necessary and should consider a triple road train as the design vehicle.

6.1.2 Barkly Highway / Stuart Highway Intersection

Triple road train swept paths have been undertaken for all foreseeable manoeuvres associated with Route 1 and the future Route 2. **Figure 8** depicts the spatial uptake of these swept paths.

Figure 8 Barkly Hwy/Stuart Hwy – Triple Road Train Swept Paths



(Source: ARCCOS TIA Report)

The ARCCOS swept path assessment concluded that these manoeuvres can be accommodated within the existing intersection footprint. It is noted that this intersection has been designed to accommodate road trains with the use of mountable splitter islands and centre medians.

6.1.3 Stuart Highway / Bootu Creek Mine Road Intersection

Figure 9 presents the finding of the ARCCOS swept path assessment for the Stuart Highway/Bootu Creek Mine Road intersection.

Figure 9 Stuart Hwy/Bootu Creek Mine Rd – Triple Road Train Swept Paths

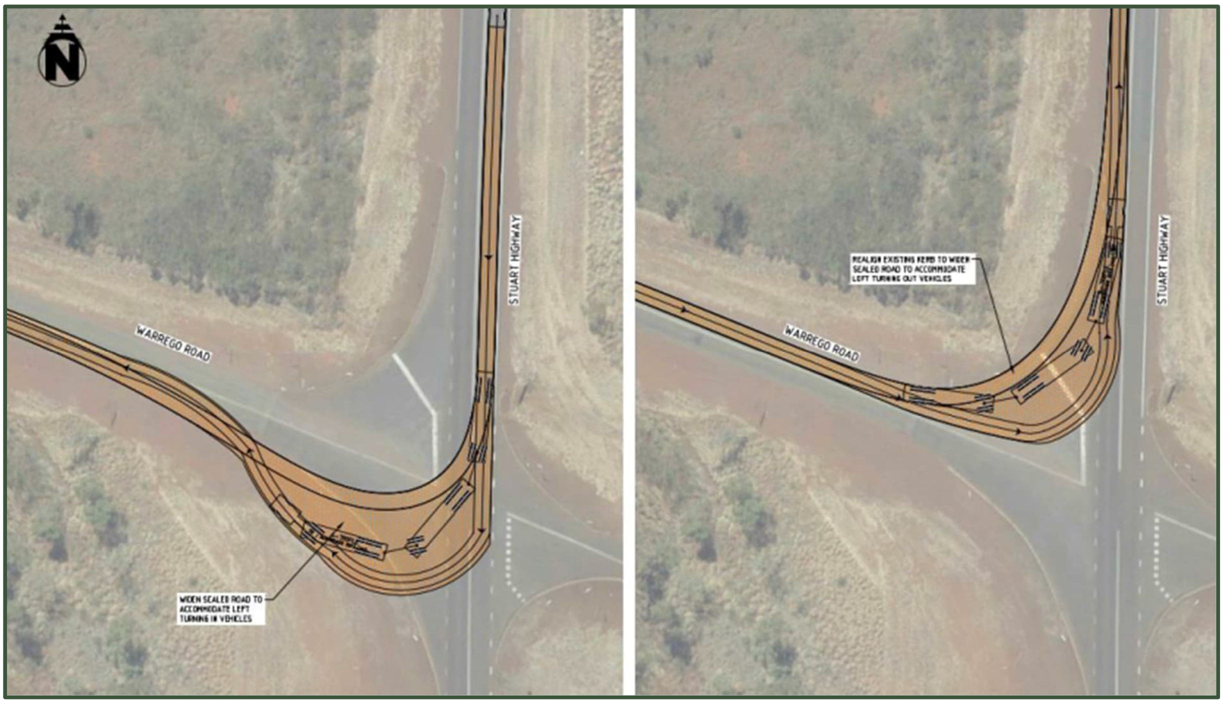
(Source: ARCCOS TIA Report)

As shown within **Figure 9**, all foreseeable haulage vehicle manoeuvres can be readily accommodated at this intersection.

6.1.4 Stuart Highway / Warrego Road Intersection

The intersection of Stuart Highway/Warrego Road is planned to be utilised as part of Route 2. **Figure 10** depicts the spatial requirements for the right turn movement into Warrego Road and the left turn movement from Warrego Road.

Figure 10 Stuart Hwy/Warrego Rd – Triple Road Train Swept Paths



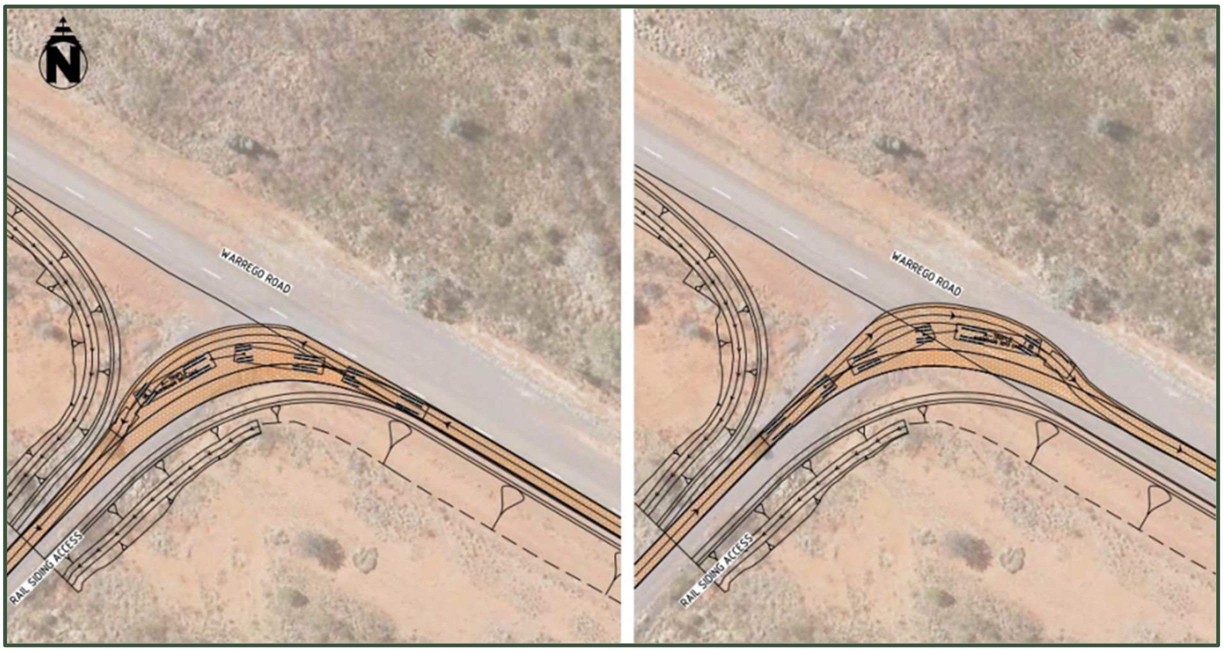
(Source: ARCCOS TIA Report)

The swept path assessment found that the triple road train vehicle exceeds the sealed intersection footprint for both manoeuvres. In May 2022, DIPL issued a request for tender for the upgrade of this intersection. In August 2022, DIPL awarded the project to Pritchard Francis Consulting for an amount of $262,441.00 to design the upgrade. Upon further investigation into the status of this project, it appears that no works have commenced as of April 2023, according to NearMap satellite imagery. SLR are of the opinion that design is still underway but should be nearing completion.

6.1.5 Warrego Road / Rail Siding Access Intersection

The triple road train swept paths for the left turn into the Rail Siding Access road and the right turn from the Rail Siding Access road are provided at **Figure 11**.

Figure 11 Warrego Road/Rail Siding Access – Triple Road Train Swept Paths



(Source: ARCCOS TIA Report)

From the ARCCOS swept path findings, it is evident that an intersection upgrade is required to seal and widen verges to accommodate haulage vehicle swept paths. These works are planned to facilitate the Project's operational needs.

6.2 Emergency Vehicles

Emergency vehicle access to and from the Project site will be available at all times while the site is in operation. There will be no disruption to emergency vehicles on any roads. Further detail is provided within the Operational SMP prepared by Avenira.

6.3 Closest Hospital / Medical Centre

The closest Hospital is the Tennant Creek Hospital located at 45 Schmidt Street, Tennant Creek. It is approximately 300 km from the subject site. Alternatively, the Mount Isa Hospital, located at 30 Camooweal Street, Mount Isa City is approximately 375km to the east of the Project. For injuries of a less severe nature, the Camooweal Health Centre, located at 52-60 Morrison Street, Camooweal is approximately 270km to the east.

7.0 Operational Phase Traffic Management Measures

7.1 Drivers Code of Conduct

Drivers operating haulage vehicles must adhere to the Avenira Drivers Code of Conduct. A copy of this Code of Conduct is provided at **Attachment 1**.

7.2 Traffic Guidance Schemes

It is recommended that a Traffic Guidance Scheme (**TGS**) is implemented at the following locations:

- Barkly Highway / Site Access Road intersection.
- Warrego Road / Rail Siding Access Road intersection.

Attachment 2 provides a generic TGS for warning motorists to anticipate heavy vehicles entering/exiting at both of these locations. These plans depict a 'Truck' symbolic within a yellow and black warning sign which are positioned in advance of each intersection, in both directions.

7.3 Site Management

The following procedures are to be observed by all vehicle drivers accessing the subject site:

- Drivers are to obey all site signage and the directions of site personnel.
- All vehicles are to park and load/unload within the site using designated parking and loading areas where possible. Vehicles are not to park or load/unload within the public road reserve.
- All drivers are required to operate vehicles in a safe and courteous manner, within and external to the subject site.

Further detail regarding on-site management measures can be found within the Avenira Operational SMP which is available upon request.

7.4 Heavy Vehicle Management

Management measures to be implemented and followed are provided within the Avenira Operational SMP. This document is extensively detailed and provides heavy vehicle management measures. The Operational SMP can be provided upon request. As a high level summary, the subsequent sub-Sections are provided in this regard.

7.4.1 General Requirements

Heavy vehicles accessing the site will need to abide by their respective company operating procedures in addition to standard Northern Territory road rules when operating the vehicle.

7.4.2 Noise Management

Noise management is not necessary in this instance due to the location of routes travelled by haulage vehicles and the volume of heavy vehicles involved.

7.4.3 Dust Management

Roadways shall be regularly watered and graded/maintained to control dust generated from vehicle traffic on site.

7.5 Mitigation Measures

Avenira is committed to its Duty of Care to provide a safe work environment for its workers, contractors and visitors. The Operational SMP for the Project provides detailed management and mitigation measures in regard to traffic and transport activities. Refer to **Attachment 1** for these details.

7.6 Risk Assessment

A Risk Assessment has been prepared by SLR for the Wonarah DSO operation. This can be found at **Attachment 3**.

8.0 TMP Monitoring / Review & Improvement Process

8.1 Implementation

The proposed haulage operations are to be carried out in accordance with the following requirements:

- The approved ARCCOS Traffic Impact Assessment.
- The approved Traffic Management Plan (this document).
- The approved Traffic Guidance Scheme's.
- All associated Federal and State statutory requirements e.g., environment, cultural heritage, etc. as required.

8.2 Monitoring and Review

This TMP has been prepared to document the management and safety measures associated with the haulage activities. The duration of mining operations is anticipated to be for 10 years. As such, monitoring and review of this TMP is recommended to be undertaken on an annual basis.

Regarding the implemented TGS plans, these shall be monitored and reviewed on a monthly basis to ensure signs and devices are installed correctly and convey the correct and intended messages.

8.3 Work Site Inspections, Recording and Reporting

Procedures for work site inspections, recording and reporting are contained within the Avenira Operational SMP. This can be provided upon request.

9.0 Incident Management

For the purposes of this CTMP, an 'incident' is an occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance. Furthermore, a 'non-compliance' is an occurrence, set of circumstances or development that is a breach of the consent.

In the event of an incident relating to traffic on a public road, the contracted truck driver must notify Avenira's Mine/Site Manager immediately, following any need to alert emergency services. Such incidents may include, but not be limited to:

- Vehicle crash or injury resulting from haulage traffic related to the Project.
- Spill of any dangerous goods or hazardous substance to ground or water.
- Substantiated complaints received from members of the community or regulatory authorities relating to traffic management.
- Land-based off-site sediment loss to the environment, including sediment tracking onto the roadway.

9.1 Contingency Plan

A contingency plan has been established within Avenira's Operational SMP. This document can be provided upon request.

9.2 Communications Strategy

A communications strategy has been documented within SLR's Environmental Management System. Refer to this document for further details.

9.3 Environmental Incident Reporting

All environmental incidents on site will be reported as per the requirements of Environmental Incident Reporting under Section 29 of the *Mining Management Act.* Any environmental incident deemed to be of a significant nature will be detailed in a formal Incident Report and submitted to the Department of Industry, Tourism and Trade (**DITT**). Under Section 29, an incident must be reported as soon as practicable. Avenira will provide a verbal report of an incident within 24 hours and provide a written report within 7 days unless instructed otherwise by the Department.

All environmental incidents off site, that are associated with Avenira's activities will be reported to the NT EPA under Section 14 of the *Waste Management and Pollution Control Act*. Notification must be received by the EPA within 24 hours. A written response must be received by the EPA within 7days. The Site Manager is responsible for all external incident reporting communications. The statutory incident reporting requirements are shown in **Table 2.**

Table 2 Statutory Incident Reporting Requirements

Entity	Trigger	Timeframe / Contact Details	Incident Reporting Details
NT Environmental Protection Authority (NT EPA)	An Incident outside of mining activities which causes, or is threatening or may threaten to cause pollution resulting in material environmental harm or serious environmental harm, or breach of operating licence compliance requirements.	NT Environmental Protection Authority (NT EPA)	An Incident outside of mining activities which causes, or is threatening or may threaten to cause pollution resulting in material environmental harm or serious environmental harm, or breach of operating licence compliance requirements.
Department of Industry Tourism and Trade (DITT)	An Incident on MLs / E's that causes environmental harm that triggers Section 29 of the *Mining Management Act*	As soon as practicable. mineral.info@nt.gov.au	Section 29 of the *Mining Management Act.* The Section 29 Notification of Environmental Incident Form requires the following details: • Site and operator details. • Location occurred and area impacted (GPS coordinates). • Date and time. • Description of incident. • Emergency and remedial actions taken. • Nature of impact and severity. • Current situation. • Details of sampling undertaken. • Notification status internally and externally. • The form is to be signed by the Environment Manager and/or General Manager for submission.
NT Worksafe	Incident which results in either: • Death of a person. • Serious injury or illness. • Dangerous incident.	Notification to NT WorkSafe as soon as practicable. Tel: 1800 019 115 ntworksafe@nt.gov.au Notification form submitted within 48hrs	Section 35 to 39 of the *Work Health and Safety (National Uniform Legislation) Act*. The NT WorkSafe Incident Notification Form requires the following details: • Person submitting details. • Incident details including date, time and human injury details. • Work activity being undertake at the time of incident. • Witness(es) details. • Details of injured / deceased persons. • Summary of injury or illness.

Entity	Trigger	Timeframe / Contact Details	Incident Reporting Details
			• Future remedial actions. • The form is to be signed by the General Manager or delegate for submission.
Aboriginal Areas Protection Authority	Entrance and/or damage of sacred site or restricted works area.	As soon as practicable. Tel:(08) 8999 5511	No standard notification form is available. However, the following should be provided within the initial notification: • Location of the site (grid reference). • AAPA certificate pertaining to the site. • Summary of damage. • Name and organisation of discoverer. • Type and method of interference (exposed and/or damaged). • Photograph of damage.
Heritage Branch	Discovery or damage to items of heritage value.	As soon as practicable Tel: (08) 8999 5039	Seek advice from the Heritage Council.

Attachment 1 Avenira Management & Mitigation Measures

3.0 Management Measures

3.1 Duty of Care

Avenira is committed to its Duty of Care to provide a safe work environment for its workers, contractors and visitors. below details the management measures set out to manage traffic and transport activities for the Wonarah DSO operation.

Table 1 Management measures

Item	Management Measures	Timing	Responsibility
Code of Conduct for Drivers: All drivers of light and/or heavy vehicles that have been engaged by Avenira must adhere to the following Code of Conduct for Drivers.			
TM1	The code of conduct forms part of the transport contractual arrangements entered into with Avenira. Avenira will carry out necessary measures to inform transport contractors, as well as audit for compliance to this code of conduct. This may be via various communication means such as driver inductions, training and toolbox talks.	At all times	Everyone
TM2	Obey all the laws and regulations that apply to vehicles on public and private roads		
TM3	Operate in full compliance with this Traffic Management Plan		
TM4	Respect the rights of others, including drivers and pedestrians, to use and share the road space		
TM5	Maintain a safe following distance between vehicles		
TM6	Ensure that the vehicle is clean and in good mechanical condition		
TM7	Not travel in convoys unless under approved escorts		
TM8	Following the designated access routes		
TM9	Abide by all NT road rules and vehicle regulations		
TM10	Ensure high level of courtesy		
TM11	Turn off flashing/rotating beacons when on public roads		
Workers, contractors and visitors			
Contractors that transport hazardous substances to the Bulk Test Sample site will comply with safety procedures and all requirements listed below.			
TM12	Wear a high visibility "vest or shirt" to enhance their visibility / location at all times whilst on or travelling to the site	At all times	Area Managers
TM13	Comply with all site traffic management policies and procedures, which include but not limited to, inductions, notices, site signage and directives from site management		
TM14	Additionally, contractors and visitors shall sign in using the site visitors and contractors register.		
Vehicles and mobile plant			
TM15	All vehicles entering the site for the delivery of products / equipment shall have as a minimum: • UHF two way radio capabilities. • Fire extinguisher. • A rotating orange flashing light operating at all times. • Be compliant with NT road rules. • Maintained vehicle in a roadworthy condition.	At all times	Area Managers

Item	Management Measures	Timing	Responsibility
	Note: Contractor and visitors vehicles that do not comply shall be transported or escorted by a Avenira light vehicle.		
Light vehicles (not exceeding 4.5 t)			
TM16	Light vehicles owned, leased and operated by Avenira shall comply with the above, in addition to the following requirements: • Four wheel drive capacity. • Internal roll cage (if required by mine specifications). • Hi-vis reflective taping. • Clearly displayed identifying number. • 3.2 m flag pole with attached orange flag. • Head lights, front and back indicator lights and additional brake lights on head boards. • Reversing beeper. • Rear vision mirrors. • A fire extinguisher. • First-aid kit. • Serviced as per manufacturer's instructions. • Compliant with NT road rules. • Maintained in a roadworthy condition. • Safe operating procedures and emergency plans are located in the vehicle. **Note:** Additional measures may also be identified, that may be required for the site and will be implemented to operate a light vehicle on site	At all times	Area Managers
Operating vehicles on site			
TM17	All personnel driving a light vehicle, mobile plant or road trucks on the site shall have a current valid driver's licence and appropriate training (Section 3.2) unless the Mine Manger deems it safe to dive on the private Bulk Test Sample roads in line with current legislation.	At all times	Area Managers
TM18	Avenira personnel and contractors are obligated to notify the Resident Mine Manager when their driver's licence has been suspended, cancelled or expired.		
TM19	No Avenira personnel will drive any company vehicle on a public road when their drivers licence has been suspended.		
Mobile plant			
TM20	Mobile plant owned, leased and operated by Avenira shall comply with the following requirements: • Head lights, front and back indicator lights and brake lights. • Reversing beeper. • Rear vision mirrors. • Clearly displayed identifying number. • A fire extinguisher. • First-aid kit. • Compliant with NT road rules if applicable. • Serviced as per manufacturer's instructions.	At all times	Area Managers

Item	Management Measures	Timing	Responsibility
	• Safe operating procedures and emergency plans located in the mobile plant. • ROP canopies fitted or built in. **Note:** Additional measures may also be identified. They will be implemented if required (e.g. monitor and reversing camera, proximity and collision avoidance devices).		
TM21	All mobile plant shall use the following horn signals to alert other workers and vehicle operators of the vehicles intent to move from its position. • 1 horn blast and wait 5 seconds prior to starting the vehicle. • 2 horn blast and wait 5 seconds prior to driving forward. • 3 horn blast and wait 5 seconds prior to reversing the vehicle.		
TM22	Front-end loaders and haul trucks shall have an audible reversing siren installed.		
TM23	Front-end loaders, graders and bulldozers shall travel with their buckets, blades or rippers between 0.5 metres and one metre from the ground.		
TM24	Haul trucks shall travel around the site with their body in a lowered position and with their headlights on at all times (day and night).		
TM25	All operators shall prior to exiting mobile plant, ensure: • One row of tyres on wheeled mobile plant are placed in a V-Drain or against a safety berm (with tyres turned into the berm) or bump stop when at a go–line area. • Be fundamentally stable (on level ground) prior to applying parking brake when away from the go-line. • Front-end loaders, excavators, graders and bulldozers shall have their buckets, blades and attachments lowered to the ground. • The ignition turned off.		
Road trucks			
TM26	Road trucks that enter or are operated on the Bulk Test Sample site shall have the minimum requirements: • Head lights, front and back indicator lights and brake lights. • Tarping system that can be operated from the ground or within the cabin. • Reversing beepers. • Rear vision mirrors. • Clearly displayed identifying number. • A fire extinguisher. • First-aid kit. • Compliant with NT road rules if applicable. • Serviced as per manufacturer's instructions. • Safe operating procedures and emergency plans located in the truck.	At all times	Area Managers
TM27	All operators shall park up and ensure that: • It is fundamentally stable (on level ground) prior to applying parking brake		

Item	Management Measures	Timing	Responsibility
	• Placed in neutral and the ignition turned off. • Ensure that it is safe to exit vehicle. • Place wheel chocks behind the rear wheels of a prime mover.		
Site design			
TM28	Avenira operational areas shall be designed to ensure that while workers, contractors and visitors are operating vehicles or mobile plant on site, they are, so far as reasonably practicable, safe from risk to health and safety. A road network has yet to be designed for the new infrastructure that will be built. This TMP will be updated to reflect new infrastructure and road network for the DSO MMP.	At all times	Area Managers
Prevailing weather and environmental conditions			
TM29	All drivers and operators of light vehicles, mobile plant and road trucks shall reduce speed by and drive to conditions during rain events.	At all times	Area Managers
TM30	All roadways and mobile plant operating areas shall be inspected daily and more frequently during and after heavy rain events for any signs of cracking, sinking or slippage.		
TM31	All vehicle operations shall cease immediately when the vehicles steering, braking or accelerating operations become uncontrolled during rain events or when instructed by site supervisor.		
TM32	In addition to the above, light vehicles; mobile plant and road trucks shall also cease operations when the following occurs during rain events: • Poor visibility during rain events or dry weather. • Pooled water on roadways. • Deep erosion on roadways and work surfaces, which could cause a driving hazard. The operator or drivers shall park the vehicle in safe area on level ground and contact site supervisor and wait for instructions. **Note:** When cracking, sinking or slippage occurs on road surfaces, benches and levels, waste dumps and stockpiles the Site Manager and site personnel shall be informed and the area shall be sectioned off and inspected by a geotechnical / mining / civil engineer.		
Buildings and structures			
TM33	All buildings and structures shall be positioned on site in such a manner that eliminates, where reasonably practicable, the risks to personnel who use the buildings or structures or potential damage to the buildings or structures from vehicles, mobile plant and environmental conditions.	At all times	Area Managers
TM34	Where elimination of risk is not reasonably practicable, control measures shall be implemented to manage the risks. Distance barriers such as earthen mounds, guard railings concrete blocks shall protect buildings and structures.		
TM35	Suitable and adequate lighting shall be provided around buildings and structures to illuminate the immediate areas if night time operations occur and before sun rise or after sun set.		
TM36	Buildings and structures shall not be positioned next to embankments or edges of drop offs where there is a risk of personnel being injured or buildings and structures being damaged by collapsing / falling ground.		

Item	Management Measures	Timing	Responsibility
TM37	Buildings and structures shall be positioned above flood plain levels and provided with adequate drainage in the event of heavy rains.		
TM38	Service areas for deliveries, pick-ups and maintenance shall be provided and clearly identified around buildings and structure.		
Parking areas (carparks, go-lines, office and workshops)			
TM39	Car Parks: • All parking areas shall be adequately illuminated with artificial lighting to safely move about vehicles, parking and crossing areas when working hours dictate starting / finishing times are prior to daybreak or after sun set (insufficient natural light present). • Ensure the surface areas are level and free from pot holes and pooled water. • Ensure the surface is sheeted with suitable material to prevent muddy and slippery conditions forming. • Be constructed with crushed gravel which will define the boundaries of the parking area. • Have clearly defined parking areas (sun flower yellow line marking paint on concrete or bitumen) on semi-permanent hard stands. • Reverse parking for all light vehicles. All other vehicles park in the go line. • Have 10 km/h speed limit signage clearly sign posted on entry and exit to parking areas. • Have separate entry and exit point which are sign posted • Install blind spot bubble (convex) mirrors if exit points have blind spots. • Suitable signage to direct personnel to report to offices / building areas when they first arrive on site.	At all times	Area Managers
TM40	Go Lines: • Ensure the surface areas are level and free from pot holes and pooled water. • Ensure the surface is sheeted with suitable material to prevent muddy and slippery conditions forming. • Be constructed with earthen mounds which will define the boundaries of the parking area. • Have V Drains or bump stops installed for mobile plant to position themselves into or against to ensure they are fundamentally stable when parked and left unattended. • Go line vehicles will park with front wheels into v-drains or bump stops • Have 10 km/h speed limit signage clearly sign posted on entry to parking area • Have separate entry and exit point which are sign posted. • Install blind spot bubble (convex) mirrors if exit points have blind spots. • Be of a suitable size to accommodate all mobile plant.	At all times	Area Managers
Offices, workshops and fixed plant areas			
TM41	Signage to identify parking locations	At all times	Area Managers

Item	Management Measures	Timing	Responsibility
TM42	Designated vehicle speeds of 10 km/h around offices, workshops and fixed plant structures		
TM43	Install blind spot bubble (convex) mirrors if exit points have blind spots		
TM44	Have clearly defined parking areas (sun flower yellow line marking paint on concrete or bitumen) on semi-permanent hard stands		
TM45	Clearly established walkways which are 600 mm wide and delineated and separated from road ways and thoroughfares		
TM46	Access doors to enter and exit buildings		
TM47	Signage stating “beware of forklift” on workshop buildings and confined spaces		
TM48	Signage stating “sound horn prior to entering or exiting” located on workshop / confined areas vehicle access openings		
Pedestrian crossing			
TM49	Be sign posted to clearly identify where pedestrians must cross road ways	At all times	Area Managers
TM50	Be used in areas with high levels of anticipated pedestrian traffic		
TM51	Have signage on road ways (20 m) prior to the crossing, to alert approaching drivers and operators		
TM52	Be sign posted with “give way” on the left-hand side of the road where the crossing begins to alert the drivers and operators.		
TM53	Other options for delineating pedestrian access / high traffic areas that will be used are: • Hi Vis Fluro Orange PVC Triangle on nylon rope and star pickets with caps. • Orange Barrier Mesh Fencing and star pickets with caps. • Hi Vis Orange Temporary Bollards and Bases.		
Tarping areas (securing loads)			
TM54	All loads shall be tarped prior to leaving the site if dust is likely to be excessive. A designated tarping area shall be provided for truck drivers to safely tarp (secure) their truck and trailer loads.	At all times	Area Managers
TM55	Areas shall have earthen mounds delineating the area from main traffic roads and signed posted with “tarping area”. The risk controls for tarping include: • All road trucks shall have cabin or ground-activated tarping mechanisms for truck and trailer bodies. • Any viewing platforms made and or installed at designated tarping areas shall comply with AS 1657: 2013 Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation. • Signage shall be displayed at the where platforms are installed stating that personnel are prohibited from accessing (climbing) the truck from the platform.		
Road design, construction and maintenance			
TM56	Road design and construction for all road outside the opencut and stockpile areas shall be undertaken in the following manner: • The design and construction of roadways shall take into account any in situ overhead power lines and structures and design around them where possible.	Construction	Road designers

Item	Management Measures	Timing	Responsibility
	• For two-way traffic roads, the width shall be a minimum of 3.0 times the width of the widest vehicle operating on the site for straight sections of the roads. • For bends and corners, the road width shall be a minimum of 4.0 times the width of the widest vehicle. • For one-way traffic roads, the width shall be a minimum of 1.5 times the width of the widest vehicle. • Where this is not possible, additional controls (passing bays, reduced speed limits, additional safety berms and signage and radio communication procedures) shall be implemented. • All roadways shall be designed and constructed (where possible) to eliminate gradients steeper than 1:10. • Roads shall be made of suitable layered material which provides good compaction, which reduces water penetration and the likelihood of cracking, sinking or slippage. • Road surfaces shall be formed and or sheeted with suitable material which provides a firm surface and adequate traction for all vehicles to safely operate upon. • Roads shall be designed with cambers of no greater than 2 degrees. • Corners shall be designed with cross-falls of no greater than 5 degrees. • Drainage provisions shall be installed on all roadways, levels and benches to remove pooled water from rain events. • Where roads are divided by a centre berm, a 'Keep Left' or 'Keep Right' sign shall be mounted at the beginning of the centre berm dividing the road. • Hazard warning signage shall be displayed a minimum 30 m prior to the centre berm dividing the road to alert the driver and operators of upcoming road condition. **Note:** Where passing bays are used, a procedure shall be in place detailing the road rules, and clear signage explaining right of way shall be displayed.		
TM57	Maintenance: • Roadways shall be regularly watered and graded / maintained to control dust generated from vehicle traffic on site. • Major on-site road maintenance shall occur outside of production hours, where possible. • All workers shall be notified (e.g. toolbox and prestart meetings, UHF radio communication) when on-site road maintenance is conducted. • Maintenance on roadways shall be coned or flagged off with signage for roadworks and reduced speed limits in place to alert all traffic. • Road surfaces shall be maintained by in-filling and resurfacing, where required. • Obstacles and debris shall be cleared from the road at all times.	At all times	Area Managers

Item	Management Measures	Timing	Responsibility
	• Roadways shall be inspected for any cracking, sinking or slippages, including during and after periods of heavy rain events. • More frequent inspections and maintenance shall be given during periods of heavy rain events. • Site roadway inspections shall be completed and documented at a minimum, quarterly.		
Road signage			
TM58	All traffic management signage shall comply with the following Australian standards: • AS 1744: 1975 Standard Alphabets for Road Signs. • AS/NZS 1906.1: 2007 Retro-reflective materials and devices for road traffic control purposes – Retro-reflective sheeting. • AS 1742.3: 2009 Manual of Uniform Traffic Control Devices, Part 3: Traffic Control for Works on Roads. • AS 1743: 2001 Road Specifications. Signage shall be: • Clearly visible and legible at all times and identify traffic management controls and or site risks. • Positioned so they do not create a hazard. • A minimum 2 m from the edges of the road or where safety berms are in place, either on top or on the outer side of the berm (signage must still be visible by all vehicles). • Positioned at all entry points to the site and haul road, instructing vehicle operators give way to heavy mobile plant and trucks. • Instruct haul truck operators and road truck drivers to use the retarder / exhaust brake on sloped roadways and lower gear. Signage shall be installed on the entrance to the site stating: • Site entry speed limit. • All personnel entering the site must report to the weighbridge / site office. • Radio communication channel (UHF 3). • Emergency communication channel (UHF 12). • Turn on flashing lights when entering. • Turn off their flashing light when leaving (on inside of gate). Site speed limits shall be clearly signposted for all following operating areas: • Site entry and exit 40 km/h. • Access roads 80 km/h unless stipulated by NT road rules. • Car parking areas 10 km/h. • Go - line areas 10 km/h. • Haul road 40 km/h. • Offices and workshops 10 km/h.	At all times	Area Managers
Sign and stopping distances			

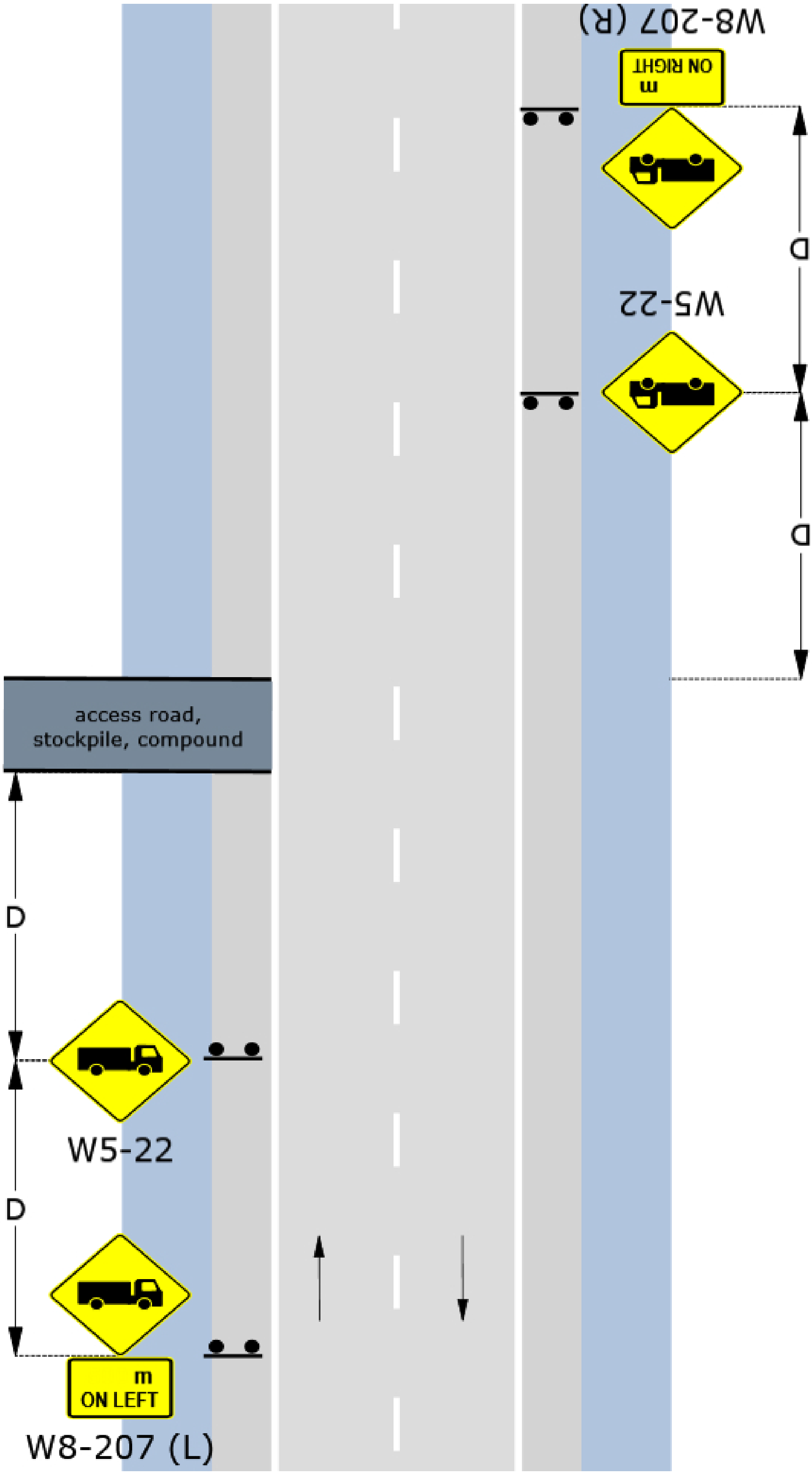
<table>
<tr><th>Item</th><th>Management Measures</th><th>Timing</th><th>Responsibility</th></tr>
<tr><td>TM59</td><td>All risk controls implemented shall ensure that separation (sight) distances are greater than the stopping distance of the largest vehicle on site.
Lines of sight shall be maintained at all times for corners, intersections and signage.
Stockpiles shall be strategically placed so as not to restrict the vision of vehicle drivers and operators from corner positions, intersections, signage locations and other traffic on site.
Vegetation shall be cleared regularly to ensure corners, intersections and signage are visible.
Signage shall be cleaned on a regular basis to ensure it remains legible.
Install blind spot bubble (convex) mirrors if exit points have blind spots.
Warning signage identifying the road hazard shall be installed 20 m prior to blind corners, intersections and crests.</td><td>At all times</td><td>Area Managers</td></tr>
<tr><td colspan="4">Edge protection (safety berms / bunds)</td></tr>
<tr><td>TM60</td><td>Edge protection shall be implemented on all roadways (haul access, bench and levels, stockpiles, waste dumps and run off mine (ROM) pads) where there is a possible risk of vehicles and mobile plant rolling over the edges of embankments, faces and drop offs.
Safety berms shall be:
2 m in from edges of embankments, drop offs or faces where possible.
At least the axel height of the largest tyred vehicle operating on the site.
Constructed out of a combined of suitable material i.e. fines and solid rock.
Be of a consistent triangular shape, kept free from erosion and regularly inspected and maintained.
Delineation markers where operations run at night times.
Note: Where it is impractical to use edge protection, alternative controls such as escape ramps and centre berms, shall be considered.</td><td>Construction</td><td>Road designers</td></tr>
<tr><td colspan="4">Intersections, crests and corners</td></tr>
<tr><td>TM61</td><td>All intersections, crests, corners on roads where mobile plant operate, shall be eliminated, where reasonably practicable. Where they cannot be eliminated, the road shall be clearly signposted (e.g. reduced speed limits, warning signs upon approaching the intersection, crest or corner, right of way rules, give way or stop rules).
All traffic shall have clear visibility in all directions when entering roadways. Four way intersections shall be eliminated or off set to reduce the possibility of driving straight through intersections.
If necessary an island will be installed in the centre of large intersections to reduce the speed at these intersections.
Where visibility is restricted on crests, rises and corners, the roadway shall be divided (where practicable) to provide separation for vehicles (e.g. a centre berm and guidance posts).</td><td>Construction</td><td>Road designers</td></tr>
</table>

Item	Management Measures	Timing	Responsibility
	• Centre safety berms shall be a minimum of 1.5 m high and be made of a "more solid" construction to prevent vehicles and mobile plant from punching through berms. • Large earthmoving tyres will be placed at each of centre bunds and painted white to highlight the ends of the bunds.		
ROM pads, waste dump and stockpiles			
TM62	All ROM (run off mine) pads, waste dumps and stockpiles locations shall: • Take into account any in-situ overhead power lines and structures and design around them where possible. • Have windrows that are at least the axel height of the largest vehicle tipping where there is a risk of mobile plant rolling over the edges of embankments when inspecting or reversing to tip off material or to push off materials. • Be built on an incline to reduce the risk of runaway vehicles and mobile plant free rolling over edges of embankments. • Be designed and formed to ensure there is adequate room to safely manoeuvre the vehicle or mobile plant on top of pad, dump or stockpile.	Construction	Road designer
Runaway vehicle provisions in operational areas			
TM63	Avenira shall implement runaway vehicle provisions in operational areas where there is the possibility for vehicles to run away on steep grades when operating close to their design limits, or experience and history shows there is a problem keeping vehicles under control. There are two types of runaway provisions: escape ramps or centre berms which will be implemented if required. Escape ramps shall be: • Attached to the haul road and designed so the vehicle operator can safely steer the vehicle into the escape ramp. • Wide enough to accommodate the largest tyred vehicle on site and of sufficient length to allow vehicle time for it to slow and stop. • Constructed with high rolling resistance material which is not easily compacted. Centre berms shall: • Accommodate the nature and size of the vehicle that will need to drive onto or straddle the centre berm. • Be constructed of material that provides sufficient drag on the vehicle to slow and stop its momentum and limits damage to the underside of the vehicle. • Positioned so a vehicle has only limited time to pick up speed before it straddles the berm. Runaway vehicles on pit ramps are to use the pit wall to bring the vehicle to a halt.	Construction	Road designer
High wall drop zones			
TM64	High walls are often located alongside haul roads, levels and benches. These present a hazard in the form of a rock fall or ground collapse. High walls can become less stable over time due to factors such as weathering and effects of water. High walls shall be subject to regular inspection for evidence of rock falls, open joints, water damage, or overhangs.	At all times	Area Manager

Item	Management Measures	Timing	Responsibility
	Unstable material shall be removed where possible or, where this is not practicable, access to the area shall be restricted. Earthen mound barricading shall be used to prevent entry into restricted areas; the earthen mound shall be positioned to stop rolling rocks striking personnel or plant and equipment. • Signage will be erected on entry points identifying restricted areas. • Positioning of barricades shall take into account the height of the face and how far the rocks out may fall and bounce from the base of the wall.		
Isolation / holding bays			
TM65	Where there is a possible risk of mobile plant coming into contact with overhead power lines or heat building up in the tires as a result of long-haul roads, a bunded (earthen mound) vehicle / mobile plant isolation bay for tyre explosions shall be in place. The isolation bay shall have: • Earthen mounds around three sides of the mobile plant (i.e. back, left and right) and be the height of the largest tyred vehicle on site. • Be designed to accommodate the largest mobile plant on site. • Signage stating mobile plant isolation bay. • Signage stating that the area shall be kept clear for emergencies. • No-one is allowed to enter this area for 24 hours. • Before the expected vehicle is returned to service, a competent person shall assess the condition of the tyres.	At all times	Area Managers
Restricted access / exclusion zones			
TM66	Pedestrian exclusion zones shall be identified, signposted and workers shall be notified of their existence and location. • Signage shall advise unauthorised vehicles or personnel of no entry to the area. • Visitors are not permitted to walk around the stockpiles unless a worker appointed by the Mine Operator accompanies them. That appointed person must be carrying a UHF radio. • Workers are not allowed to walk within stockpile areas unless verbal communication (direct or by UHF radio) has occurred and the drivers and operators of the mobile plant or heavy vehicles operating within that area have received a response. This communication shall occur before the personnel enter the exclusion zone. • Customers are not permitted to leave the cabin of their vehicle while parked within the stockpile area unless they are directed to do so by the work area supervisor or appointed person. • Visitors or workers are not permitted to walk within half the face height at the bottom of a quarry face. • Signage shall be displayed at the following areas prohibiting unauthorised personnel and vehicles entering. • ROM pads, stockpiles and waste dumps, drill pads, blast pads, haul roads, workshops and fixed plant areas.	At all times	Area Managers

Attachment 2 Generic Traffic Guidance Scheme

D.4.7 Static: Access to depot, stockpile, quarry, gravel pit etc. all roads (formerly TCP 195)



Attachment 3 Risk Assessment

Risk Assessment Register

Wonarah Phosphate DSO Project

Avenira Ltd

13/6 Duoro Rd
West Perth WA 6005

Prepared by:

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SLR Project No.: 680.V13432

18 September 2023

Revision1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0.1	30 June 2023	J. Woodworth	S. Harrison	
1.0	18 September 2023	E. Aliotti	S. Harrison S. Buxton	J. Woodworth
	Click to enter a date.			
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	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables in Text

1.0 Introduction

1.1 Background

Avenira Ltd (Avenira) proposes to develop the Wonarah Phosphate direct shipping ore (DSO) Project (the Project) in the Northern Territory (NT) on Mineral Lease (ML)33344 and ML33343. The Project involves the mining of two phosphate deposits, known as 'Arruwurra' and 'Main Zone'. The project is located in the Barkly Tableland of the NT 26 km directly south of the Barkly Highway, approximately 240 km east of Tennant Creek and approximately 960 km south-east of Darwin. The Wunara Community is the closest populated area to the project. It is located 10 km east of the ML boundary. The Project area includes the ML Area, which is located south of the Barkly Highway, a proposed borefield on the northern side of the highway on the Dalmore Downs pastoral lease and the water supply pipeline corridor that connects these two areas.

Prior to the commencement of mining and the development of the Mine Management Plan (MMP) for the Phosphate DSO Project, a risk assessment was conducted for the Project. The risk framework and assessment as described below has been used to identify the nature of risks and potential impacts associated with the Wonarah DSO Project to inform the development of appropriate management measures as addressed in the Environmental Management Plans (EMPs) developed under the Environmental Management System (EMS).

The risk assessment framework for the Project has been developed and implemented in accordance with international best practice standard methodologies including:

- AS/NZS ISO 31000:2018: Risk management— Principles and guidelines (Standard).
- HB 203:2006: Environmental risk management — Principles and process (Guide).

This risk assessment has also been developed with consideration of the NT EPA Environmental Factors and Objectives (NT EPA 2021b[1]) framework. The framework has been developed and assessment completed to ensure that residual impacts can be managed in a way that the objectives of each environmental factor and stakeholder expectations can be met.

The Project and associated activities have been subject to a site-specific risk assessment conducted on 25 May 2023. The objective of the risk assessment was to ensure that any significant risks were identified, evaluated and 'treated' to mitigate these risks. The risk assessment framework provides a mechanism for the proponent to identify and proactively address potential significant risk. It also demonstrates to stakeholders and regulators that the proposed Project risks have been considered in accordance with relevant guidelines and good practice, and that risk mitigation is appropriate to minimise any potential impacts.

[1] https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/804602/guide-ntepa-environmental-factors-objectives.pdf

2.0 Risk Assessment Process

The risk assessment for the Project was conducted, with specific consideration of potential impacts to terrestrial ecosystems and hydrological processes. In accordance with NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a[1]), the risk assessment accounts for all six environmental factors listed in the guidance:

- Terrestrial environmental quality.
- Terrestrial ecosystems.
- Hydrological processes.
- Inland water environmental quality.
- Aquatic ecosystems.
- Community and economy.

This section describes how potential environmental risks from the implementation of the Project have been identified, evaluated and treated. Avenira has considered risks arising from all phases of the Project including recommissioning, operation, temporary shutdowns, care and maintenance, decommissioning and closure.

The risk assessment will be re-evaluated annually during the life of the mine (or when a significant change is made to the Project). This will ensure any new risks can be identified and treated to be maintained at a "As Low As Reasonably Practicable" (ALARP) level.

2.1 Risk Identification

Risk relates to the effect of uncertainty on objectives. These objectives are primarily environmental goals for the Project as well as the objectives of the NT EPA for each environmental factor applicable to the Project. Risks are determined and assessed using a combination of the likelihood of occurrence and the consequence of an event. Identifying risks for the Project recommissioning, operational, decommissioning and closure phases are based on the failure of control(s) associated with the environment, people, infrastructure or equipment in hazardous situations. The assessment considered potential direct, indirect and cumulative impacts.

Identifying the source of the risk, the likelihood of occurrence and the consequence of that occurring; the treatment or mitigation of the risk to reduce its impact, and determining the remaining residual risk has been undertaken using a standard qualitative risk matrix (**Table** 1). This process is aligned to the AS /NZS ISO 31000:2018 standard. This framework also aligns with the NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a[1]), which states:

"*Provide information that permits the general reader to understand the likelihood of occurrence and severity of each potentially significant environmental impact presented by the proposal. Consideration of risks presented by the proposal may be guided by undertaking a risk assessment consistent with the AS/ISO 31000 risk management series…..the analysis, including development of likelihood and consequence ratings for inherent and residual risk assessments, is to be based on referenced and relevant actual data and modelled predictions as appropriate*."

2.2 Risk Matrix

The assessment of risk has been conducted through pragmatic consideration of the circumstances around risks, identifying necessary controls to address potential impacts and assuming effective implementation of planned and committed mitigation of potential impacts. While prioritisation has been given to avoidance as per the environmental decision- making framework, mitigation is proposed, where possible, to achieve a reduced residual risk (risk after mitigation) to below “Extreme” or “High” risk outcomes to the extent that is reasonably practicable.

Table 1 provides a summary of the qualitative risk matrix adopted and the levels of risk for the various consequence and likelihood combinations.

Table 1: Qualitative Risk Analysis Matrix

	Consequence				
Likelihood	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Significant
(5) Almost certain	Medium (2)	Medium (2)	High (3)	Very High (4)	Very High (4)
(4) Likely	Medium (2)	Medium (2)	High (3)	Very High (4)	Very High (4)
(3) Possible	Low (1)	Medium (2)	High (3)	High (3)	Very High (4)
(2) Unlikely	Low (1)	Low (1)	Medium (2)	High (3)	High (3)
(1) Rare	Low (1)	Low (1)	Low (1)	Medium (2)	High (3)

Risk level and target action	
Very High	Escalation to the Directors and MD attention needed, action plans and management responsibility specified
High	Senior Management attention needed, action plans and management responsibility specified
Medium	Manage by specific monitoring or response procedures, with management responsibility specified
Low	Manage by routine procedures, unlikely to need specific application of resources

Definitions of likelihood are provided in **Table 2** Likelihoods are categorised around the probability of occurrence, within the context of reasonable timeframes and frequencies given the Project life. A brief description of each risk classification and interpreted outcome is also provided below in **Table 3**.

Table 2: Definition of Likelihood Classification

Rating	Likelihood	Frequency	Probability	Occurrence as Percentage
5	Almost certain	More than once per month	The event is expected to occur at some time as there is a history of continuous occurrence with similar projects/activities	91-100%

Rating	Likelihood	Frequency	Probability	Occurrence as Percentage
4	Likely	Less than once per month, but more than once per year	There is a strong possibility the event will occur as there is a history of frequent occurrence with similar projects /activities.	61-90%
3	Possible	Less than once per year, but more than once per five years	The event might occur at some time as there is a history of infrequent occurrence of similar issues with similar projects/activities.	41-60%
2	Unlikely	Less than once per five years	Not expected, but there's a slight possibility it may occur at some time.	11-40%
1	Rare	Unlikely to ever occur	Highly unlikely, but it may occur in exceptional circumstances.	0-10%

Table 3: Description of Risk Classification

Rating	Definition
Extreme	Unacceptable risks primarily critical in nature in terms of consequences (e.g. extensive and long term environmental harm, permanent sacred site damage, fatality, massive economic impacts) that are considered a possibility through to almost certain to occur. Such risks significantly exceed the risk acceptance threshold and require comprehensive control measures, and additional urgent and immediate attention towards the identification and implementation of measures to reduce the level of risk.
High	Typically relate to significant to critical consequences (e.g. a major environmental or heritage damage, and considerable safety, social or economic impacts) that are inclined to cut across the possible to almost certain likelihood ratings. These are also likely to exceed the risk acceptance threshold and although proactive control measures have been planned or implemented, a very close monitoring regime and additional actions towards achieving further risk reduction is required
Moderate	As suggested by the classification, medium level risks span a group of risk combinations varying from relatively low consequence / high likelihood to mid-level consequences /mid-level likelihood, to relatively high consequence / low likelihood scenarios across environmental, social and economic areas. These risks are likely to require active monitoring as they are positioned on the risk acceptance threshold
Low	These risks are below the risk acceptance threshold and although they may require additional monitoring in certain cases are not considered to require active management. In general, such risks represent relatively low likelihood and low to mid-level consequence scenarios.

Table 4 describes the types of consequences that have been identified and assessed as part of the risk assessment process. These are grouped into the NT EPA environmental themes and factors, to demonstrate direct line-of-sight of the evaluation of risk with the key environmental factors as per the NT EPA objectives.

Table 4: Consequence Classification

NT EPA Themes and Factors		Consequence				
Theme	Factors	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Significant
Land	Terrestrial Environmental Quality	Negligible impact to isolated area.	Contained low impact, not impacting on any environmental values of soil or land.	Uncontained impact, able to be rectified in short-term without causing pollution or contamination to soil or land.	Extensive hazardous impact on an environmental value requiring long-term remediation of soil or land.	Uncontained hazardous impact with residual effect, even with long term remediation of soil or land.
	Terrestrial Ecosystem	Alteration or disturbance to an isolated area that is unlikely to affect the habitat, species or ecosystem functioning.	Alteration or disturbance to less than 5% of a habitat, species or ecosystem functioning resulting in a minor, recoverable impact within 1 year.	Alteration or disturbance to 5-30% of a habitat, species or ecosystem functioning resulting in a moderate, recoverable impact within 1-2 years.	Alteration or disturbance to 30-70% of a habitat, species or ecosystem functioning result in a major, recoverable impact within 3-10 years.	Alteration of more than 70% of a habitat, species or ecosystem functioning resulting in an extinction or permanent change, or reduce threshold level below 30%. Recovery, if possible is greater than 10 years.
Water	Hydrological Processes	Negligible impact to hydrological processes in Project area (surface or groundwater) and no consequence to the use of water.	Contained low impact to hydrological processes in Project area (surface or groundwater) with minor recoverable impact within 1 year.	Uncontained impact to hydrological processes that will affect the use of the water including outside the Project area but can be remediated in the short-term (1-2 years).	Extensive impact to hydrological processes that will affect the use of the water including outside the Project area and requires long-term remediation (3-10 years).	Uncontained hazardous impact to hydrological processes with residual effect, even with long-term remediation (greater than 10 years).

NT EPA Themes and Factors		Consequence				
	Inland Water Environmental Quality	Negligible impact to water quality (surface or groundwater) in Project area and no consequence to the human or ecological uses of the water.	Contained low impact to water quality (surface or groundwater) in Project area with minor recoverable impact within 1 year.	Uncontained impact to water quality that will affect the human or ecological use of the water including outside the Project area but can be remediated in the short-term (1-2 years).	Extensive impact to water quality that will affect the human or ecological use of the water including outside the Project area and requires long-term remediation (3-10 years).	Uncontained hazardous impact to water quality with residual effect, even with long-term remediation (greater than 10 years).
	Aquatic Ecosystems	Negligible impact to aquatic ecosystems through quality or flow changes in Project area, but unlikely to affect the habitat, species or ecosystem functioning.	Contained low impact to aquatic ecosystems through quality or flow changes in Project area, with minor recoverable impact within 1 year.	Uncontained impact to aquatic ecosystems through quality or flow changes, with moderate consequence to habitat, species or ecosystem functioning including outside the Project area but can be remediated in the short-term (1-2 years).	Extensive impact to aquatic ecosystems that will affect the species or ecosystem functioning including outside the Project area and requires long-term remediation (3-10 years).	Uncontained impact to aquatic ecosystem with residual effect, even with long-term remediation (greater than 10 years).
People	Community and Economy	Incident with or without minor injury. No impact on human health or very minor short term inconvenience or symptoms OR Adverse local social or economic implications that are brief or periodic.	Injuries requiring first aid treatment. Minor short term inconvenience or symptoms to human health OR Adverse local or regional, social or economic implications that last for 1 year.	Injury or illness requiring medical treatment. Short term or reversible disabling effect (impairment) to human health OR Adverse local or regional, social or economic implications that last for 1-2 years.	Injuries requiring hospitalisation. Serious long term or permanent disabling effects on human health Adverse local, regional or territory-wide, social or economic implications that last for 3-10 years.	Loss of life / fatality or long term or permanent disabling effects on human health Adverse local, regional territory-wide or national, social or economic implications that last for greater than years.

The level of certainty surrounding the proposed risk rankings was also assessed in accordance with **Table 5**. Where proposed mitigation measures resulted in a reduction in risk ranking from inherent risk to residual risk, justifications for this were also provided.

Table 5 Level of Certainty

Control Rank	Description	Guidance
C1	Low	Risk ranking is based on subjective opinion or relevant past experiences.
C2	Moderate	Risk ranking is based on similar conditions being observed previously and/or qualitative analysis.
C3	High	Risk ranking is based on testing, high fidelity modelling or simulation, use of prototype or experiments. Analysis is based on verified models and/or data. Assessment is based on an historical basis.

2.3 Risk Treatment

In accordance with the NT EPA Guidance on preparing an Environmental Impact Statement (NT EPA 2021[1]), when considering risk mitigation, the environmental decision-making hierarchy has been used to guide the identification and selection of appropriate controls. As per the guideline, proponents must demonstrate that the environmental decision-making hierarchy has been applied to avoid or mitigate potentially significant environmental impacts where practicable. Section 26 of the *Environment Protection Act 2019* states the environmental decision-making hierarchy is as follows:

a. "Ensure that actions are designed to avoid adverse impacts on the environment;

b. Identify management options to mitigate adverse impacts on the environment to the greatest extent practicable; and

c. If appropriate, provide for environmental offsets in accordance with the Act for residual adverse impacts on the environment that cannot be avoided or mitigated.

In making decisions in relation to actions that affect the environment, proponents must ensure that the potential for actions to enhance or restore environmental quality is identified and provided for to the extent practicable."

The hierarchy has been used in developing the risk assessment matrix to assist in applying appropriate mitigation measures where risks cannot be avoided. Generally, mitigation measures for significant environmental risks include adaptive management or ongoing monitoring. Each of the key environmental factor sections also provide an avoidance, mitigation and management sub-section that prioritises measures to avoid in accordance with the hierarchy.

2.4 Risk Evaluation and Assessment

The risk evaluation and assessment section provides a discussion of the key outcomes of the risk assessment. The risk assessment provides a good understanding of the Project risk profile and has enabled priority risks to be highlighted in order to minimise the likelihood of occurrence and / or the consequence severity. Risk assessments were based on the outcomes of planned mitigation and monitoring to detect incipient or actual failure of management systems.

It is important to note that the likelihood and consequence of risks vary across the Project stages. For example, the risk of impacts from vegetation clearing are highest during the construction stage, whereas failure from the tailings dam may be greatest during operations.

The risk assessment process has considered the applicable stages and based the assessment of residual risk on the stage for which the greatest risk is expected.

2.4.1 Identified Risks

In total, 48 different sources of environmental, health, social and economic risks were identified and evaluated. Of these, 24 of the risks applied to the land factor, 10 to the water factor and 25 to the people factor (note that some risks will apply to more than one factor). The risk assessment was completed against each of the environmental factors and many of the risks applied to multiple factors. A summary of the risks are provided in **Table 6**. A full list of the identified risks and the applicable factors is provided in **Table 7**.

Table 6: Identified Risks and Relevant Factors

	Activity/Hazard		Relevant Factor					
No		**Risk/Potential Source of Impact**	**Terrestrial Environmental Quality**	**Terrestrial Ecosystem**	**Hydrological Processes**	**Inland Water Quality**	**Aquatic Ecosystems**	**Community and Economy**
1	Land clearing: Dust emissions	Decrease in air quality at Wunara due to dust emissions from land clearing activities	X	X				X
2	Land clearing: Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from land clearing activities						X
3	Construction: Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions	X	X				X
4	Land clearing: Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species)	X	X				
5	Land clearing: Removal of vegetation / disturbance	Significant Impacts to Threatened Species due to loss of habitat and direct mortality	X	X				
6	Storage and handling of hazardous materials: Spills (liquid, solids, and other dangerous material)	Loss of vegetation or degradation of vegetation health due to hazardous material contamination to soil, surface water and/or groundwater	X			X	X	
7	Land clearing: Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species) due to removal of habitat	X	X				
8	All activities: Noise, light and vibration	Reduced Species Abundance (Density and Diversity of Species) due to deterrence by noise, light and vibration from a variety of project activities: blasting, mining, crushing, haulage etc…	X	X				
9	Land clearing: Removal of vegetation / disturbance	Significant impact to threatened species due to removal and disturbance of habitat	X	X				
10	Water use: Groundwater drawdown	Groundwater drawdown due to overextraction for project related water use			X			
11	Land clearing: Erosion and sedimentation	Reduced surface water quality due to erosion and sedimentation and increased turbidity	X	X		X	X	
12	Storage and handling of hazardous materials: Spills (liquid, solids, and other dangerous material)	Reduced surface water quality due to contamination	X	X		X	X	

	Activity/Hazard		Relevant Factor					
13	All activities: Damage or disturbance to heritage or Aboriginal Sacred Sites	Loss of heritage and impacts to culture sites of significance due to damage/disturbance of sacred sites and archaeology						X
14	Mining operation, including management of waste rock, ore and topsoil storage: Dust emissions	Decrease in air quality at Wunara due to dust emissions from mining activities: blasting, crushing, screening, haulage etc…						X
15	Drilling activities: Dust emissions	Decrease in air quality - visual amenity, dust impacts to vegetation	X	X				X
16	Mining operation, including management of waste rock, ore and topsoil storage: Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from mining activities						X
17	General vehicle movement: Dust emissions	Decrease in air quality at Wunara due to dust emissions from vehicle movement on unsealed roads within the mineral lease	X	X				X
18	General vehicle movement: Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from vehicle movement on unsealed roads within the mineral lease						X
19	Haulage (including loading and unloading) of ore: Dust emissions	Decrease in air quality due to heavy vehicles travelling along the ore transport route, for people using rest stops, the Barkly Roadhouse, and residences along the transport route						X
20	Power generation and use: Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions						X
21	Non-ore waste management: Disposal of waste	Decrease in air quality due to odour from sewage treatment plant and putrescible waste landfill causing nuisance for sensitive receptors (mainly residents of Wunara community)	X	X				X
22	Blasting and vehicle use: Chemical compounds and diesel hydrocarbons	Decrease in air quality due to odour from blasting activities and vehicle movements with fumes	X	X				
23	Power generation and use: Exhaust emissions and diesel fuel consumption	Significant increase in greenhouse gas emissions						X
24	Mining operation, including management of waste rock, ore and topsoil storage: Noise and vibrations from machinery and equipment	Disturbance and noise nuisance to Wunara community	X					X
25	Topsoil stockpiling: Inappropriate topsoil removal and storage	Reduction in soil quality due to mixing of topsoil and subsoil through inappropriate topsoil removal and storage	X	X				
26	Mining operation, including management of waste rock, ore and topsoil storage: Compaction of soils	Reduced soil quality due to soil compaction and reduced permeability from heavy machinery operating on soils	X	X				
27	Storage and handling of hazardous materials: Spills and leaks from fuel storages	Reduced soil quality due to contamination of soils from seepage from putrescible waste and spills of chemicals/fuels	X	X				
28	Topsoil stockpiling: Erosion and sedimentation	Reduced soil quality due to erosion and sedimentation of disturbed soils and stockpiled soils	X	X		X	X	

	Activity/Hazard		Relevant Factor					
29	All activities: Restricted access to the mineral lease	Reduced availability of land for traditional hunting and gathering						X
30	All activities: Restricted access to areas surrounding the mineral lease	Restriction of Traditional Owner access to sites of cultural significance						X
31	All activities: Removal of vegetation / disturbance	Reduced Conditions Favourable for Plant Growth due to dust and disturbance	X	X				
32	General vehicle movement: Weed introduction and spread by machinery and equipment	Reduced habitat quality due to introduction of new weeds and/or increased density and distribution of existing weeds	X	X				
33	Construction of infrastructure: Alteration of surface water flows	Loss of riparian vegetation due to reduced water availability for riparian vegetation due to alteration of surface water flows	X	X		X	X	
34	Mining operation, including management of waste rock, ore and topsoil storage: Acid Rock Drainage (ARD) from WRD	Reduced Species Abundance (Density and Diversity of Species) due to use of contaminated water by fauna	X	X		X	X	
35	All activities: Increased pests and vermin	Impacts to fauna due to increased abundance of introduced species	X	X				
36	Storage and handling of hazardous materials: Spills (liquid, solids, and other dangerous material)	Reduced groundwater quality due to spills or seepage of hazardous materials and/or waste			X	X	X	
37	Water use: Groundwater drawdown	Reduced groundwater quality due to groundwater drawdown increasing salinity due to reductions in dilution of salts in the aquifer due to overextraction of groundwater			X	X	X	
38	Construction of infrastructure: Alteration of surface water flows	Alteration to surface water flows due to construction of infrastructure for the mine and mining-related alteration of the landform			X	X	X	
39	Workforce: Workforce influences local community	Social disruption due to changes in population and demographics.						X
40	Workforce: Workforce influences local community	Increased competition for skilled labour.						X
41	Workforce: Increased local population	Pressure on existing emergency services						X
42	Workforce: Increased local population	Inadequate existing infrastructure and community services.						X
43	Workforce: Increased local population	Reduced availability and affordability of housing at Tennant Creek and Wunara						X
44	Haulage (including loading and unloading) of ore: Increased road traffic on major roads	Increased traffic on roads, with a consequent safety risk and reduced amenity for road users.						X
45	Workforce: Workforce influences local community	Increased availability and affordability of drugs and alcohol, with consequent negative social impacts.						X
46	Workforce: Workforce influences local community.	Increase in security breach on site.						
47	Haulage (including loading and unloading) of ore: Increased road traffic on major roads	Adverse effects on safety due to increased road traffic.						X
48	Haulage (including loading and unloading) of ore: Degradation of Barkly Hwy	Degradation of Barkly Highway due to increased road traffic. Track intersection with rocks and gravel from site dragged into the Barkly Highway.						X

Table 7 Risk Assessment Register

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
1 TEQ TE CE	Air Quality	Land clearing	Dust emissions	Decrease in air quality at Wunara due to dust emissions from land clearing activities	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18 km closest section of the haul road and approx. 34 km to the north-east of the Arruwurra deposit) and the prevailing wind direction, which is a south-easterly direction away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	Low	Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion. • Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion. • Watering areas to be disturbed immediately prior to clearing during windy conditions. • Undertake dust suppression • Using existing disturbance areas where possible to reduce land disturbance requirements • Bitumen on T-intersection from site access road to Barkly Hwy	1	2	Low
2 CE	Air Quality	Land clearing	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from land clearing activities	>20 km direct from mining disturbance to the Barkley Hwy. ~18 km closest section of the haul road is to the Wunara community and approx. 34 km to the north-east of the Arruwurra deposit Dirt haul road joins the Barkly Hwy -potential dust for motorists Land clearing footprint is <100 ha.	3	2	Medium		2	2	Low
3 TEQ TE CE	Air Quality	Construction of infrastructure	Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions	In practice, emissions of sulfur dioxide, nitrogen dioxide and carbon monoxide from open cut mines, which would span a similar distance, are much too small and the equipment too widely dispersed for these to cause exceedances of the ambient air quality criteria. Land clearing footprint is <100 ha.	3	2	Medium	Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. • Vehicles and machinery will be fitted with the appropriate emission control equipment and maintained and serviced frequently. • Conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program outlined in the Dust Management Plan (daily and monthly) and consider any new technologies that may be available to reduce emissions. • Using existing disturbance areas where possible to reduce land disturbance requirements • Short duration of DSO mining activities.	2	1	Low
4 TEQ TE	Flora	Land clearing	Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species)	Land clearing footprint is <100 ha. While the diversity of species may remain the same following vegetation clearing, the density of individual plants will reduce in the short term. The attraction of grazing animals to the project area will be prevented wherever possible and undertaken in accordance with the mitigation and management measures outlined adjacent. The area will be actively managed to prevent overgrazing from native and introduced fauna (e.g., kangaroos, camels, rabbits or cows). The main vegetation community of the project area is described as *Eucalyptus opaca*, (bloodwood) low open woodland with *Triodia pungens* (soft spinifex) hummock grassland understorey (Wilson et al. 1990). This particular vegetation community covers 28,095 km^2 in the Northern Territory (Wilson et al. 1990), of which the project constitutes <0.004% of this area.	3	2	Medium	Avenira has minimised, where practical, the area of vegetation required to be cleared by using existing disturbances. Other measures to avoid, mitigate and manage the risks associated with reduced species abundance include: • Minimising the area of direct land clearing, and only clearing areas immediately prior to their development. • Minimising the area of direct land clearing in areas sensitive to disturbance, such as erosion sensitive soils and drainage lines. • Ensuring the development and implementation of relevant clearance protocols. • Hiring a spotter catcher to relocate fauna species and to be present during clearing. • Restricting clearing activities to existing disturbed areas, where possible. • Progressively rehabilitating disturbed areas, including mine pits, and avoiding unnecessary future disturbance of these areas.	2	1	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									• Ensuring vegetation debris (e.g., wood) on areas that do not require clearing is left in situ and not collected for firewood or other purposes. • Consulting with the AAC for clearance approval of potentially culturally significant trees. • Minimising the potential for water to pool in areas where it is applied as a dust suppressant (e.g., along unsealed access roads) to reduce the attraction of grazing animals.			
5 TEQ TE	Flora	Land clearing	Removal of vegetation / disturbance	Significant Impacts to Threatened Species due to loss of habitat and direct mortality	• No vegetation communities or flora species listed under the EPBC Act identified in the project area during field surveys or desktop assessment. • No vegetation communities listed under the TPWC Act were recorded in the project area. • Species of conservation significance communities listed under the TPWC Act that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas's) include flora species *Bonamia alatisemina*, *Distichostemon barklyanus*, *Heliotropium ballii*, *Heliotropium pulvinum*, *Sporobolus latzii*, *Triumfetta deserticola*, *Bergia barklyana* and *Hibiscus brachychlaenus*. • Project area lies within the 'Wonarah Beds' Site of Botanical Significance (SOBS). 6.7% of the Wonarah Beds SOBS is overlain by the MLs. Of this <0.07% will be within the proposed disturbance footprint of the areas of the Wonarah Beds SOBS. • White et al. (2000) note that there is the potential for a number of species of conservation significance occurring within the Wonarah Beds SOBS. Land unit mapping derived suggested that *Sporobolus latzii* occurs within the ephemeral lakes land unit, the largest of which occurs to the north of the Arruwurra prospect. This area is currently within a cultural exclusion zone which prevents mining activities within the area, limiting the likelihood of works impacting upon this known record. Furthermore, proposed works are located away from the ephemeral lake land unit thus minimising impacts on this species potentially occurring elsewhere in this land unit (LES 2009). • The area may potentially contain further threatened species that have not yet been located; however, it is unlikely that, were these species found to be present, project-related disturbance will result in significant impacts at a local level. Any impacts that did result would be insignificant at a regional, territory and national scale. All habitat types to be disturbed by the project are common in the region and any impact to threatened species will be limited.	3	2	Medium	Along with measures to mitigate and manage the risks associated with reduced species abundance outlined above, measures specifically designed to avoid, minimise and manage significant impacts to threatened species include: • Conducting walkovers of land to be cleared to identify plant species of conservation significance. • Continually monitoring low lying areas subject to inundated for the plant species *S. latzii.* If found, a Flora Management Plan will be developed to avoid and/or minimise the impacts to this species. • Erecting flagging tape to mark 'no-go' zones to ensure areas to be protected are clearly defined, identified and avoided and that clearing and ground disturbance only occur within designated areas. • Investigating the opportunities to use TWPC Act listed species known to occur in the region in rehabilitation. • Hiring a spotter catcher to relocate threatened fauna species and to be present during clearing. • Avoiding the clearance of vegetation communities associated with ephemeral lakes, with such areas classified as 'no-go' areas and flagged accordingly. • Mitigative measures outlined in LES (2009) to be implemented (fire management, feral animals, weeds, pre-clearance surveys, education of workforce for ID of threatened species, minimising clearing especially near drainage lines, progressive rehabilitation, monitoring programs).	2	2	Low
6 TEQ IWEQ AE	Flora	Storage and handling of hazardous materials	Spills (liquid, solids, and other dangerous material)	Loss of vegetation or degradation of vegetation health due to hazardous material contamination to soil, surface water and/or groundwater	With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation emergency response management plan, it is unlikely that fuels, oils and other chemicals will report to downstream environments. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit.	3	2	Medium	• Above-ground fuel storage double skinned tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									• Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled			
7 TEQ TE	Fauna	Land clearing	Removal of vegetation / disturbance	Reduced Species Abundance (Density and Diversity of Species) due to removal of habitat	The disturbance footprint is <100 ha. As a result of vegetation clearing, that habitat will be lost during operations and fauna may be forced out of the area or die. Fauna may also move out of the immediate vicinity of the mine due to noise, light, dust and vibration emissions. Therefore, it is possible that the abundance of fauna species present in the project area and surrounds will be reduced for the life of the project. However, due to the abundance of similar flora communities and habitat surrounding the project area small scale, duration and extent of mining operations these impacts are unlikely to impact on fauna communities in the long term. None of the project infrastructure will encircle habitats and prevent fauna from moving between habitat areas.	3	2	Medium	Project footprint has been minimised to avoid disturbance to new areas where possible. Other measures to avoid, mitigate and manage the risks associated with habitat removal or change include: • Minimising and consolidating areas of vegetation to be cleared for access tracks and infrastructure pathways so that large blocks of habitat, rather than small fragments, are preserved. • Rehabilitating cleared land both progressively during the life of the project and following project completion. • Regularly inspecting potential ‘fauna traps’ such as temporary trenches required during construction. • Progressive clearing as required.	2	2	Low
8 TEQ TE	Fauna	All activities	Noise, light and vibration	Reduced Species Abundance (Density and Diversity of Species) due to deterrence by noise, light and vibration from a variety of project activities	Species sensitive to disturbance by noise, vibration and light from blasting, mining and drilling activities are likely to relocate to other suitable habitat in the project area or surrounds.	3	2	Medium	• Locating noisy and illuminated infrastructure (e.g., crushing and screening plant) close together to localise areas affected by noise and light from equipment. • Where possible, locating vehicle and machinery access roads outside high-quality habitat to minimise the potential for disturbance to resident fauna. • Limiting the number of roads constructed in the project area. • Blasting during the day to minimise the potential for disturbance to nocturnal species such as the dunnarts which forage at night and bird and mammal species particularly active at dawn and dusk.	2	2	Low
9 TEQ TE	Fauna	Land clearing	Removal of vegetation / disturbance	Significant impact to threatened species due to removal and disturbance of habitat	• Land clearing proposed disturbance footprint is <100 ha. • No habitats of ecological significance were recorded during LES field surveys in the project area • Species of conservation significance that have been recorded inside the Wonarah Phosphate Project area during on-site investigations (LES field surveys and NT Flora & Fauna Atlas’s) include fauna species, Australian bustard (*Ardeotis australis*), northern nailtail wallaby (*Onychogalea unguifera*), long-haired rat (*Rattus villosissimus*) and woma (*Aspidites ramsayi*). Known to be present: • Australian bustard - due to the highly mobile nature of the species and widespread availability of habitat, small, localised disturbance is not likely to affect its conservation status. • Northern nail-tailed wallaby - unlikely to be impacted by the project due to its ability to move into other suitable surrounding habitat. Potentially present: Given the ubiquitous nature of the habitat in the project area and surrounds, the likelihood of any significant impacts on fauna of conservation significance is unlikely. Due to the limited presence of fauna of conservation significance	2	2	Low	To mitigate impacts to significant fauna the following techniques will be implemented: • Undertaking a walk over survey of all areas to be disturbed prior to commencement of works to locate the presence of any significant species. Rescue and relocation protocols will be developed in consultation with NT National Parks and Wildlife Service and/or DEPWS • Training of key staff in the identification of significant species and any traces left by them. • Managing pest species and native predators	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
					any impacts to populations (i.e., the removal of a few individuals) would be minor.							
10 HP	Groundwater	Water use	Groundwater drawdown	Groundwater drawdown due to overextraction for project related water use	• Water will be required for road construction, dust suppression for roads, crushing and screening plant and domestic / potable use for camp. The total water demand during construction is estimated to peak at 8 L/s. • Water will be sourced from existing bores - using the exploration camp bore for camp potable water and access road dust suppression and a bore at Arruwurra for mining. • Proposed max pit depth is 30 m • Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated. Dewatering requirements are therefore likely to be negligible and insignificant to groundwater drawdown.	2	2	Low	• Avenira groundwater monitoring program will monitor groundwater levels. • Groundwater extraction licence will be obtained as required under the Water Act for volumes >5ML/yr per parcel of land or Mineral Licence	2	2	Low
11 TEQ TE IWEQ AE	Surface water	Land clearing	Erosion and sedimentation	Reduced surface water quality due to erosion and sedimentation and increased turbidity	• <100 ha of land and soils will be disturbed by land clearing and development for the mining activities. • Semi-arid environment average rainfall 300-400 mm/yr. No receiving drainage lines within the Project area. • Soil types suitable for land use – existing Arruwurra Pit from 2009 bulk test sample from previous operator (Minemakers). No obvious erosion or sedimentation issues presenting on satellite imagery beyond disturbance footprint of existing infrastructure. • Proposed disturbance footprint flat to <2% slope • One distinctive soil class within the project area: By4 - composed of undulating ridge and slope terrain on lateritic sediments; some rock outcrops: chief soils seem to be shallow sands usually containing large amounts (> 60%) of mixed and variable gravels or ironstone gravels, and also uniform coarse sands with some gravels on ridges and upper slopes generally. Kandosols and Rudosols dominate the sand plains within the project area. • Erodibility of soils was assessed through combining erosivity potentials of classified soils in accordance with descriptions of arid land soils and topography. Most soils were found to have low erodibility potentials, except deep soils (mostly Rudosols with loose rock aggregations) on slopes. • Waste rock storages will be vulnerable to erosion and sediment mobilisation in the short and long term by wind and seasonal rains • Release of fugitive sediment from the project area will be minimised by waste dump design and construction • Implementation of on site sediment control measures, which include diversion drains to separate clean and dirty water and appropriately designing sediment control structures will minimise the release of fugitive sediment off the Mineral Lease. High sediment loads are likely to occur only during high flow periods following	3	2	2	• Site surface water management will be based on the principle of diverting clean surface water runoff away from disturbed areas and into existing natural watercourses and drainage lines, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment. • Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Runoff from the waste rock stockpiles is likely to generate sediment-laden stormwater only during high intensity rainfall events. Waste dump designed to limit erosion and sedimentation (maximum height 20 m) and final contoured 14-degree slope with berms every 10 vertical meters that are 3.7 m wide. • Progressive clearing as required.	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
					long dry periods in semi-arid environments; therefore any sediment impacts in the overall context are likely to be minimal.							
12 TEQ TE IWEQ AE	Surface water	Storage and handling of hazardous materials	Spills (liquid, solids, and other dangerous material)	Reduced surface water quality due to contamination	With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation Emergency Response Management Plan, it is unlikely that fuels, oils and other chemicals will report to downstream environments. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit. No receiving drainage lines within the Project area.	3	2	Medium	• Above-ground fuel storage double skinned tanks (where possible) used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled	2	2	Low
13 CE	Indigenous and non-indigenous cultural heritage	All activities	Damage or disturbance to heritage or Aboriginal Sacred Sites	Loss of heritage and impacts to culture sites of significance due to damage/disturbance of sacred sites and archaeology	There are sacred sites and a site of moderate archaeological significance outside the mineral lease. There are four identified sites of low archaeological significance and one of moderate archaeological significance within the mineral leases. There is one site of low archaeological significance outside the ML within 30 m of the haul road realignment. Although the site has been surveyed by an archaeologist and Traditional Owners, there is low potential for unidentified heritage to exist within the disturbance area. AAPA Certificate is no longer valid, Avenira are in discussions with Arruwurra Aboriginal Corporation (ACC) to have it updated. If the Indigenous cultural exclusion zones are disturbed, it is likely that the disturbance would attract the concern of the adjacent AAC, Wunara community and associated parties within the wider community	3	2	Medium	• Set up cultural exclusion zones around sacred sites • AAPA authority certificate application in progress and involves relevant groups • Consultation with Traditional Owners early on in project development to identify exclusion zones. • Avenira will seek consent under the NT Heritage Act for all ground disturbing works within 30 m of all silcrete outcrops. • Disturbance permit protocols and procedures to be adhered to • Minimise disturbance • No driving off designated tracks • All Avenira' employees will be made aware of the location of these cultural exclusion zones through project inductions and access (and therefore disturbance) to these areas will be prohibited. • Chance find / stop work procedures will be implemented	2	2	Low
14 CE	Air quality	Mining operation, including management of waste rock, ore and topsoil storage	Dust emissions	Decrease in air quality at Wunara due to dust emissions from mining activities	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18 km closest section of the haul road and approx. 34 km to the north-east of the Arruwurra deposit) and the prevailing wind direction, which is a south-easterly direction away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	Low	Manage waste rock, ore and topsoil storage, including such measures as: • Positioning the stockpiles lengthways to the predominant wind direction. • Minimising the slope of the upwind surfaces. • Stockpiling coarser material on the outer slopes of stored material to prevent wind blown dust and protecting with cleared vegetation. • Watering stockpiles to prevent wind losses when required (e.g., during dry windy weather, when stockpiles have been recently formed, and have surface dust). • Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement offsite. • Cease mining and clearing operations during severe meteorological conditions (wind speeds above around 40 km/h) causing extreme levels of dust. • Spray water and/or the dust suppressant agents on unsealed trafficked areas and other dust generating areas. • Reduce speed limit in sensitive areas • Avenira will keep daily records of the: – Operational hours of all water trucks.	2	1	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									– Amount of water and dust suppressant used. – Numbers of water trucks in operation. – Time any mining operations are ceased due to severe meteorological conditions			
15 TEQ TE CE	Air quality	Drilling activities	Dust emissions	Decrease in air quality - visual amenity, dust impacts to vegetation	• Mine site is remote from sensitive receptors. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18 km closest section of the haul road and approx. 34 km to the north-east of the Arruwurra deposit) and the prevailing wind direction, which is a south-easterly direction (i.e., the wind originates from the southeast and travels north-west) away from the community which is located east of the Mineral Lease. • Dust deposition expected to occur within the Arruwurra ML where grade control drilling is planned	3	2	Medium	• Dust suppression will be undertaken where possible • Implementation of erosion and sediment control practices to improve stabilisation of cleared areas to prevent wind erosion, which will minimise dust emissions. • Progressive clearing of drill pads as grade control schedule required • Minimise size of drill pads to accommodate required drill rig	3	1	Low
16 CE	Air quality	Mining operation, including management of waste rock, ore and topsoil storage	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from mining activities	• Ore handling including loading and unloading and ore process with crushing and screening will generate dust. This will impact the surrounding environment such as the local vegetation and fauna and the employees' health and safety with low visibility and small particles breathing. • Given the dirt haul road joins the Barkly Hwy, the movement of nuisance dust off the mineral lease from haulage is possible. The consequence of dust nuisance and amenity impacts for motorists is considered moderate, as this is an offsite impact and if visibility is reduced they will have to adjust their driving accordingly. >20 km direct from mining disturbance to the Barkly Hwy.	3	2	Medium	• Spray water on active work areas including loaders and stockpiles. • Stockpiles to be positioned lengthways to the predominant wind direction. • Minimise drop heights for materials handling when loading and unloading. • Avoidance of material transfer during moderate to fresh wind conditions (~20-30 km/h). • Monitoring to be conducted by an Occupational Hygienist to generate heat map of hotspot areas for targeted dust suppression and improve safety precaution. • Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement offsite. • Bitumen of T-intersection from site access road to Barkly Hwy • Reduce speed limit near Barkly Hwy intersection • Spray water and/or the dust suppressant on unsealed trafficked areas and other dust generating areas. • Avenira will keep daily records of the: – Operational hours of all water trucks. – Amount of water and dust suppressant used. – Numbers of water trucks in operation. – Time any mining operations are ceased due to severe meteorological conditions	2	2	Low
17 TEQ TE CE	Air Quality	General vehicle movement	Dust emissions	Decrease in air quality at Wunara due to dust emissions from vehicle movement on unsealed roads within the mineral lease	The mitigation and management measures will limit the dust emissions from the site. Potential impacts to the Wunara community are further limited by the large separation distance between the dust sources and the community (i.e., ~18 km closest section of the haul road and approx. 34 km to the north-east of the Arruwurra deposit) and the prevailing wind direction, which is a south-easterly direction away from the community which is located east of the Mineral Lease. Land clearing footprint is <100 ha.	2	2	Low	Manage mine traffic, including such measures as: • Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use. • Prohibiting off road driving. • Restricting site access to necessary site vehicles only. • Limiting parking of vehicles to designated parking areas to minimise soil disturbance. • Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust	2	1	Low
18 CE	Air Quality	General vehicle movement	Dust emissions	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from vehicle movement on unsealed roads within the mineral lease	Given the proximity of unsealed roads within the mineral lease and the Barkly Highway, the movement of nuisance dust off the mineral lease is possible. The consequence of dust nuisance and amenity impacts for motorists is	3	3	High	• Limiting load sizes of haul trucks on-site to ensure material is not above the level of the vehicle sidewalls • Bitumen of T-intersection from site access road to Barkley Hwy	1	3	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent Likelihood	Inherent Consequence	Inherent Risk	Summary of Controls	Residual Likelihood	Residual Consequence	Residual Risk
					considered moderate, as this is an offsite impact and if visibility is reduced they will have to adjust their driving accordingly, however dust generated is expected to be limited and there are mitigations available.							
19 CE	Air Quality	Haulage (including loading and unloading) of ore	Dust emissions	Decrease in air quality due to heavy vehicles travelling along the ore transport route, for people using rest stops, the Barkly Roadhouse, and residences along the transport route	All public roads used for the transport of ore will be sealed roads which will reduce the potential to generate dust through liberation of particulate matter from the road surface and while in transport, the ore will be covered so loss of material and airborne dust will be minimal. While the closest sensitive receptors to the transport route are the rest areas and the Barkly Roadhouse (all located less than 100 m from the transport route), the transport route and method will minimise any potential dust generation. It is highly unlikely that air quality will be affected by dust generated through the transport of ore.	2	2	Low	To reduce the amount of dust carried on vehicles from site onto the Barkly Highway, Avenira will: • Compact the soil at ore loading and unloading sites. • Prohibiting off road driving. • Restricting site access to necessary site vehicles only. • Limiting parking of vehicles to designated parking areas to minimise soil disturbance. • Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust. • Bitumen of T-intersection from site access road to Barkley Hwy. • Use water cart with frequency to be adjusted to achieve effective dust suppression. • Use of agent additives on ROM and loading area pad preparation for dust suppression. Dust will be minimised during the transport of ore from the mine site to the rail siding by: • Haulage contractors implementing management measures to prevent any product loss while transporting product from the mine site to the rail siding • Using covered haul trucks for the transport. • Installation of rumble strips to reduce truck speed. • Minimising double handling. • Using covered rail wagons during the transport of ore from the rail siding to East Arm Port. • Using purpose-designed and built ore storage and handling facility at East Arm Port.	2	1	Low
20 CE	Air Quality	Power generation and use	Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions	Even in large mines, the rate of emission of sulfur dioxide, nitrogen dioxide and carbon monoxide from vehicles and equipment are small compared with the emissions from traffic in an urban setting. For example, the traffic travelling on 3 km of arterial road carrying, for example, 60,000 vehicles per day and consuming 6,000 L of fuel per day would not normally cause exceedances of the ambient air quality criteria. In practice, emissions of sulfur dioxide, nitrogen dioxide and carbon monoxide from open cut mines, which would span a similar distance, are much too small and the equipment too widely dispersed for these to cause exceedances of the ambient air quality criteria.	2	2	Low	• Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. • Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently. • Conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions.	2	1	Low
21 TEQ TE CE	Air Quality	Non-ore waste management	Disposal of waste	Decrease in air quality due to odour from sewage treatment plant and putrescible waste landfill causing nuisance for sensitive receptors (mainly residents of Wunara community)	Emissions of odour from the sewage treatment plant are not expected to be detectable off-site or in the accommodation camp. Even if odorous emissions were to occur, which would be rare, they will be extremely localised and will have insignificant consequences. Therefore, the residual risk of odorous emissions is low.	2	1	Low	Avoidance • Location of the sewage treatment plant will comply with Northern Territory's Code of Practice for the small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent (DHF, 1998) and the EPA guidelines that specify a minimum separation distance of 100 m for plants servicing less than 1,000 people. • The putrescible waste landfill has been designed with consideration of, and will be managed in accordance	2	1	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									with, the Northern Territory Government's Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory (EPA, 2003). • Sewage treatment plant to be used on-site will be a package membrane bio-reactor design. This type of treatment plant does not require any permanent standing wastewater ponds and will be covered to mitigate any potential entry by mosquitoes. The need for specific measures will be considered if complaints are received, taking into account frequency of occurrence, intensity, duration, offensiveness and location			
22 TEQ TE	Air Quality	Blasting and vehicle use	Chemical compounds and diesel hydrocarbons.	Decrease in air quality due to odour from blasting activities and vehicle movements with fumes	Emission of odour from the blasting and the use of use of vehicles will result in noxious odours. However, given the limited vehicle in operations during this period and XXXXXX.	4	2	Medium	• Minimise the potential for delayed firing of shots which have been loaded into wet holes within the constraints of prevailing weather conditions. • Conduct a pre-blast environmental assessment considering wind speed, direction and shear and the strength of temperature inversions prior to each blast. Whenever practicable, blasts will be fired in suitable weather conditions that minimise the potential for blast generated dust and/or blast fumes to be blown towards neighbouring residential areas. • Vehicle engines on only when required during use.	2	1	Low
23 CE	Greenhouse gas emissions	Power generation and use	Exhaust emissions and diesel fuel consumption	Significant increase in greenhouse gas emissions	• Operation of plant and equipment will result in some GHG emissions. However, given the limited clearing, short duration of the mine operation and limited plant and equipment in operations during this period. the project will not exceed Large Emitters thresholds.	2	2	Low	• Develop and apply policies and procedures for efficient mine operation that will ensure fuel use is minimised. • Minimise haul distances to minimise diesel use in vehicles and subsequent combustion emissions. • Monitor energy consumption (e.g., diesel and electricity) and calculate greenhouse gas emissions. This data can then be used to identify and address any key opportunities to reduce greenhouse gas emissions. • Identify and assess economically viable opportunities for reductions in emission rates, e.g., reducing areas of vegetation clearance and exploring opportunities to use more efficient fuel technology such as natural gas. • Use renewable energy sources where available and viable (e.g. solar hot water systems, monitoring systems powered by solar energy). • Ensure that vehicles and equipment are mechanically sound, serviced regularly and fitted with appropriate emission control equipment. • Use energy efficient lighting in all accommodation and office areas. • Use 5-star appliances in accommodation and offices where available (e.g., refrigerators, air conditioners and cookers). • Continue to pursue opportunities to reduce combustion emissions from ore transportation through development of a rail link between the mine and Tennant Creek.	2	1	Low
24 TE CE	Noise and vibration	Mining operation, including management of waste rock, ore and topsoil storage	Noise and vibrations from machinery and equipment	Disturbance and noise nuisance to Wunara community	• The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 34 km to the north-east of the Arruwurra deposit and ~18-km from the closest section of the haul road • >20km direct from mining disturbance to the Barkly Hwy. • Limited blasting requirement for mining activities.	2	2	Low	Avoidance through design. Regardless, the following mitigations apply: • Service all plant, machinery and vehicles regularly. • Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles. Reverse alarms to be hissers to reduce noise. • No unauthorised entry • No public access	1	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									• Turn off machinery when not in use • Monitor noise impacts by complaint, developing additional mitigation measures if necessary • Strictly manage blasting procedures to ensure the comfort of employees and to protect mine infrastructure. • Design each blast using a suitably qualified person, with initial blasts being conservatively designed. • Monitor blasting impacts by complaint, developing additional mitigation measures if necessary			
25 TEQ TE	Landform, geology and soils	Topsoil stockpiling	Inappropriate topsoil removal and storage	Reduction in soil quality due to mixing of topsoil and subsoil through inappropriate topsoil removal and storage	By following the management and mitigation measures to handle, store and replace excavated topsoil and subsoil, it is unlikely that the project will result in a significant long term reduction in soil quality due to an altered profile. Should it occur, the impacts of this altered profile will be minor as the re-handling of soil can occur prior to machinery being moved off-site at the completion of mining.	3	2	Medium	• Prior to development of any site infrastructure, including the pits, the topsoil layer will be stripped. Where possible stripped topsoil will be immediately reused elsewhere to preserve the seed store and nutrients. • When immediate reuse is not possible, topsoil will be stored in stockpiles no higher than 2 m and adjacent to the area and around the pit as a bund in readiness for reuse in rehabilitation. • Where possible, stockpiles will be respread within three to six months of removal.	2	2	Low
26 TEQ TE	Landform, geology and soils	Mining operation, including management of waste rock, ore and topsoil storage	Compaction of soils	Reduced soil quality due to soil compaction and reduced permeability from heavy machinery operating on soils	Soil will be compacted during construction and operation of the project. However, management and mitigation measures will be used to minimise the potential for this and to rehabilitate compacted soil. These measures are readily available and standard practice in earthworks activities. Should it occur, the consequence of this impact will be minor, as it will be relatively straightforward to rehabilitate.	3	2	Medium	• All areas where the soil has been compacted during construction and operation (other than those with infrastructure to remain after closure) will be ripped, spread with topsoil and revegetated with native species	2	2	Low
27 TEQ TE	Landform, geology and soils	Storage and handling of hazardous materials	Spills and leaks from fuel storages	Reduced soil quality due to contamination of soils from seepage from putrescible waste and spills of chemicals/fuels	Soil may be locally contaminated by project activities (e.g., spill of fuel, discharge of hydraulic fluid); however, spill response measures will be followed to ensure that the impacts of the spill are minimised. Widespread contamination from mining activity is unlikely. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit.	3	2	Medium	• Above-ground fuel double skinned storage tanks used over short life of mine - lowers risk associated with diffuse pollution over time. • Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled • If mining works result in contamination of the soil, then the soil will be appropriately remediated and site contamination assessment will be carried out; or Contaminated soil will be removed from site and transported to an appropriate waste facility for treatment.	2	2	Low
28 TEQ TE IWEQ AE	Landform, geology and soils	Topsoil stockpiling	Erosion and sedimentation	Reduced soil quality due to erosion and sedimentation of disturbed soils and stockpiled soils	• <100 ha of land and soils will be disturbed by land clearing and development for the mining activities. • Erosion may affect the quality of soil in the project area. However, management and mitigation measures will be used to minimise the spatial and temporal extent of any potential erosion. These measures are common to the mining and earthworks industries and will be adapted as site conditions demand.	3	2	Medium	• Progressive clearing • Restricting clearing to essential areas and minimising the area of exposed cleared land. • Watering unsealed roads and other dust sources during windy conditions. • Minimising the period of time subsoil is exposed and topsoil is stored. • Minimising disturbance to the ground layer by restricting machinery access from areas not required for project works, and through selection of equipment	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									that will minimise disturbance (e.g., track type, weight, weight to track size ratio). • Topsoil stockpiles maximum height 2 m Measures specific to controlling sediment, and therefore maintaining the local quality of soil, include: • Controlling drainage and diverting it away from infrastructure. • Diverting clean water away from disturbed areas through diversion channels. • Directing runoff from exposed subsoil to the pit and sediment basins for settlement. • Hydroseeding or veneering where applicable.			
29 CE	Land use	All activities	Restricted access to the mineral lease	Reduced availability of land for traditional hunting and gathering	The loss of land available for hunting and gathering will be temporary. The total area (MLs) that will not be available for traditional hunting and gathering as a result of mining is 2.3% of the total land owned by and available to the Arruwurra Aboriginal Corporation (approximately 611,051 ha). This provides a significant amount of similar land surrounding the project area that is available and suitable for hunting and gathering purposes. Avenira will have an access and land use agreement with the AAC Traditional Owners	3	2	Medium	• The immediate loss of land for traditional hunting and gathering will be compensated for, as agreed during discussions and negotiations with the AAC Traditional Owners and Avenira and will be formalised in a Mining Agreement between the parties. • Rehabilitation and revegetation of the project area post mining will assist in the project area being suitable for the future end land use (e.g. hunting and gathering use) after mining has finished.	3	1	Low
30 CE	Land use	All activities	Restricted access to areas surrounding the mineral lease	Restriction of Traditional Owner access to sites of cultural significance	It is almost certain that the Traditional Owners residing in, or accessing the culturally significant sites from, the Wunara Community will have a reduction in their ease of access to these sites as a result of the project; however, access to the sites will not be restricted as a result of the mining activities. Safe, alternative access routes will be developed in consultation with the Traditional Owners.	3	2	Medium	• Prior to construction of the project Avenira will develop alternative access routes to the sacred sites in consultation with the AAC Traditional Owners. These access routes will be designed to ensure safe access to the sites and the safe operation of the mine; it is likely that access routes will be restricted to the western side of the Mineral Lease boundary and not allow for unauthorised crossing of haul roads	3	1	Low
31 TEQ TE	Flora	All activities	Removal of vegetation / disturbance	Reduced Conditions Favourable for Plant Growth due to dust and disturbance	Dust suppression measures, such as water trucks, will be used throughout the life of the mine to minimise dust emissions. However, given the nature of operations activities and the semi-arid environment, some dust generation is likely, which is likely to contribute to reduced conditions for plant growth. Studies on commercial crops and on vegetation in higher rainfall areas do not show any adverse effects on vegetation at dust deposition levels of the order of 4 g/m^2/month, hence detectable effects on vegetation are only likely within a few tens of metres of actively mined areas. Given the high background dust levels it is expected that local flora species will be tolerant of similarly high dust deposition levels.	4	1	Medium	• Measures designed to avoid, minimise and manage the risks associated with increased rates of erosion and dust generation • Progressive clearing as required to allow fauna to escape. • Shallow stockpiles to provide fauna refuge.	3	1	Low
32 TEQ TE	Flora	General vehicle movement	Weed introduction and spread by machinery and equipment	Reduced habitat quality due to introduction of new weeds and/or increased density and distribution of existing weeds	Weed management measures such as minimising the area of vegetation disturbed, and regularly monitoring and promptly controlling any outbreaks of weed infestation, will reduce the likelihood for significant increases in the density and distribution of weeds. Measures to prevent the introduction of new weed species, and limit their potential to become established if present, will ensure that it is unlikely that new weed species will present a threat to the native flora of the region	3	3	High	Measures designed to avoid, minimise and manage the risks associated with weed infestation as a result of the project include: • Minimising the area of vegetation to be cleared. • Using targeted weed control measures for any observed significant increase in the distribution or density of existing weeds, particularly buffel grass. • Inspecting construction areas for weed outbreaks following rainfall events. • Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides and recently cleared areas.	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
									• Controlling and/or preventing weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction during respreading of topsoil. • Instigating the ongoing rehabilitation of disturbed areas to reduce the potential for weed species to become established. • Liaising with NTG Weeds Branch on appropriate measures to eradicate or control weed outbreaks, should they occur • Ensuring that vehicles and project equipment arrive on site clean and free of vegetative matter, seeds and mud. This include weed and seed inspection to be signed off, also mandatory within the site induction. • Implementation of dedicated area to clean weed infested vehicles. Applying appropriate chemical control and timing (wed species specific) according to the Weed Management Handbook (DEPWS 2018). • Focussing on the control of declared weed species present in and around the project area, and preventing their spread during the life of the project. • Using targeted weed control measures for new populations of weeds identified in previously uninfested areas			
33 TEQ TE IWEQ AE	Flora	Construction of infrastructure	Alteration of surface water flows	Loss of riparian vegetation due to reduced water availability for riparian vegetation due to alteration of surface water flows	It is unlikely that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be insignificant due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event.	2	2	Low	• Mine infrastructure (waste dump and haul road) located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Project components located to minimise changes to the flow regime. • Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing natural watercourses or drainage lines.	2	1	Low
34 TEQ TE IWEQ AE	Fauna	Mining operation, including management of waste rock, ore and topsoil storage	Acid Rock Drainage (ARD) from WRD	Reduced Species Abundance (Density and Diversity of Species) due to use of contaminated water by fauna	Following significant rainfall, surface runoff may contain sediment and metal concentrations that have the potential to be toxic to wildlife. However, geochemical analysis has revealed high levels of metals or toxins in sedimentation is unlikely. It is assumed surface water management actions will be effective	2	2	Low	• Monitoring of water quality from WRDs, stockpiles and pit water • Sediment and erosion control measures • Containment and reuse of mine affected water	2	2	Low
35 TEQ TE	Fauna	All activities	Increased pests and vermin	Impacts to fauna due to increased abundance of introduced species	Introduced species are already present in the project area in relatively low densities. Management and mitigation measures will provide for the control of introduced species and it is unlikely that the density and distribution of these species in the project area will increase as a result of project activities.	2	2	Low	Measures designed to manage and mitigate the risks associated with an increased abundance of introduced species include: • Controlling existing feral animal populations • Targeting new populations, or significant increases in the current population, of foxes and/or feral cats. • Ensuring that waste management procedures are diligently followed to reduce potential resources for these species. • Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species (e.g., camp and around water sources).	2	1	Low
36 HP IWEQ	Groundwater	Storage and handling of	Spills (liquid, solids, and other dangerous material)	Reduced groundwater quality due to spills or seepage of hazardous materials and/or waste	Hazardous materials and chemicals stored on site will be minimal, with notable items being fuel, and sundry lubricants and cleaning chemicals. All hazardous materials stored on	3	2	Medium	• Above-ground fuel storage double skinned tanks used over short life of mine - lowers risk associated with diffuse pollution over time.	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
AE		hazardous materials			site will be contained within bunded areas and will be managed to minimise spillage. The implementation of the spill management procedures in the waste management plan will also minimise any risk of contamination of groundwater aquifers as a result any spills. Bulk hydrocarbon fuel contained proposed on site (~20,000 L) self-contained unit. No magazine / explosives storage proposed for storage onsite				• Fuel storage and handling in designated areas and accordance with AS1940. • Surround storage areas for fuels and oils with an impervious bund that contains 120% of the largest container stored in the bund – as per AS1940 • Refuel vehicles within bunded areas • Make available spill containment equipment kits at the works area that are adequately-sized to manage the volume of fuels that could be spilled • Appropriately storing and managing hazardous substances on-site • If a reduction in groundwater quality does occur, it will be detected by the groundwater monitoring program and the necessary remedial measures will be put in place			
37 HP IWEQ AE	Groundwater	Water use	Groundwater drawdown	Reduced groundwater quality due to groundwater drawdown increasing salinity due to reductions in dilution of salts in the aquifer due to overextraction of groundwater	Regional groundwater quality data show groundwater salinities range from 500 to 4,000 mg/L TDS. Groundwater across the Barkly Tableland is used extensively for stock watering purposes; acceptable salinity limits can be as high as 5,000 mg/L TDS (or 7,000 µS/cm EC) (ANZECC/ARMCANZ, 2000). Water use is minimal and not likely impact groundwater quality.	2	2	Low	• Ensuring the extraction of groundwater does not exceed sustainable yield limits • Groundwater extraction licence will be obtained as required under the Water Act for volumes >5ML/yr per parcel of land • Avenira groundwater monitoring program will monitor groundwater quality	2	2	Low
38 HP IWEQ AE	Surface water	Construction of infrastructure	Alteration of surface water flows	Alteration to surface water flows due to construction of infrastructure for the mine and mining-related alteration of the landform	• No significant watercourses traverse the project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit. • No physical works proposed in any waterway • No surface water extraction proposed • Seasonally flooded swamps occur in the south-west of the project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding. Contributing factors to such extensive flooding include Arruwurra deposit located in a topographic low; within a large upstream catchment area of the watercourse and the lack of discernible channel. It is unlikely that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be insignificant due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event.	3	1	Low	• Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease. • Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing drainage lines.	2	1	Low
39 CE	Socio-economic	Workforce	Workforce influences local community	Social disruption due to changes in population and demographics.	A change in regional demographics may result an influx of mine workers who are typically male and in their 20s to 40s; this could contribute to social disruption in Tennant Creek and Wunara due to increased law and order issues, tension between newcomers and existing residents and increases in drug and alcohol use. The fly-in fly-out (FIFO) workforce will increase the temporary population of the Barkly	3	3	High	• Accommodation of majority of workforce in purpose-built facilities. • Strict enforcement of company policy regarding standards of behaviour. • Maintenance of complaints register. • Undertake a complaint/incidents investigation including 360 feedback.	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
					Tableland region. Given the insular nature of FIFO operations, this population increase may not translate into population benefits for this region (i.e., disposable incomes of the mine workers is spent in their home localities and not within the region of their employment), but will have positive benefits for other communities (e.g., those hosting the FIFO employees).							
40 CE	Socio-economic	Workforce	Workforce influences local community	Increased competition for skilled labour.	The workforce will be preferentially sourced from the local, regional, territory and then national level. Providing employment opportunities for the local community will be a priority and will be determined by the skills of people living in Wunara and Tennant Creek. Sourcing labour from within the existing, local, labour market will increase local employment opportunities and may provide incentives for more skilled workers to move to the area and for skilled workers who have left the area to return to country. This type of structural adaptation in the workforce is common to the entry of any new industry into an area and is likely to create opportunities for both the existing and future workforce. Avenira will preferentially source labour from Wunara and Tennant Creek.	3	1	Low	• Work with existing training providers to ensure that programs they deliver will provide appropriate training programs. • Inform local community of the types of jobs that will be required and the skills and qualifications people will require to fill them. • Use local businesses to fill contract positions where contractors are competitive and appropriately skilled. • Support the development of business opportunities within the local Indigenous community. • Implement stakeholder consultation plan.	2	1	Low
41 CE	Socio-economic	Workforce	Increased local population	Pressure on existing emergency services	The provision of site-based emergency response teams and medical assistance, combined with the strong safety culture, operational and management systems implemented through all phases of operation, make it unlikely that significant pressure will be placed on existing emergency services. If externally provided emergency medical evacuation was required, the Royal Flying Doctor Service would be used. The expected infrequent reliance on external emergency and medical services results in this impact having a minor consequence. Avenira will liaise with local emergency services to ensure they have capacity to deal with any credible mine-related emergencies that may occur.	2	2	Low	• Implement workplace health and safety processes and procedures throughout all phases of the project. • Provide on-site emergency response team and facilities. • Consult with local emergency services.	2	2	Low
42 CE	Socio-economic	Workforce	Increased local population	Inadequate existing infrastructure and community services.	Employment of local people will not place additional strain on existing infrastructure services such as power, water and schooling as they are already using these services. The fly-in-fly-out workforce will be workers only (i.e., not families) and will not be located in Tennant Creek, so it should not place significant pressure on existing infrastructure services. Given this, it is unlikely that the project will result in existing infrastructure and community services being inadequate.	2	2	Low	• Liaise with the Barkly Shire Council and Northern Territory Government to assist future planning and development activities.	2	2	Low
43 CE	Socio-economic	Workforce	Increased local population	Reduced availability and affordability of housing at Tennant Creek and Wunara	The provision of accommodation villages at the multi-user hub and mine site make it unlikely that the project workforce will impact the availability and affordability of housing and accommodation. It is recognised that there may be pressure on housing associated with the flow-on effects of the mine (i.e., the increased business development in Tennant Creek); however, the direct project workforce will be accommodated within the villages. Traditional Owners who return to the area to work at the mine may wish to live in the	2	2	Low	• Consultation with government, shire council, AAC / Traditional Owners.	2	2	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
					community. With a total of four houses, the Wunara community does not have the housing to provide for a significant influx of such people, although it is not known how many people this is likely to be. Therefore, it is possible that there will be a lack of accommodation for Traditional Owners who return to country. This may require them to construct additional houses. However, Traditional Owners interviewed have highlighted the return to country of these people as a major potential positive benefit of the project. Accommodation for employed Traditional Owners will be available at the workers camp for these people until suitable additional housing can be constructed.							
44 CE	Socio-economic	Haulage (including loading and unloading) of ore	Increased road traffic on major roads	Increased traffic on roads, with a consequent safety risk and reduced amenity for road users.	It is assumed transport drivers will adhere to speed limits and regular servicing will be effective. It is also assumed other road users will drive to the conditions and speed limits. The project is small scale, extent and short duration so unlikely to impact in the long-term.	2	2	Low	• Impose speed limits on ore trucks. • Ensure all vehicles are mechanically sound and serviced and inspected regularly All roads will be constructed and maintained according to the NT guidelines https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/road-safety-treatments	2	2	Low
45 CE	Socio-economic	Workforce	Workforce influences local community	Increased availability and affordability of drugs and alcohol, with consequent negative social impacts.	Although Avenira has proposed controlling access to the bar to only those people employed on site or legitimately visiting the site in connection with the operation, there is still the potential for alcohol to be taken onto site illegally. Avenira believes that with responsible management and implementation of the drug and alcohol management plan, impacts to the residents of the Wunara Community will be prevented. The availability of self-testing facilities at both the multiuser hub and mine site accommodation villages will allow the opportunity to prevent a person from presenting for work in an unfit condition and thereby risk losing their employment. The reality is that wherever there is money there is the potential for drugs to be brought into the community. Avenira believes a zero tolerance approach to drugs, supported by a random testing regime, will deter most people from risking possessing or using drugs while on-site. Through the strict management of the consumption and supply of alcohol in the accommodation villages, the likelihood of increased social problems due to drug and alcohol use as a result of the project is unlikely.	3	2	Medium	• Implement a drug and alcohol management (Covered in the Operations Mine Safety Management Plan). • Implement substance abuse testing and management in all aspects of the operation. • Implement random drug and alcohol testing. • Zero tolerance approach for rules about drugs and alcohol.	2	2	Low
46 CE	Socio-economic	Workforce:	Workforce influences local community.	Increase in security breach on site.	The Project will increase the local population; therefore, the probability for crimes. There is a potential for people to break in the site for stealing.	3	2	Medium	• Fence surrounding the Project site. • Hazardous substances storage locked. • Cameras installed at hot spot areas: Hazardous substances, office.	2	2	Low
47 CE	Traffic and transport of ore	Haulage (including loading and unloading) of ore	Increased road traffic on major roads	Adverse effects on safety due to increased road traffic.	It is possible that there will be an increased risk of accident on a public road due to mine related traffic. The implementation of the traffic management plan will ensure that road transport of ore will be conducted in a responsible and legal manner with minimal disruption to other road users, particularly as the road trains hauling ore to the multi-user hub and back will not enter Tennant Creek. The consequence of an increased risk of accident is moderate as it will attract the concern of the community.	3	3	High	• Carry out any road upgrades prior to the commencement of ore transportation. • Implement traffic management plan. • Adequate road maintenance by government.	1	3	Low

Risk ID[1]	Factor	Activity	Hazard/Aspect	Description of Impact	Assumptions/Assessment Outcomes	Inherent			Summary of Controls	Residual		
						Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
					However, when the risk of traffic accidents is placed into context of normal day-to-day driving undertaken by the general public, the risk will most likely be lower.							
48 CE	Traffic and transport of ore	Haulage of ore: Degradation of Barkly Hwy	Degradation of Barkly Highway	Adverse effect on safety due to the degradation of Barky Highway.	It is possible that rocks and gravel from site will be dragged onto the Barky Highway from the T-intersection.	4	3	High	• Street swept regime to avoid flyrock (windscreen damage) and dust.	2	2	Low

[1]NT EPA Factors
TEQ = Terrestrial Environmental Quality
TE = Terrestrial Ecosystems
HP = Hydrological Processes
IWQ = Inland Water Quality
AE = Aquatic Ecosystems
CE = Community and Economy

Making Sustainability Happen

Making Sustainability Happen

APPENDIX O GROUNDWATER MANAGEMENT PLAN

Groundwater Monitoring Plan

Wonarah Test Pit and DSO Phosphate MMP

Avenira Limited

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SLR Project No.: 680.V13432

12 September 2023

Revision 2.0

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
2.0	12 September 2023	E. Aliotti	J. Woodworth	J. Woodworth
1.1	8 September 2023	J. Woodworth	S. Buxton S. Harrison	
1	29 August 2023	J. Woodworth	E. Aliotti	J. Woodworth
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	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables in Text

Figures in Text

1.0 Introduction

1.1 Background and Purpose

Avenira Limited (Avenira) propose to develop the Wonarah DSO Phosphate Project (the Project) for a large-scale direct shipping ore (DSO) after completing the Bulk Test Sample mine program at the Arruwurra site. The Project is located approximately 240 km east of Tennant Creek and approximately 26 km directly south of the Barkly Highway, Northern Territory (NT). This Project targets the Arruwurra deposit on the current Mineral Lease (ML) application ML33344.

This Groundwater Monitoring Plan (GMP) forms part of the Environmental Management System (EMS) (MMP: Appendix B) for Avenira's Wonarah DSO Phosphate Project and the Bulk Test Sample (MMP Appendix O in the Wonarah Bulk Test Sample) and is considered a working document. It will be updated, if required, following formal assessment by Department of Industry, Tourism and Trade (DITT), in consultation with pastoralists and traditional owners. This GMP has been developed to provide a framework for the monitoring and management of groundwater across and adjacent to the Arruwurra mine site.

1.2 Commitment

1. Avenira commit to maintaining groundwater quality and will include details of the groundwater monitoring program in reporting for the Project.

2. Avenira commit to ongoing evaluation of groundwater quality and depth data, and verification/refinement of the existing groundwater model for the Project area.

Reporting is discussed in **Section 4**.

1.3 NT EPA Recommendations

The following recommendations relating to groundwater management were made by the NT EPA after review of the Wonarah DSO Project EIS submitted in 2010 and listed in Assessment Report 64.

Recommendation 22

Minemakers (Avenira) shall include a commitment to maintaining groundwater quality, and include details of the groundwater monitoring program in the Mining Management Plan for the Project.

Minemakers (Avenira) shall commit to ongoing evaluation of groundwater quality and depth data, and verification/refinement of the existing groundwater model for the Project area.

Recommendation 23

Minemakers (Avenira) shall prepare a formal biennial report and review the groundwater monitoring program every two years with particular consideration to the comparison of modelled and observed data. The report shall be included as part of the Mining Management Plan and forwarded to Water Resources DNRETAS[1]. The report shall include as a minimum: monitoring data, data analysis and updates of model predictions of drawdown and recharge.

[1] Now Department of Environment, Parks and Water Security

Recommendation 24

If groundwater extraction impacts on other groundwater users, Minemakers (Avenira) shall provide another water supply by one or more of the following:

- *Deepening existing bores.*
- *Providing additional bores.*
- *Determining a new area suitable for groundwater extraction.*
- *Trucking adequate water supplies to affected parties.*
- *Piping adequate water from its bores to a location required by affected bore user.*

1.4 Objectives

This GWM has been developed to:

- Monitor groundwater quality and hydraulic heads in the immediate proximity of the planned areas of disturbance prior to, during and following mining operations.
- Adress the NT EPA Recommendations from Assessment Report 64.
- Prevent the degradation of groundwater quality due to mining-related activities for recipients downstream of the mine site.
- Monitor groundwater standing water level and quality.
- Assess toxicants against ANZG (2018) 95% species protection guideline values for freshwater.
- Monitor hydrocarbons.
- Regular monitoring of groundwater bores.

1.5 Scope

A risk assessment for the Project identified a number of groundwater related risks. All risks were ranked as Low, except for the risk of groundwater supply failure and unacceptable impacts upon the environment, which were rated as Moderate. The adequate mitigation of these risks can be achieved through effective control measures, including adequate monitoring, provision of sufficient redundancy in the groundwater supply and installation of additional suitably located bores if required.

1.6 Legislation and Guidelines

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- Australian Guidelines for Water Quality Monitoring & Reporting (ANZG 2018[2]).
- Australian Drinking Water Guidelines (NHMRC/ARMMC) (2011, updated August 2018).
- Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ, 2013).

[2] https://www.waterquality.gov.au/guidelines/anz-fresh-marine

2.0 Existing Environment

2.1 Climate

The project is located within the internally draining Barkly Surface Water Management Area (SWMA), immediately west of the Georgina River catchment. Although situated in a semiarid region with average annual rainfalls of between 300 and 400 mm, significant short duration rainfall events can and do occur, with daily rainfalls in excess of 200 mm having been recorded locally. The climate in this region is highly variable, both spatially and temporally, and this can make hydrologic analysis and the design of water management measures difficult.

Climatic conditions in the region characterised by well-defined wet and dry seasons, with nearly all rain falling between November and March and the greatest incidence during January and February. Light rains are sometimes received during the dry season, but the period between April and September is frequently rainless.

2.2 Aquifers and depth

The Project occurs within the central portion of the Georgina Basin and the Barkly Tablelands. The main aquifers on the Barkly Tableland comprises cavernous zones that are commonly weathered and fractured, within calcareous units of the Wonarah Formation and Camooweal Dolomite. Groundwater offers the only source of reliable water within the region and is recharged predominantly from rainfall infiltration.

Groundwater levels in the MLs are variable and range from around 3 m to 103 m below ground level. This variability in groundwater level suggests a heterogeneous groundwater system, with poor hydraulic connections between aquifers. Water-table levels are below the base of the ore across the deposits, with the exception of a few isolated locations that show evidence of minor or perched waterbodies.

Groundwater levels measured within the Main Zone and Arruwurra areas were generally below the base of the ore zones, apart from a few minor occurrences that are judged to be isolated.

2.3 Yield

Minor groundwater supplies were found within the vicinity of the Arruwurra deposit. Test pumping carried out show a modest aquifer transmissivity at the Arruwurra zone of about 15 m^2/d. The combined yield from the five short-term Arruwurra production bores is estimated at about 12.5 L/s, using standard methods. Good groundwater supplies were identified north of the Barkly Highway with maximum bore yields of about 20 L/s.

2.4 Groundwater Users

The main aquifers on the Barkly Tableland have been used to provide domestic and stock water across the tableland for nearly a century.

Ten existing boreholes lie within the vicinity of the MLs, all located along the Barkly Highway. Seven of these boreholes were installed by the Northern Territory Government for construction and maintenance of the highway. An additional six existing boreholes lie within a 10 km radius of the northern borefield, these bores were installed by Dalmore Downs Station for stock watering purposes.

2.5 Groundwater quality

Groundwater quality is fresh to brackish ranging from 500 to 4,000 mg/L total dissolved solids (TDS), with iron and silica detected in the bores north of the Barkly Highway and at Arruwurra. Boron was detected in the camp bore above the ANZG (2018) 95% species protection level. The camp bore groundwater will be treated prior to use as drinking water; therefore, boron will be removed during the reverse osmosis treatment process and will not be considered a contaminant of concern for environmental or human health.

Metals were generally below detection limits. pH ranged from neutral to slightly alkaline. Based on water quality sampling conducted in 2009, there are no key contaminants of concern as all analytes were below the ANZG (2018) 95% species protection level, with the exception of boron.

2.6 Groundwater contamination risks

Groundwater contamination risks from mining operations are normally associated with seepage from tailings storage facilities. However, the current investigation is associated with the first stage of the project development, which relates to the mining of a test pit sample requiring no processing beyond ore crushing and screening. The crushing only option removes the requirement for a processing plant and hence a tailings storage facility.

The risks of groundwater contamination are, therefore, associated with management of hazardous materials storage areas, e.g., chemicals and hydrocarbons, in particular rainfall runoff from these areas. The design of runoff control measures have been identified by Groundwater Resource Management (GRM) in the surface water management report for the Wonarah Project (GRM, 2009) and subsequently reviewed by an independent expert in the Erosion and Sediment Control Plan, located in Appendix K of the Bulk Test Sample MMP and Appendix M of the DSO MMP.

2.7 Drainage

No significant watercourses traverse the Project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit (**Figure 1**). All of the site drainage lines nearby to the Project are minor and ephemeral in nature and are likely to only carry runoff for short periods following significant rainfall events. Seasonally flooded swamps occur in the south-west of the Project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding.

Although a lack of surface water flow data exists for the project area, modelling of surface water flows in the Project area for a 100-year average recurrence interval (ARI) flood event was undertaken based on local meteorological and topographic conditions and catchment areas and using data from the Ranken and Georgina rivers and a potential flow rate of 480 m^3/s. Under these modelled flood conditions, the local drainage line of most concern to the Project, which flows in a north-westerly direction towards Arruwurra deposit, floods an area greater than 1 km in width. Contributing factors to such extensive flooding include the large upstream catchment area of the watercourse and the lack of a discernible channel.

2.8 Water management

The Project is located within the Daly Roper Beetaloo Water Control District and used for agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater.

2.9 Water uses

There are no major water storage, diversion or supply infrastructure or current surface water licences within the vicinity of the Project area. Any water use is for stock watering, with groundwater resources providing the main water source in the region.

2.10 Groundwater uses

It is estimated that 6 L/s, with a peak of 8 L/s will be required for construction of the bulk test sample and ancillary activities. Thus, greater than 5 ML/yr groundwater extraction is required to be sourced from the nearby Arruwurra bore field on ML33344 for dust suppression and raw water for office ablutions, and from the Wonarah Main Zone area, ML33343 for camp supply. Bore locations for potential use are shown on **Figure 2** and **Figure 3**.

A groundwater extraction licence will be applied for under the NT *Water Act* and approved prior to extraction of >5 ML/yr per ML.

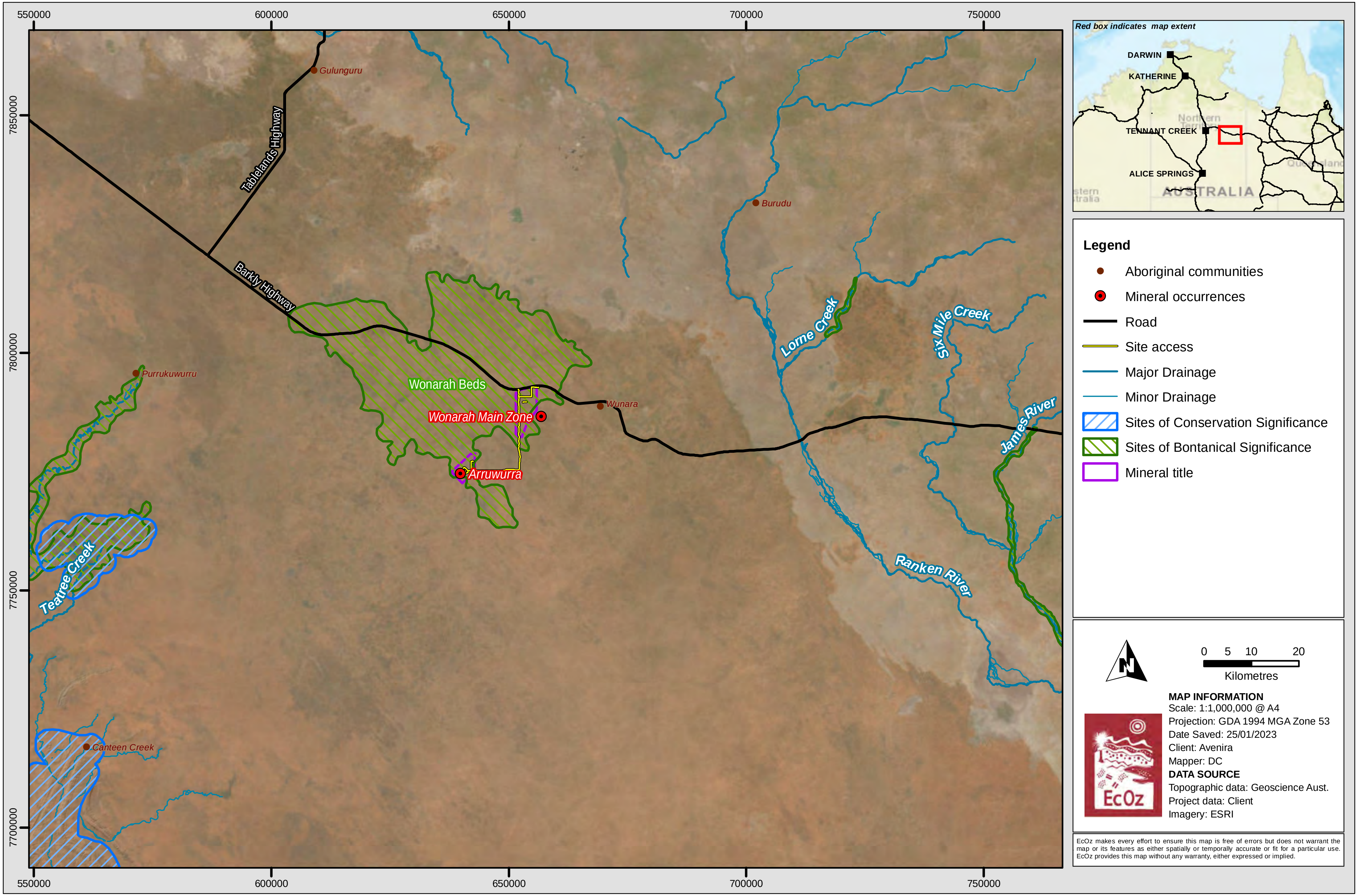
The Pit will be dewatered to enable the bulk test sample to be extracted. This water will also be used for dust suppression activities and raw water for temporary mobile ablutions in the interim.

2.11 Water supply and demand

Water requirements are expected to be 6-8 L/s for the bulk test sample stage 1.1 and ancillary activities. Water is required for dust suppression and potable/domestic use. Water from the pit sump and site bores will be used for dust suppression. Water from the camp bore will be used for potable/domestic use.

A groundwater extraction licence application will be completed for approval under the *Water Act* prior to extraction of groundwater.

A groundwater level survey carried out at Arruwurra show levels mostly lie below the base of the ore. Dewatering requirements are, therefore, likely to be negligible, possibly limited to localised sump pumping to manage short-term seepage inflows.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ22138 - Wonarah MMP\1. Project Files\2. Report Maps\EZ22273\Bioregions, waterways, SOBS and SOCS.mxd

Figure 1. Map of Project surrounding waterways, SOBS and SOCS

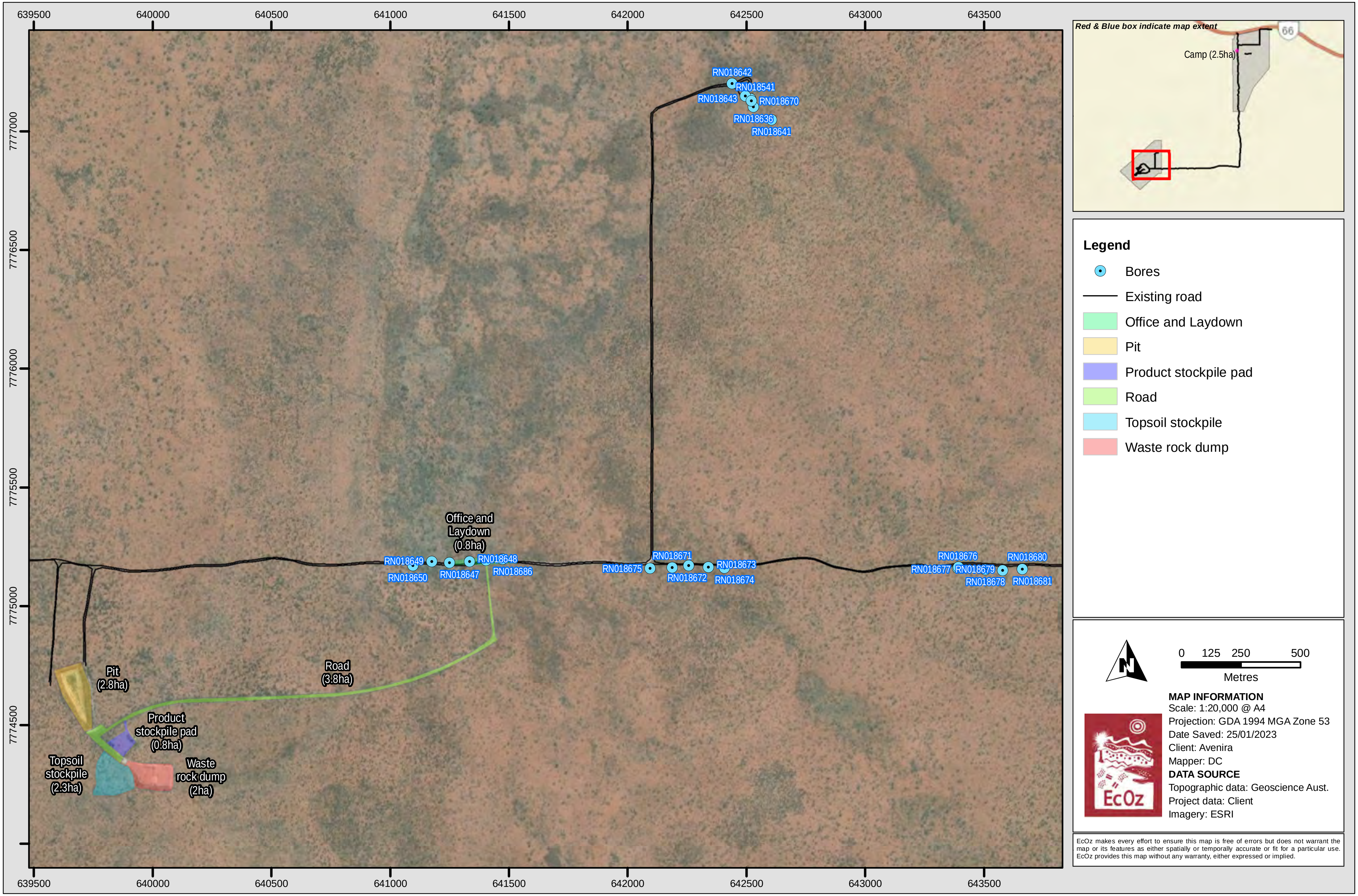


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Figure 2. Map of existing disturbances and bore locations at the Arruwurra deposit

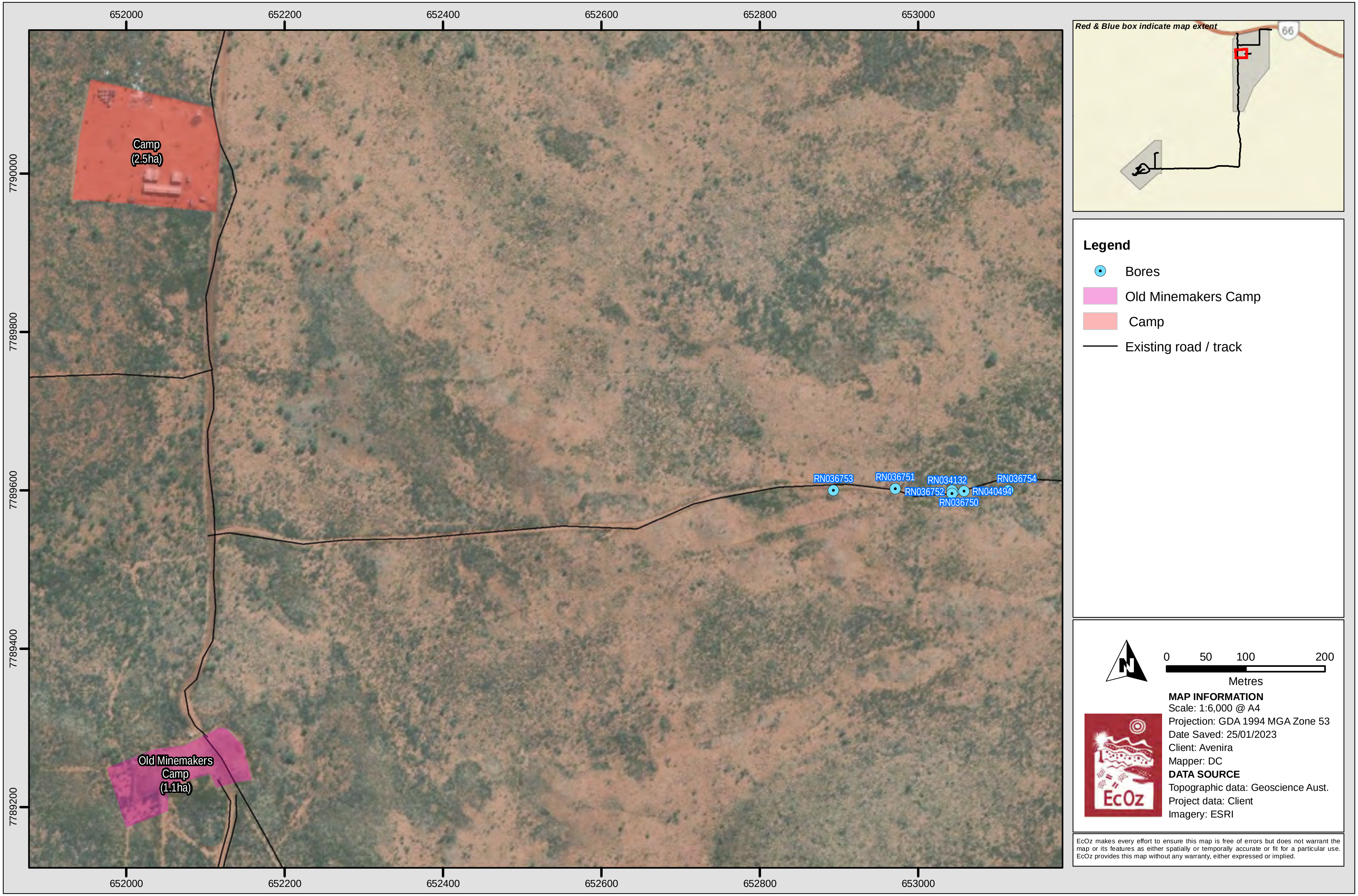

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Figure 3. Map of existing disturbance and bore locations at Wonarah Main Zone

3.0 Monitoring

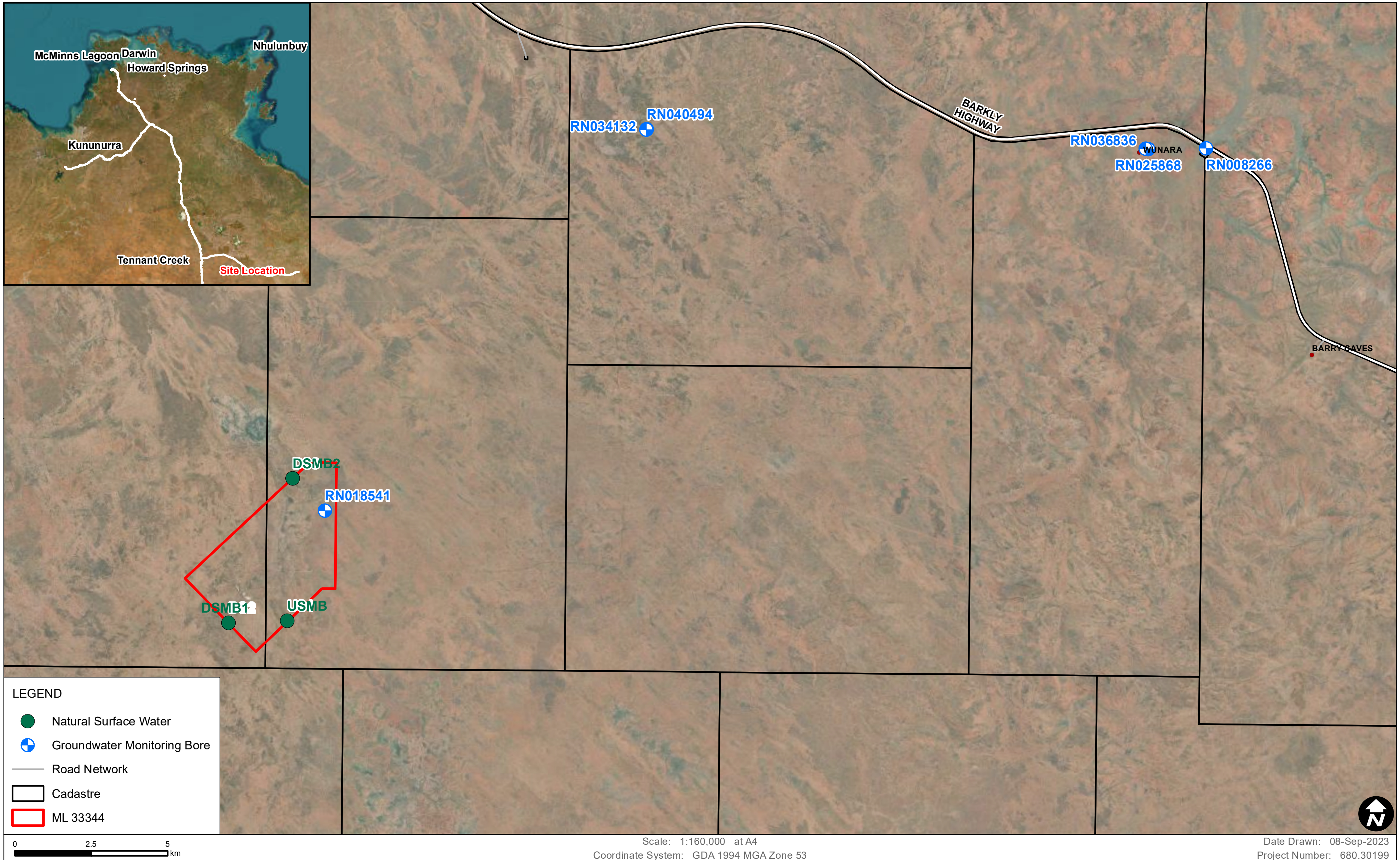
3.1 Groundwater Monitoring Bores

Four production bores and four monitoring bores will be monitored in this program. These sites were selected by GRM are the locations are further discussed in Appendix C of the Bulk Test Sample MMP. **Table 1** shows the bores and their purpose and **Figure 4** shows the location of the bores. Bore construction details are located in Appendix C of the Avenira Bulk Test Sample MMP.

Table 1 Monitoring Bore Locations

Bore ID	Purpose	Location (GDA 94 / MGA Zone 53)	
		Easting	Northing
RN040494	Production and monitoring	653051.858	7789606.778
RN018541	Production and monitoring	642514.274	7777139.657
RN025868	Production	669472.516	7788967.995
RN035836	Monitoring	669397.069	7788973.486
RN008266	Monitoring	671370.289	7788987.497
RN034132	Monitoring	653042.828	7789601.276
Upstream Monitoring Bore (USMB)	Monitoring	641280	7773530
Downstream Monitoring Bore 1 (DSMB1)	Monitoring	639360	7773460
Downstream Monitoring Bore 2 (DSMB2)	Monitoring	641460	7778190

The monitoring bores (USMB and DSMB) proposed to be located on the ML boundary will need to be ground truthed for access and depth of groundwater. Groundwater depth at the Arruwurra site has been estimated at 20 – 35 mbgl.



Scale: 1:160,000 at A4
Coordinate System: GDA 1994 MGA Zone 53

Date Drawn: 08-Sep-2023
Project Number: 680.30199

Data Source:
ESRI Basemaps

SLR

GROUNDWATER MONITORING LOCATIONS

FIGURE 4

H:\Projects-SLR\680-DRW\680-DRW\680.30199.00000 Wonarah MMP RFI\06 SLR Data\01 CADGIS\GIS\SLR68030199_Groundwater_Monitoring_Bores_04.mxd

3.2 Monitoring Frequency

Table 2 shows the frequency and monitoring parameters for the production and monitoring bores for the Wonarah Project area. The monitoring program shown in **Table 2** will be conducted prior to the commencement of mining in order to obtain baseline data and verify the bore network for use at the site.

Table 2 Monitoring Program

Bore ID	Parameter	Frequency	Parameter	Frequency
RN040494	Groundwater level depth (m)	Monthly	Water quality laboratory analysis: Ammonia, carbonate alkalinity, bicarbonate alkalinity, calcium, chloride, hardness, total alkalinity, fluoride, magnesium, nitrate, total nitrogen, dissolved organic carbon, TKN, total phosphorous, phosphate, potassium, sodium, sulphate, nitrite, TDS. Hydrocarbons (TRH, BTEXN) Total and filtered metals: aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, uranium, zinc	Pre-mining Biannually
RN018541		Monthly		
RN025868		Monthly		
RN035836		Monthly		
RN008266		Monthly		
RN034132		Monthly		
UPMB		Monthly		
DSMB1		Monthly		
DSMB2		Monthly		

3.3 Trigger levels and Trigger Action Response Plan

To identify mine impacts on the production and monitoring bores, trigger levels are assessed against a benchmark of the natural conditions. These natural conditions will be established through the monitoring program over the first 12 months of monitoring. At this stage, interim trigger values are proposed and are presented in **Table 3.**

Table 3 Proposed Interim Trigger Values

Parameter	Measure	Benchmark	Trigger Level
Groundwater level	Standing water level	Established baseline ± natural variation	20% decrease
Groundwater quality	Filtered metals pH	ANZG (2018) water quality guidelines	If baseline data is below ANZG (2018) water quality guidelines, then exceedances of three times the guideline or on three consecutive occasions triggers further investigation as discussed in **Table 4.**

A Trigger Action Response Plan (TARP) has been developed for providing directions on requirements if a significant upward trend in groundwater parameter results (including a downward trend for pH) is detected. **Table 4** shows the TARP for identified upward trends in groundwater results once sufficient data has been obtained.

Table 4 TARP for Groundwater

Trigger	Action	Response
An investigation is triggered if: Exceedances of three times the guideline or on three consecutive occasions if baseline data is below ANZG (2018) 95% species protection water quality guidelines. If baseline data is above ANZG (2018) 95% species protection water quality guidelines, exceedances will be deemed to occur when there is a non-significant upward trend ($r^2 > 0.5$) (or downward trend for pH) in dissolved metal concentrations and standing water levels using historical data at the sampling site (greater than 5 sample points are required for a trend analysis in ESDAT). Standing water levels are increasing or decreasing >20% from normal depth	On becoming aware of upward trend or exceedance, conduct further investigation of source of metals or low pH within the groundwater. Standing water levels decreasing 20% greater than normal variations for that bore.	• Initiate investigation. • Assess CoC, laboratory data and duplicate samples. Discuss results with laboratory. • Assess data against historical results. • Conduct additional sampling to confirm source of exceedance if required. • Confirm elevated analyte or changes in standing water levels are due to mine activities. Review monitoring program. Based on the outcome of the investigation a mitigation or management measure will be adopted to mitigate or prevent environmental impacts. Examples of what will be considered as part of this process have been provided in **Section 3.4.** Cease water extraction until standing water level returns to normal within variation for that bore.

3.4 Proposed Mitigation Measures

If a trigger value is exceeded the proposed investigation will provide guidance on the most appropriate mitigation or improvement measures to be taken. For groundwater this will include consideration of one or all of the following actions:

- Identify the source of the contamination. Manage source to prevent infiltration to groundwater.
- Conduct a risk assessment to determine the potential for impacts on environmental or human health.
- Manage contaminated groundwater to minimise contact with surface water and limit environmental exposure.
- Remediate groundwater if required.
- Cease water extraction if required.

4.0 Reporting

Avenira shall prepare a formal biennial report and review the groundwater monitoring program every two years with particular consideration to the comparison of modelled and observed data. The report shall be included as part of the MMP and forwarded to the Water Resources division of the Department of Environment, Parks and Water Security (DEPWS). The report shall include as a minimum: monitoring data, data analysis and updates of model predictions of drawdown and recharge.

5.0 Mitigation

If groundwater extraction is found to impact other groundwater users, Avenira shall provide another water supply by one or more of the following:

- Deepening existing bores.
- Providing additional bores.
- Determining a new area suitable for groundwater extraction.
- Trucking adequate water supplies to affected parties.
- Piping adequate water from its bores to a location required by affected bore user.

6.0 Review

The GMP will be reviewed and updated if required on a biennial basis.

Making Sustainability Happen

APPENDIX P ENVIRONMENTAL POLICY

ENVIRONMENTAL POLICY

Avenira Limited regards sound environmental management and protection as an integral part of its business and of playing its part in the community and is committed to excellence in this area of activity.

Minemakers aims to minimise environmental impacts at every stage of work from planning, exploration, development, mining, production and decommissioning.

To achieve this goal, the Company will:

- seek to identify, monitor and manage all environmental impacts arising from its operations;
- integrate environmental considerations into project planning and operations;
- develop, implement and enforce a comprehensive Environmental Management System;
- provide information and training to our workforce, contractors, suppliers and customers to provide a greater understanding of environmental issues and responsibilities in relation to our business;
- undertake consultation with appropriate community and government groups to ensure that community interests are addressed;
- comply with applicable laws, regulations and standards;
- monitor performance and provide safeguards and contingency plans for all activities to detect and prevent any potential impacts;
- review the Company's operations in the context of technological advances to seek improvements in production processes, waste management and the efficient use of resources.

As with all areas of its operations, Minemakers will be a responsible corporate citizen in respect to the environment. All employees and contractors are responsible for upholding the Company's standards of environmental management and care.

BRETT CLARK

Executive Chairman
21 March 2023

APPENDIX Q SURFACE WATER MANAGEMENT PLAN

Surface Water Management Plan

Wonarah DSO Phosphate MMP

Avenira Limited

13/6 Douro Rd
West Perth, WA 6005

Prepared by:

SLR Consulting Australia

Unit 5, 21 Parap Road, Parap NT 0820, Australia

SLR Project No.: 680.V13432

18 September 2023

Revision:1.0

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	18 September 2023	J. Woodworth	S. Buxton S. Harrison	J. Woodworth
0.1	4 September 2023	J. Woodworth	S. Buxton S. Harrison	
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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables in Text

Figures in Text

Acronyms and Abbreviations

AMD	Acid Mine Drainage or Acid and Metalliferous Drainage
ANZG	Australian and New Zealand Guidelines
APH	Lower grade Arruwurra Phosphate geological domain
ARI	average recurrence interval
BFD	Blind field duplicates
BPH	High-grade Basal Phosphate geological domain
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
DEPWS	Department of Environment, Parks and Water Security
DITT	Department of Industry, Tourism and Trade
DNRETAS	Department of Natural Resources, Environment, the Arts and Sport
DQI	Data quality indicators
DSO	Direct shipping ore
EC	Electrical conductivity
EIS	Environmental Impact Statement
EMS	Environmental Management System
ha	Hectare
km	Kilometre
MAW	Mine Affected Water
ML	Mineral Lease
ML	Mega Litre
MMP	Mining Management Plan
MWD	Mine Water Dam
MWRD	Mine Water Release Dam
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
OV	Operating volume
QA / QC	Quality assurance / quality control
ROM	Run of Mine
RPD	Relative percent difference
SD	Sediment Dam
SWMA	Surface Water Management Area
SWMP	Surface water monitoring plan
TARP	Trigger Action Response Plan
TRH	Total Recoverable Hydrocarbons
TSF	Tailings Storage Facility
WDL	Waste discharge licence

WMS	Water Management System
WRD	Waste Rock Dump
WRM	Water Resource Management

1.0 Introduction

1.1 Background

Avenira Limited (Avenira) propose to develop the Wonarah DSO Phosphate Project (the Project) for a large-scale direct shipping ore (DSO). The Project is located approximately 240 km east of Tennant Creek and approximately 26 km directly south of the Barkly Highway, Northern Territory (NT). This Project targets the Arruwurra deposit on the current Mineral Lease (ML) application ML33344.

This Surface Water Monitoring Plan (SWMP) forms part of the Environmental Management System (EMS) for Avenira's Wonarah DSO Phosphate Project and is considered a working document. This Plan will be updated following formal assessment by the Department of Industry, Tourism and Trade (DITT) as part of the mining authorisation process if required.

1.2 Purpose

This Surface Water Management Plan (SWMP) is required for Avenira to proceed to an operational phase at the Arruwurra Phosphate DSO site as water management is an integral part of managing the mine site and its interaction with the surrounding environment. This SWMP has been developed to provide effective water management strategies and activities that will be undertaken for the site. The intention of the SWMP is to support the activities of the Wonarah DSO Phosphate Mine Management Plan (MMP). Annual updates to the SWMP will be required to reflect any changes in management policy, regulatory requirements (e.g. the application of a Waste Discharge Licence (WDL)) and site conditions that may have occur in the previous year.

1.3 NT EPA Recommendations

The following recommendations relating to surface water management were made by the NT EPA after review of the Wonarah DSO Project EIS submitted in 2010 and listed in Assessment Report 64.

Recommendation 25

Minemakers (Avenira) shall investigate opportunities to maximise the efficient use of water on site including reusing treated effluent; minimising sources of dust generation to reduce requirements for dust suppression; and using any stored water in pits as a seasonal supplement. Proposed measures are to be included in the Mining Management Plan for the Project.

Recommendation 26

Minemakers (Avenira) shall report to the Department of Resources all incidents of overtopping of sediment ponds and release of water.

Water quality of discharge water shall be monitored, and reported. Discharges from water holding structures travelling off the Mining Lease may potentially require a waste discharge licence, and must be reported to Environmental Operations section of DNRETAS[1], and to the Department of Resources[2].

1.4 Commitments

1. Avenira commit to maintaining surface water quality and will include details of the surface water monitoring program and reporting for the Project.
2. Avenira commit to ongoing evaluation of surface water quality and downstream ecosystem protection.
3. To address Recommendation 25, Avenira commit to efficient use (and reuse where possible) of water for site activities.
4. To address Recommendation 26, Avenira commit to reporting overtopping of any mine infrastructure to meet the reporting requirements under Section 29 of the *Mining Management Act 2001*.

1.5 Scope

A risk assessment for the Project identified three surface water related risks.

1. Reduced surface water quality due to erosion and sedimentation and increased turbidity
2. Reduced surface water quality due to contamination
3. Alteration to surface water flows due to construction of infrastructure for the mine and mining-related alteration of the landform

All risks were ranked as Low and will be managed under this Surface Water Management Plan and the following Environmental Management Plans:

- Hazardous Substances Management Plan (DSO MMP Appendix C)
- AMD and WRD Management Plan (DSO MMP Appendix E)
- Dust and Air Quality Management Plan (DSO MMP Appendix H)
- Environmental Incident Response Plan (DSO Appendix L)
- Erosion and Sediment Control Plan (DSO Appendix M)

1.6 Legislation and Guidelines

The SWMP has been developed with reference to DITT, Northern Territory Environmental Protection Authority (NT EPA), Department of Environment, Parks and Water Security (DEPWS) and the Australian and New Zealand Governments (ANZG 2018) guidelines including:

[1] Now Department of Environment, Parks and Water Security (DEPWS)

[2] Now Department of Industry, Tourism and Trade (DITT)

- Template for the Preparation of a Mining Management Plan. NT Mining Management Act. (Department of Mines and Energy, Northern Territory Government)[3]
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)[4]
- Australian Guidelines for Water Quality Monitoring & Reporting (ANZG 2018)[4]
- Australian Drinking Water Guidelines (NHMRC/ARMMC) (2011, updated August 2018)
- Assessing and Managing Water Quality in Temporary Waters (ANZG 2020)[4]
- Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ, 2013).
- Australian/New Zealand Standard, Water Quality – Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples. AS/NZS 5667.1, 1998
- Australian/New Zealand Standard, Water Quality – Sampling Part 4: Guidance on sampling from lakes, natural and man-made. AS/NZS 5667.4, 1998; and
- Australian/New Zealand Standard, Water Quality – Sampling Part 6: Guidance on sampling from rivers and streams.AS/NZS 5667.6, 1998.

[3] https://nt.gov.au/industry/mining/applications-and-processes/mining-authorisation/develop-a-mining-management-plan

[4] https://www.waterquality.gov.au/guidelines/anz-fresh-marine

2.0 Existing Environment

2.1 Climate

The project is located within the internally draining Barkly Surface Water Management Area (SWMA), immediately west of the Georgina River catchment. Although situated in a semiarid region with average annual rainfalls of between 300 and 400 mm, significant short duration rainfall events can and do occur, with daily rainfalls in excess of 200 mm having been recorded locally. The climate in this region is highly variable, both spatially and temporally, and this can make hydrologic analysis and the design of water management measures difficult.

Climatic conditions in the region characterised by well-defined wet and dry seasons, with nearly all rain falling between November and March and the greatest incidence during January and February. Light rains are sometimes received during the dry season, but the period between April and September is frequently rainless (**Figure 1**).

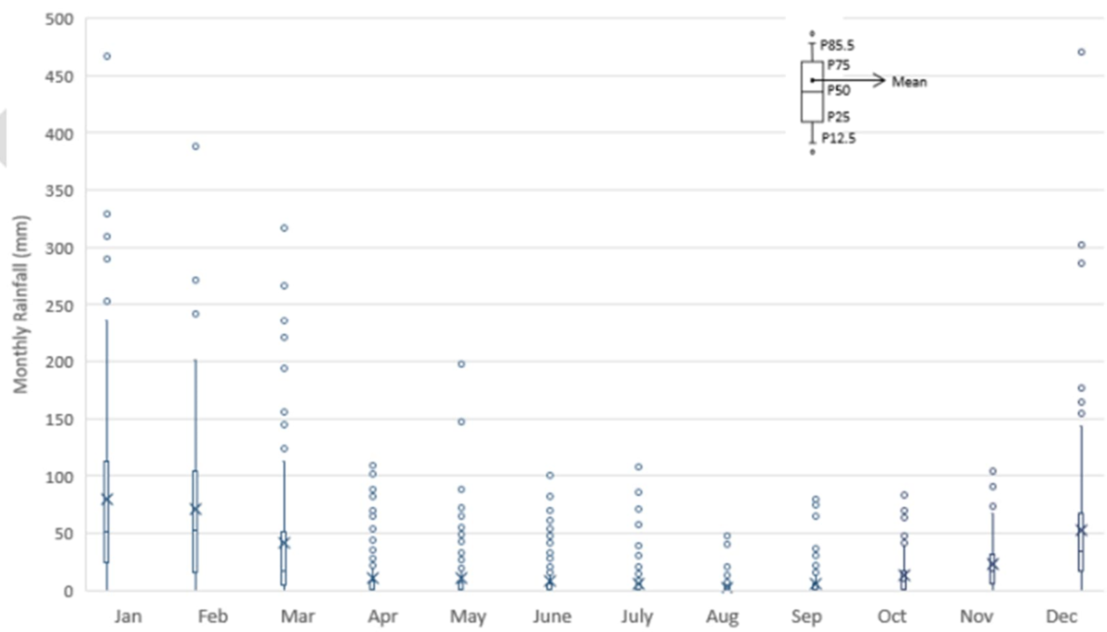

Figure 1 Long term Monthly Rainfall from SILO (WRM 2023)

2.2 Water courses

No significant watercourses traverse the Project area, with the closest significant watercourse being the ephemeral Ranken River about 80 km to the east of the Arruwurra deposit (**Figure 2**). All of the site drainage lines nearby to the Project are minor and ephemeral in nature and are likely to only carry runoff for short periods following significant rainfall events. Seasonally flooded swamps occur in the south-west of the Project site, around Arruwurra. Occasionally, flows will be significant enough to cause flooding.

The region surrounding the Arruwurra site is characterised by generally flat topography with slopes generally less than 5% and poorly defined drainage paths. **Figure 3** shows the surface water drainage network surrounding the Arruwurra Project area. The mine Arruwurra site is located near the bottom of a hillslope adjacent to a large area of flat topography. Runoff from the surrounding hillslopes drains to the flat area near the mine site where water would pond during runoff events, forming large, shallow lakes. Water ponding in this area can potentially drain in two directions:

- Northwards between two areas of higher topography; or
- South-west across flat land.

Indicative directions of surface flow are shown in **Figure 3**. Local catchments and flow directions near the Arruwurra mine site are shown in **Figure 4**.

Although a lack of surface water flow data exists for the project area, modelling of surface water flows in the Project area for a 100-year average recurrence interval (ARI) flood event was undertaken based on local meteorological and topographic conditions and catchment areas and using data from the Ranken and Georgina rivers and a potential flow rate of 480 m^3/s. Under these modelled flood conditions, the local drainage line of most concern to the Project, which flows in a north-westerly direction towards Arruwurra deposit, floods an area greater than 1 km in width. Contributing factors to such extensive flooding include the large upstream catchment area of the watercourse and the lack of a discernible channel.

2.3 Surface Water Contamination Risks

Surface water contamination risks from mining operations are normally associated with seepage from tailings storage facilities (TSF) and waste rock dumps (WRD). Mining at the Arruwurra site involves ore crushing and screening. The crushing only option removes the requirement for a processing plant and hence a tailings storage facility, thus eliminating one source of mine affected water (MAW). However, without mitigation, rainwater runoff from the WRD does have potential for MAW to enter waterways. Generally, MAW are characterised by low pH, high electrical conductivity (EC) and elevated metal concentrations. However, the geochemistry study conducted on the waste rock by Environmental Geochemistry International (2009) showed that the leachate of the waste rock samples contained low concentrations of calcium, sodium, sulfate and chloride resulting in low electrical conductivity ranging between 92 µS/cm and 146 µS/cm. The pH values ranged between 7.2-7.8 with subsequent low metal concentrations at or below detection limits.

All samples tested were classified as non-acid forming (NAF)

Mitigation for these risks to reduce the potential for MAW to enter the environment are located in the AMD and WRD Management Plan (DSO MMP Appendix E) and the Erosion and Sediment Control Plan (DSO MMP Appendix M).

Limited hazardous substances will be used on site and there may be potential for adverse environmental impacts if an uncontained spill occurs on site and the chemical has potential to enter the environment. The Hazardous Substances Management Plan (DSO MMP Appendix C) provides mitigation measures to reduce this risk.

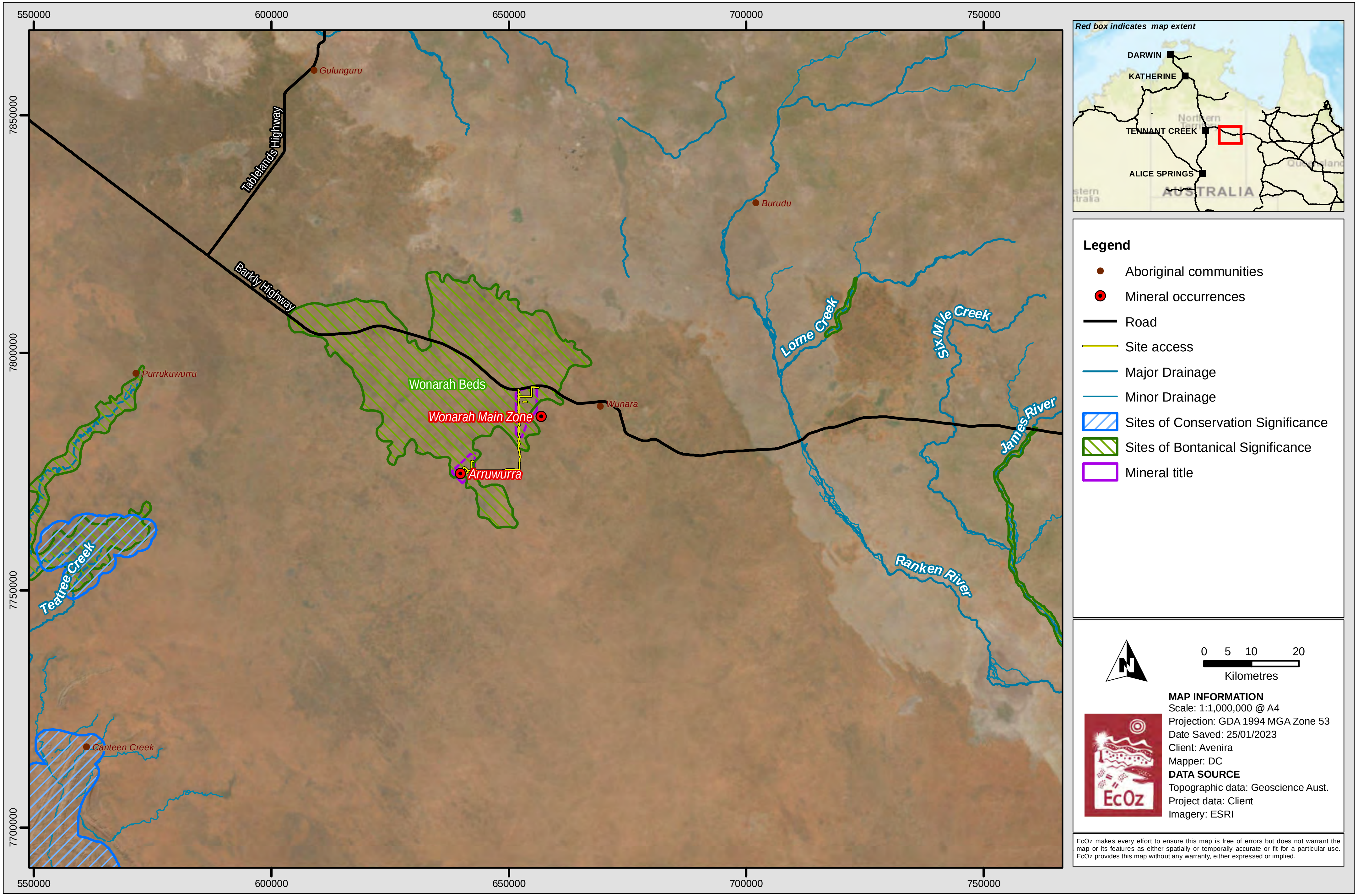

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Figure 2. Map of Project surrounding waterways, SOBS and SOCS

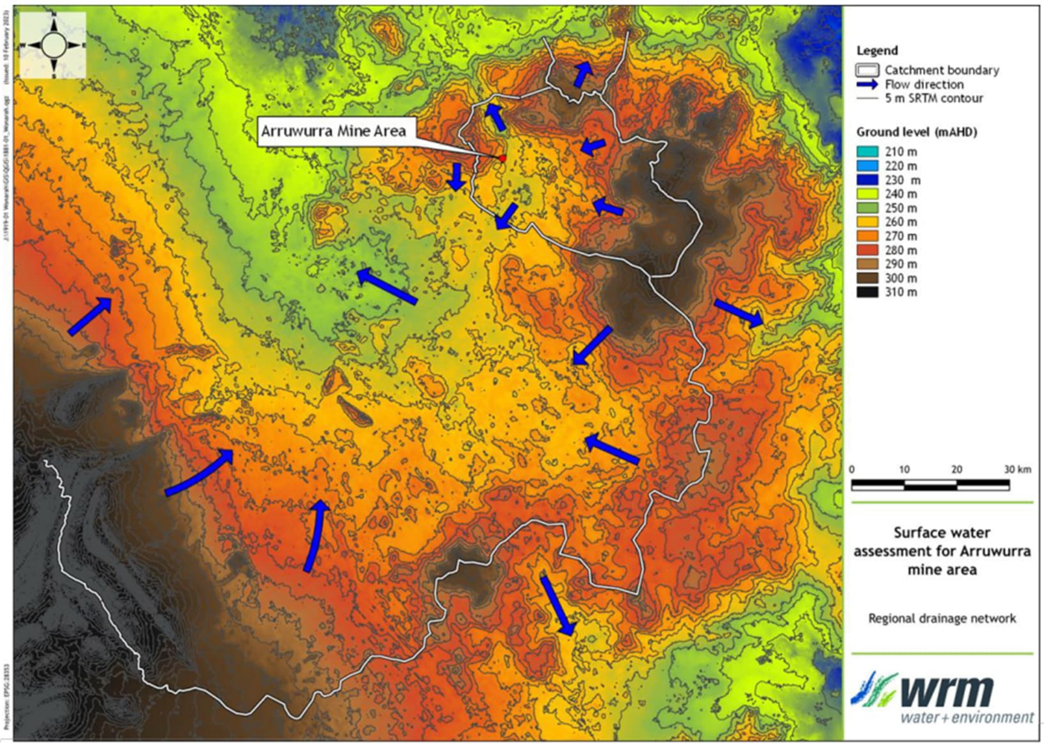


Figure 3 Regional Drainage Network (WRM 2023)

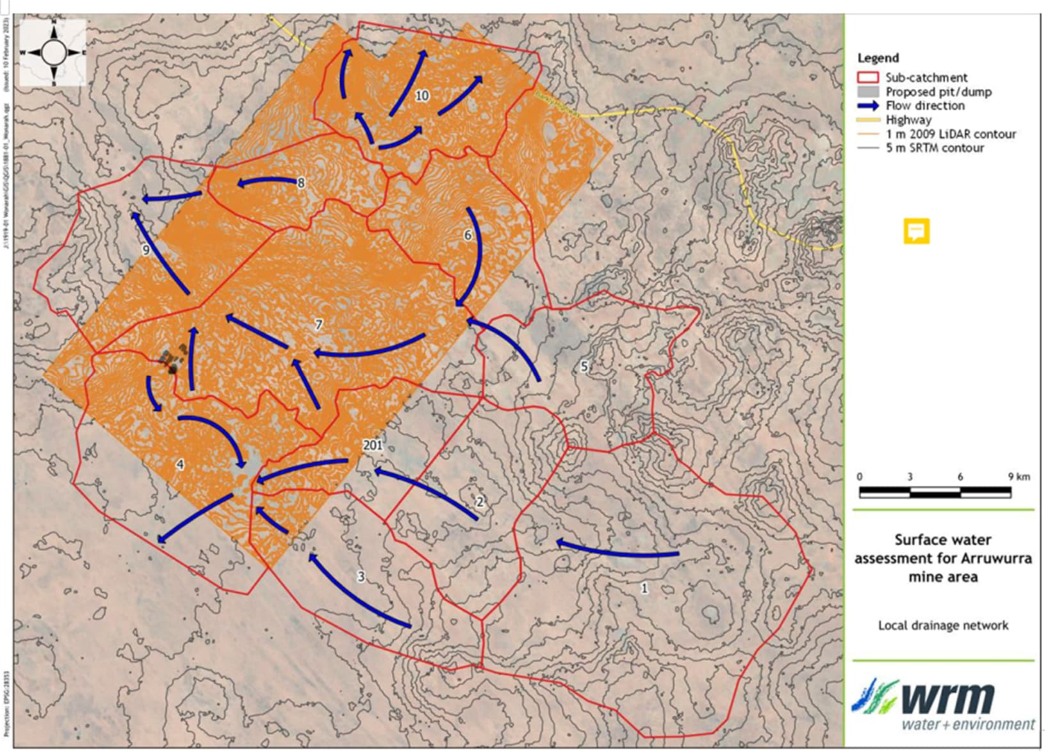


Figure 4 Local Topography and Drainage Directions (WRM 2023)

3.0 Water Management

The Project is located within the Daly Roper Beetaloo Water Control District where surface water and groundwater are used for agriculture, aquaculture, public water supply, cultural, industry, rural stock and domestic, mining activity and petroleum activity for all surface water and groundwater.

There are no major water storage, diversion or supply infrastructure or current surface water licences within the vicinity of the Project area. Any water use is for stock watering, with groundwater resources providing the main water source in the region.

3.1 Pit Dewatering

The existing Pit will be dewatered prior to bulk test sample extraction. The pit water will be transferred to an 8 ML turkey's nest located on the existing ROM Pad next to the WRD. This water will be used for dust suppression activities during the Bulk Test Sample mining and DSO production at Arruwurra. The turkey's nest will be a temporary structure as the mine water dams will take over site water storage activities.

3.2 Water Management Strategy

Avenira's water management strategy is to prevent MAW from entering the environment and to utilise all site water in mining activities mainly for dust suppression. Water will be transferred from pits and dams to meet site demands, prevent water accumulating in pits and prevent discharge to the environment.

The proposed site water management strategy is summarised as follows:

- If required, pits will be dewatered to the Mine Water Dams and the water used for no-site dust suppression. If this is not possible, the water will be held in the pit (up to 40 ML).
- Non-active pits would be prioritised to receive water from the active pit if the Mine Water Dams are near capacity.
- If the active pit water is above 40 ML and the above strategies are not possible, pits will be dewatered to the Mine Water Release Dam for controlled release to the environment (following Waste Discharge Licence (WDL) requirements).

Water required for site demands would be sourced from the water storage facilities, in the following order of priority (based on proximity):

1. Mine Water Dams
2. Sediment Dams
3. Mine Pits
4. Raw Water Tanks

The surface water management system will be operated to contain mine water on the site under most climatic conditions. However, the mine water management system includes a release point from the Mine Water Release Dam (MWRD) to the receiving environment, which may be required if unusually wet climatic conditions are experienced during the mine life. **Table 1** shows a summary of proposed transfer of water around the site during mining.

Table 1 Water Operations Summary

Infrastructure	Operations
'External' bore water	Supplies to Raw Water Tanks as required or direct to site demands at a maximum rate of up to 1.35 ML/d
Dust suppression	Supplied from mine water dams (First priority), sediment dams (Second priority), raw water tanks (Lowest priority)
Miscellaneous (i.e. industrial and infrastructure demands)	Supplied from mine water dams (First priority), sediment dams (Second priority), Pits (Third priority) and raw water tanks (Lowest priority)
Open cut pits	Receives surface water inflow
	Receives groundwater inflows (negligible).
	Dewaters to MWD2 and MWD3 at up to 4 ML/d if dam volume is below Max OV.
	Dewaters to MWRD at 8 ML/d if pit volume is above 40 ML.
Raw water tanks	Supplies dust suppression demand and miscellaneous demands.
	Receives external water from bores
Mine water dam 1 (MWD1)	Supplies dust suppression demand and miscellaneous demands.
	Receives runoff from crusher area
	If water level is above Max OV and MWD2 and MWD3 dam water level is below its Max OV, pumps to MWD2 and MWD3.
	Pumps to MWD2 at 8 ML/d if all MWDs are above their Max OV.
Mine water dam 2 (MWD2)	Supplies dust suppression demand and miscellaneous demands.
	Receives runoff from Stockpile 1 (BPH stockpile)
	Receives pumped water from mine pits if water level is below Max OV.
	Receives pumped water from MWRD if water level is below Max OV
	If water level is above Max OV and MWD1 or MWD3 water level is below its Max OV, pumps to MWD2 or MWD3.
	Overflows to Pit 1.
Mine water dam 3 (MWD3)	Supplies dust suppression demand and miscellaneous demands.
	Receives runoff from Stockpile 2 (APH Stockpile)
	Receives pumped water from mine pits if water level is below Max OV.
	If water level is above Max OV and MWD1 and MWD2 dam water level is below its Max OV, pumps to MWD2 and MWD2.
	Pumps to MWD2 at 8ML/d if all MWDs are above their Critical Volume.
Mine water release dam	Receives pumped water from mining pits at 8 ML/d when pit water level is above 40 ML and MWD1, 2 and 3 are above Max OV.
MWRD	Pumps to MWD when water level is above 0ML and MWD2 water level is below Max OV.
	Supplies dust suppression demand and miscellaneous demands.
	Overflows to Receiving Waters
Sediment dam 1	Receives runoff from WRD 1
SD1	When the MWD2 stored volume is below Max OV, transfers to Raw Water Tank at up to 2 ML/day

Infrastructure	Operations
Sediment dam 2 **SD2**	Receives runoff from WRD 1 When the MWD2 stored volume is below Max OV, transfers to Raw Water Tank at up to 2 ML/day
Sediment dam 3 **SD3**	Receives runoff from WRD 2 When the MWD2 stored volume is below Max OV, transfers to Raw Water Tank at up to 2 ML/day
Sediment dam 4 **SD4**	Receives runoff from WRD 2 When the MWD2 stored volume is below Max OV, transfers to Raw Water Tank at up to 2 ML/day
Max OV = Maximum operating volume	

Four (4) mine water dams are proposed on site which are listed in **Table 1** and shown in **Figure 6**. MWD1, MWD2 and MWD3 will collect runoff water from BPH stockpile, APH stockpile and the crusher area. An additional turkey's nest mine water dam (MWRD) will be used to provide additional wet weather storage capacity.

Mine water dams were sized to limit pit inundation to 10%ile (wet) conditions, based on the operations shown in **Table 1**. **Table 2** shows the water infrastructure volumes for the site.

Table 2 Water Infrastructure Storage

Infrastructure	Catchment area (ha)	Dam Surface Area (ha)	Volume (max OV) (ML)
SD1	27.8	0.28	5.1
SD2	33.3	0.30	5.5
SD3	6.4	0.09	1.1
SD4	3.0	0.07	0.5
MWD1	11.7		30 (25)
MWD2	14.3		30 (28)
MWD3	11.7		30 (18)
MWRD	0.8		20 (-)
Pit Storage Capacity at the end of each stage			
	Stage 1 (ML)	Stage 2 (ML)	Stage 3 (ML)
Pit 1	1,688	2,761	2,694
Pit 2	0	2,071	2,071
Pit 3	0	597	0
Pit 4	0	610	610
Pit 5	0	475	475

Table 3 Dust Suppression Demand (WRM 2023)

Mine stage	Haul Road Length (km)	Haul Road Area (ha)	Average Demand (ML/yr)
Stage 1	35.3	10.6	86
Stage 2	41.2	12.4	100
Stage 3	43.9	13.2	107

Table 4 Estimated Daily Operational Water Demands

Operation	Forecast Demand (ML/d)		
	Stage 1	**Stage 2**	**Stage 3**
Haul road dust suppression	0.2	0.3	0.3
Crusher and miscellaneous	0.2	0.2	0.2
Ore processing	0	0	0
Total	0.4	0.5	0.5

The proposed mine water dams can contain mine affected water up to 10%ile wet climatic conditions (ie. 1 in 10 year rainfall event), without risk of pit inundation. Among these, MWD1 and MWD3 have no risk of spill. MWD2 spills to Pit1 and the expected spill volume ranges from 15-21 ML in the 10%ile wet climatic conditions scenario. MWRD is operated to have controlled releases to the environment under extreme rainfall conditions. For other scenarios, the following outcomes are expected:

- For median or drier conditions, all mine water dams are expected to be mostly empty during the life of mine.
- For 10%ile wet conditions all mine water dams are empty during the dry season and will reach their maximum operational limit during these wet seasons. Controlled releases are not required for these conditions. MWD2 spills to Pit 1 at times but there is no risk of pit inundation.
- For 1%ile wet conditions (ie. 1 in 100 year rainfall event), all mine water dams are above maxOV in the wet season. MWD1 and MWD3 will require pumping to MWD2 to avoid a spill risk as runoff from the APH stockpile and crusher area can cause these dams to reach critical volume. MWD2 will spill to Pit 1 more frequently. Water will be pumped from pits to MWRD and controlled releases will be required to avoid pit inundation.
- During dry seasons, the dams are predicted to be empty in year 1 and always contain some amount of water in year 2.

3.3 Controlled Release

A controlled release of mine water may be required if all water storage infrastructure is at maximum capacity.

A 20 ML mine water release dam (MWRD) has been adopted to collect mine water and release off site once all other mine water storages are above their Max OV and pit water volume reaches 40 ML. It was assumed that Pit 1 is dewatered to the MWRD at 8 ML/d. Pits 2 to 5 are dewatered to MWRD at 4 ML/d. Releases from MWRD are discharged to the topographical depression within the Mine Lease and west of the AWA (see **Figure 5 – Figure 6**). The topographical depression also receives runoff from a large catchment (1,061 ha) north of the mine that is diverted by the proposed western diversion drain, as well as additional catchment to the south-west.

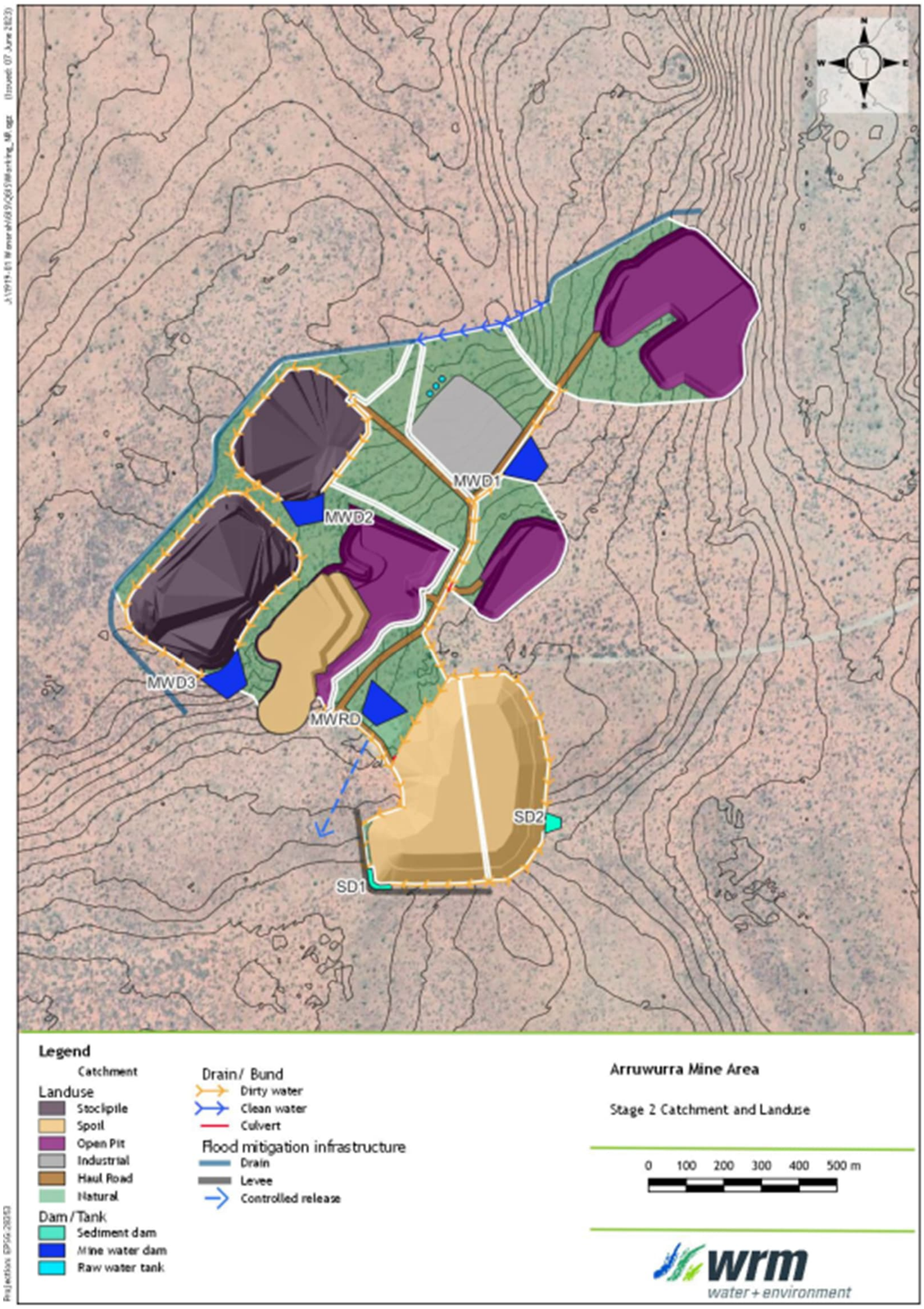


Figure 5 DSO Mine Plan Pit 1, Pit 2 and Pit 3(WRM 2023)

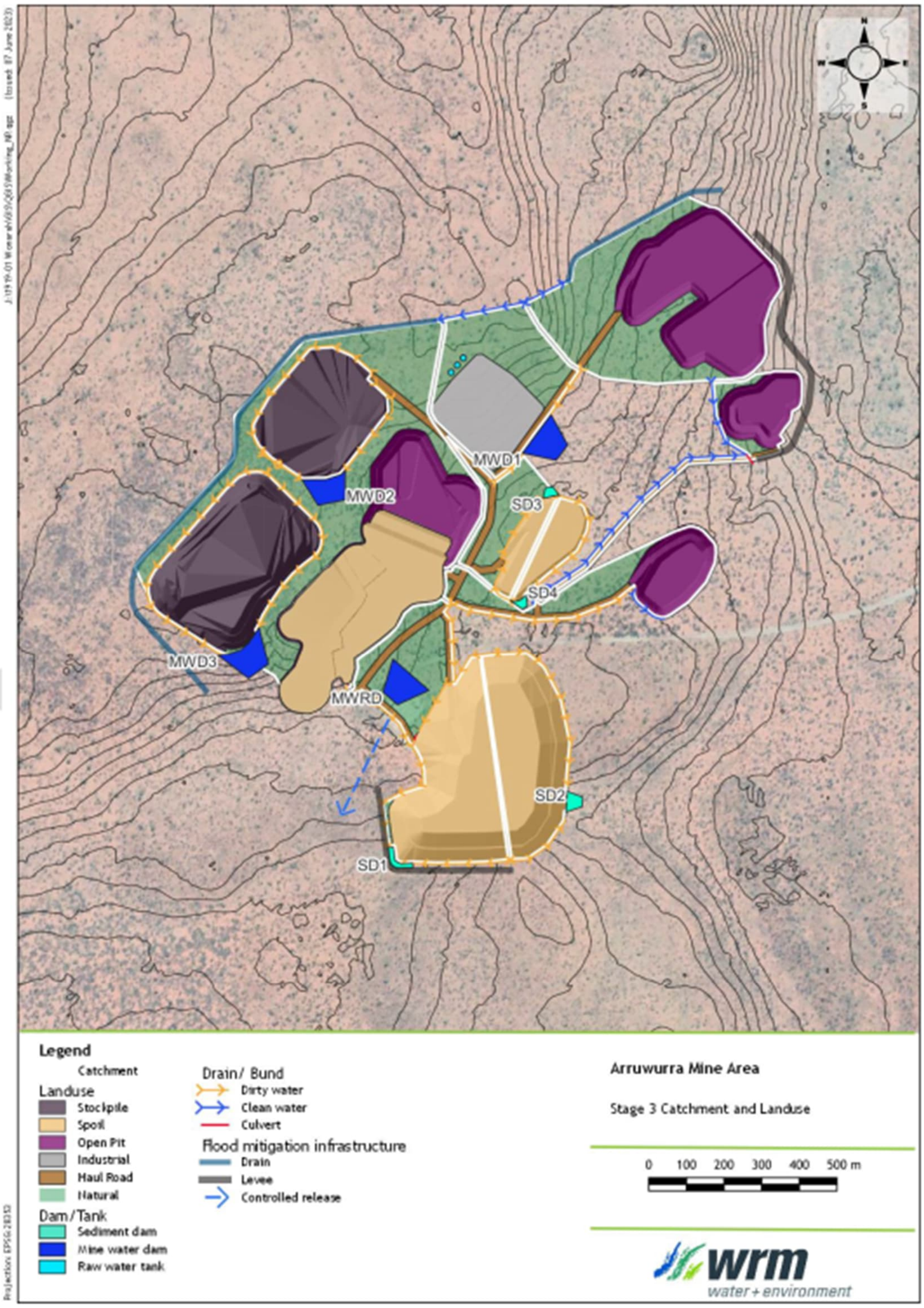


Figure 6 DSO Mine Plan Pit 1, Pit 2, Pit 3 and Pit 4(WRM 2023)

4.0 Water Balance

Figure 7 shows the conceptual water circuit schematic for the project water management system (WMS). In addition to the linkages shown in **Figure 7**, each storage will also receive inflows from catchment runoff and losses to evaporation. The schematic assumes no process water usage on site, apart from dust suppression.

The Water Balance will be updated to assess the volume of water at the end of the wet season to determine the amount of water available for dust suppression and other miscellaneous demands during the following dry season. This will assist Avenira to determine potential requirements for additional water for the dry season.

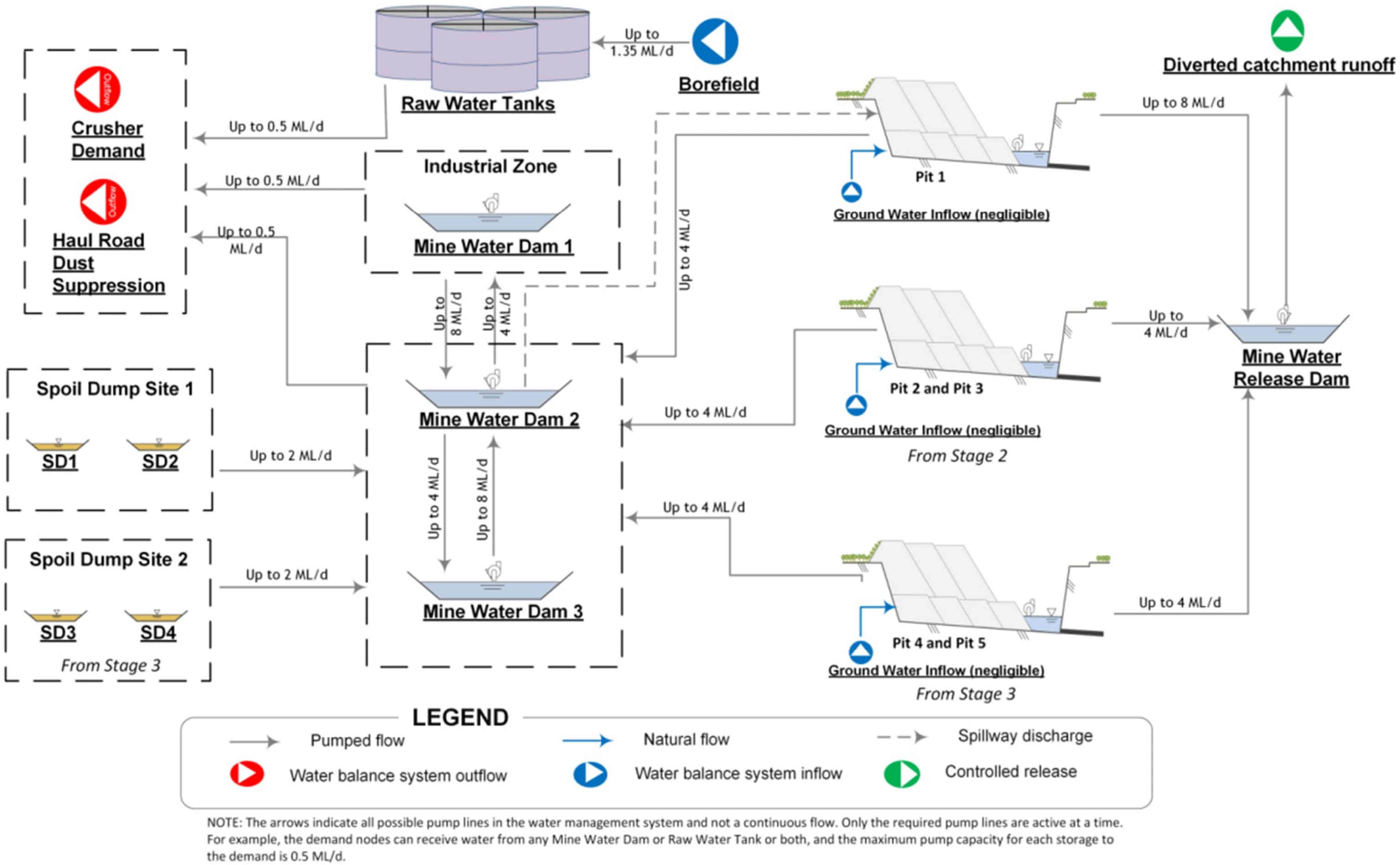


Figure 7 Site Water Balance

5.0 Monitoring

The surface water monitoring program to be conducted during mining is detailed below and is in accordance with the appropriate Quality Assurance and Quality Control Procedures based on relevant Australian Standards. Regulatory requirements are the primary drivers behind the annual routine water related monitoring programs, with additional monitoring programs implemented by Avenira for investigation and information gathering purposes, if required.

As the water management infrastructure is expected to be dry for the majority of mining life and there are no waterways on site, monitoring on a routine basis will not be able to be undertaken. Therefore, the monitoring program developed for the Arruwurra site will only be able to be implemented for wet weather events and when the mine water dams contain water that is at maximum operation volume (as per **Table 1**) and required to be pumped to the mine water release dam (MWRD) for potential release to the environment. The sites sampled will vary throughout the year as water levels and accessibility change and as operational (or legislative) requirements dictate.

Releases from MWRD are discharged to the topographical depression within the Mine Lease and west of the mine site and will merge with the catchment runoff in the area as there are no defined waterways in the areas.

5.1 Monitoring Locations

Details of the water quality monitoring locations are shown in **Table 5** and **Figure 8**Figure 8. As discussed above the site will be dry for the majority of the mine life and routine monitoring will not be able to be conducted. Accessibility to the downstream sites is unknown at this stage as flood water may be up to 1m deep across a large area as there are no defined waterways (See WRM Surface Water Assessment 2023). Safe access to the sites downstream of the MWRD release point will be assessed during the 2023/24 wet season.

The water monitoring locations in Table 5 and Figure 8 are indicative at present based on the following:

The surface water monitoring locations are indicative only and subject to the construction of each structure and access points.

The natural surface water monitoring locations are indicative and subject to confirmation with site GPS of flow paths.

Some natural surface water monitoring points may not be accessible due to ponded water within low points. Where this occurs, the sample point would be taken from the edge of the pond ponded waterbody.

An upstream and downstream natural surface water point has been included on eastern side of the disturbance area. Significant tributary catchment flows enter the mine lease from the east between the upstream and downstream monitoring locations. If it is found that there is a significant difference in water quality between upstream and downstream monitoring locations, additional monitoring points (see blue points in **Figure 8**) may be required on these eastern tributaries to determine if it is due to non-mine derived sources.

Table 5 Surface Water Monitoring Locations

Location	Description	Easting	Northing
MWD1	Mine water dam 1	640255	7775135
MWD2	Mine water dam 2	639670	7775010
MWD3	Mine water dam 3	639460	7774565
MWRD	Mine water release dam	639870	7774490
EOP	End of pipe	639720	7774080
Natural Surface Water			
US1	South-east upstream point	641280	7773530
DS1	Downstream after merging with clean water diversion	639535	7773745
DS2	Edge of Mineral Lease south of discharge point	639360	7773460
DS3	North-east downstream point	641460	7778190

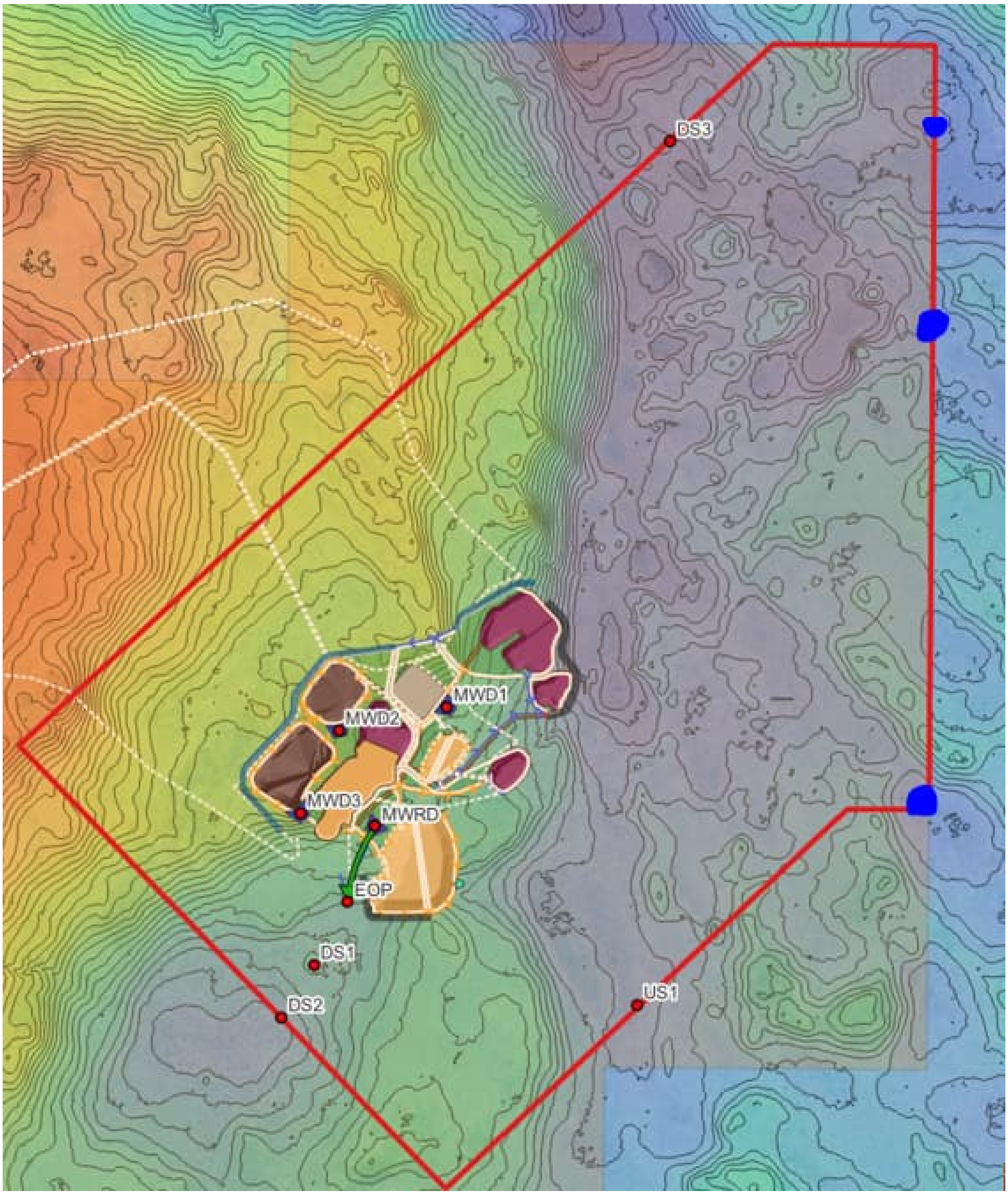


Figure 8 Surface Water Monitoring Locations (WRM)

5.2 Physical and Chemical Parameters

Table 6 Table 6 shows the water quality parameters for the Arruwurra water quality monitoring sites.

Table 6 Surface Water Analytes

Physico-chemical			
Temperature	pH	Electrical conductivity	Dissolved oxygen
Major Ions (mg/L)			
Ammonia as N	Bicarbonate Alkalinity as $CaCO_3$	Calcium	Carbonate Alkalinity as $CaCO_3$
Chloride	Hardness	Magnesium	Nitrite
Nitrate	Potassium	Sodium	Total nitrogen
Total phosphorous	Sulfate	Total suspended solids	Total dissolved solids
Total alkalinity	Dissolved organic carbon	Total Kjeldahl nitrogen	Phosphate
Fluoride			
Metals (Total and 0.45 micron filtered) (µg/L)			
Aluminium	Arsenic	Barium	Beryllium
Boron	Cadmium	Chromium	Cobalt
Copper	Iron	Lead	Manganese
Nickel	Zinc		
Hydrocarbons			
TRH (C10 – C36)	BTEXN		

5.3 Monitoring Frequency

As discussed previously, there are no waterways at the Arruwurra mine site, therefore, applying routine monitoring frequencies to the program will not be possible. **Table 7** shows the frequency proposed for water quality monitoring across the Arruwurra mine site.

Table 7 Monitoring Frequency

Location	Description	Frequency	Comments
MWD1	Mine water dam 1	Monthly	Sample only when dams reach 50% Max OV Do not sample when dams are drying (ie volumes decreasing)
MWD2	Mine water dam 2		
MWD3	Mine water dam 3		
MWRD	Mine water release dam	Monthly	Sample only when dam reaches 50% Max OV Do not sample when dam is drying
		Daily	During discharge
EOP	End of pipe	Daily	During discharge
US1	South-east upstream point	Daily	During discharge and the site is safely accessible

Location	Description	Frequency	Comments
DS1	Downstream after merging with clean water diversion	Daily	During discharge and the site is safely accessible
DS2	Edge of Mineral Lease south of discharge point	Daily	During discharge and the site is safely accessible
DS3	North-east downstream point	Daily	During discharge and the site is safely accessible

5.4 Quality Assurance and Quality Control

All surface water samples should be collected, preserved, dispatched following the Northern Territory Advisory Note for the Sampling of Surface Water which has been developed based on Australian/New Zealand Standards for Water Quality – Sampling parts 1, 6, and 11 (numbers 5667.1:1998; 5667.6:1998; and 5667.11:1998)[5] and contains procedures to ensure quality control in the field. The methodology also provides advice on appropriate QA/QC procedures, data interpretation and reporting.

6.0 Trigger Levels and Trigger Action Response Plan

The site does not have any waterways traversing the mining area. Therefore, there are no background water quality data for the site and it is not possible to calculate site specific trigger values for water quality. However, surface water at the downstream sites will be assessed against the upstream water quality sampled on the same day to assess if water leaving site contains analytes that may be related to mining activities.

The water leaving the site will be managed following the guidelines listed in the ANZG publication *Assessing and Managing Water Quality in Temporary Waters*[6].

The predominant land use in the catchment and outside the ML is pastoral use, as such the ANZG (2018) Livestock Drinking Water Guidelines will be applied at the ML boundary for use as trigger values. The proposed trigger values to be applied at DS2 are shown in **Table 8.**

Table 8 Proposed Trigger Values for DS2

Analyte (mg/L)	Trigger Value
Major Ions	
Calcium	1,000
Fluoride	2
Magnesium	2,000
Nitrate	400
Nitrite	30

[5] https://nt.gov.au/__data/assets/pdf_file/0016/203362/aa7-025-methodology-for-the-sampling-of-surface-water-advisory-note.pdf

[6] https://www.waterquality.gov.au/sites/default/files/documents/assessing-and-managing-water-quality-in-temporary-waters.pdf

Analyte (mg/L)	Trigger Value
Sulfate	1,000
TDS (cattle)	4,000
Metals (total)	
Aluminium	5
Arsenic	5
Beryllium	Insufficient data
Boron	5
Cadmium	0.01
Chromium	1.0
Cobalt	1.0
Copper	1.0
Iron	Not sufficiently toxic
Lead	0.1
Manganese	Not sufficiently toxic
Nickel	1.0
Zinc	20

A Trigger Action Response Plan (TARP) has been developed for providing directions on requirements if the proposed trigger values are exceeded at DS2. **Table 9** shows the TARP for surface water investigations.

Table 9 Trigger Action Response Plan

Trigger	Action	Response
An investigation is triggered if the proposed trigger value is exceeded at sample location DS2	On becoming aware of the exceedance conduct further investigations into the source of the contaminant causing the exceedance.	Initiate investigation Assess CoC, laboratory data and duplicate samples. Discuss results with laboratory. Assess data against upstream sampling points (US1) to determine if exceedance is related to the mine discharge. Conduct additional sampling to confirm source of exceedance if required.(if site is still discharging) Confirm elevated analyte/s are due to mine activities. Review Monitoring program. Based on the outcome of the investigation a mitigation or management measure will be adopted to mitigate or prevent environmental impacts. Examples of what will be considered as part of this process have been provided in **Section 7**.

6.1 Environmental Incidents

All environmental incidents including overtopping of mine infrastructure with the potential to cause environmental harm on site will be reported as per the requirements of Environmental Incident Reporting under Section 29 of the *Mining Management Act 2001*. Any environmental incident deemed to be of any significant nature will be detailed in a formal Incident Report and submitted to the DITT. Under Section 29 an incident must be reported as soon as practicable. Avenira will provide a verbal report of an incident within 24 hours and provide a written report within 7 days unless instructed by the Department otherwise.

All environmental incidents occurring off-site but are associated with Avenira's activities at the Wonarah site will be reported to the NT Environment Protection Authority (EPA) under Section 14 of the *Waste Management and Pollution Control Act 1998.* Notification must be received by the EPA within 24hrs. A written response must be received by the EPA within 7 days. A summary of incident reporting requirements is provided **Table 10** below.

Table 10 Reporting Requirements

Entity	Trigger	Timeframe and Contact Details	Incident Reporting Details
NT Environmental Protection Authority (NT EPA)	An Incident which causes or is threatening or may threaten to cause pollution resulting in material environmental harm or serious harm. Qualifying triggers requiring submittal of a Section 14 Incident Report to the NT EPA are any of the following: • Is not trivial or negligible in nature; and/or • Consists of an environmental nuisance of a high impact or on a wide scale; and/or Results, or is likely to result in $50,000 or more in taking action to prevent or minimise environmental harm or rehabilitate the environment; or results in actual or potential loss or damage to value of $50,000 or more of the prescribed amount (whichever is the greater).	<24 hrs post incident ntepa@nt.gov.au pollution@nt.gov.au Written response to the EPA within 7 days. Tel: 1800 064 567	Section 14 Incident Reporting Form requires the following details and is included in **Attachment 1**: • Incident causing or threatening to cause pollution; • Date & time; • How the pollution has occurred, is occurring or may occur. • Attempts made to prevent, reduce, control, rectify, investigate and/or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and • Operator details; and • The form is to be signed by the HSEC Manager and/or General Manager for submission.
Department of Industry, Tourism and Trade	An Incident which causes minor environmental impact with some minor actual or potential harm to the environment.	As soon as practicable. mineral.info@nt.gov.au.	The Section 29 Notification of Environmental Incident Form requires the following details and is included in **Attachment 2**: • Site and operator details • Location occurred and area impacted (GPS coordinates) • Date and time • Description of incident • Emergency and remedial actions taken • Nature of impact and severity • Current situation

Entity	Trigger	Timeframe and Contact Details	Incident Reporting Details
			• Details of sampling undertaken • Notification status internally and externally The form is to be signed by the HSEC Manager and/or General Manager for submission.

7.0 Contingency Planning and Mitigation Measures

If an increase of the concentrations of analytes associated with mining activities is exceeded the proposed investigation will provide guidance on the most appropriate mitigation or improvement measures to be taken. In addition to enacting the tasks listed in **Table 1** general water management practices will continue to be employed, including:

- Monitoring all dam levels and pumping contained water when and where appropriate. Daily checks of all water holding facilities during the wet season will be conducted. When significant rainfall events are forecast, pumps are to be utilised to increase water storage capacity and reduce the risk of overflow as per **Table 1.**
- Use of bunding to redirect drainage of excess water and prevent sedimentation from WRDs, haul road and other site infrastructure; and
- Continued monitoring of surface water quality as outlined in **Section 5**.

In the event of a localised spill or release of contaminants, the following emergency response procedures will be enacted to avoid impacting on the quality of adjacent surface waters:

- Take all possible safe action to contain the spill and prevent further release.
- Report the incident in accordance the relevant emergency and spill response procedures.
- Assess the environmental impact.
- Notify appropriate authorities, in accordance with regulatory requirements; and Avenira management if significant environmental harm is likely.
- Undertake remedial action.

The Environmental Incident Management Plan provides more detail (DSO Appendix L)

8.0 Waste Discharge Licence

Under the *Water Act 1992*, the Northern Territory Environmental Protection Authority (NT EPA) requires a site to hold a waste discharge licence (WDL) if there is a discharge of waste water to environmental water[7]. A WDL will manage discharge through an authorised discharge point and provide compliance conditions that are to be met for environmental protection.

The following information is required for a WDL application:

- Applicant details
- Location of the premises
- Emergency contact
- Permission to use land
- Activity Description

[7] https://nt.gov.au/__data/assets/pdf_file/0016/1131073/waste-discharge-licensing-guidelines.pdf

- Discharge point/s locations
- Mixing zone
- Mining Authorisation
- Water Management Plan
- Recent environmental data and monitoring reports
- Discharge specifications
- Conceptual site model
- Environmental aspects and impacts register
- Emergency Response Plan (Avenira's Environmental Incident Response Plan)
- Consultation and Communications Plan

The application is submitted to DEPWS and can take up to 60 days for the application to be processed.

8.1 Recommendation

As the site has potential for active and/or passive discharge from the MWRD, it is recommended that Avenira apply for a WDL for the Arruwurra site.

Making Sustainability Happen

APPENDIX R AIR QUALITY AND DUST MANAGEMENT PLAN

Air Quality and Dust Management Plan

Wonarah DSO Phosphate Project

Avenira Limited

13/6 Duoro Rd
West Perth WA 6005

Prepared by:

SLR Consulting Australia

Unit 5, 21 Parap Road, Parap NT 0820, Australia

SLR Project No.: 630.V13432

7 September 2023

Revision:2.0

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0.1	6 June 2023	Alexis Parmenter	Kelsy Sammons	
1.0	27 June 2023	Alexis Parmenter	Kelsy Sammons	Jill Woodworth
1.1	6 September 2023	Emmanuelle Aliotti	Danroy D'Souza	Jill Woodworth
2.0	7 September 2023	Jill Woodworth	Sean Buxton Steve Harrison	Jill Woodworth
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Avenira Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables in Text

Figures in Text

Attachments

Acronyms and Abbreviations

AQDMP	Air Quality and Dust Management Plan
Avenira	Avenira Limited (Ltd)
BoM	Bureau of Meteorology
DEH	Department of Environment and Heritage
DITT	Department of Industry, Tourism and Trade
DSO	Direct Shipping Ore
EMS	Environmental Management System
EPA	Environmental Protection Authority
GHG	Greenhouse Gases
µm	micrometers
ML	Mineral Lease
MMP	Mining Management Plan
NEPM	National Environmental Protection Measure
NOx	nitrogen oxides
NT	Northern Territory
PM	Particulate Matter
TARP	Trigger, Action, and Response Plan
TSP	Total Suspended Particles
WMPC Act	*Waste Management and Pollution Control Act 1998*

1.0 Introduction

1.1 Project Description

Avenira Limited (Avenira) proposes to develop the Wonarah Phosphate Project (the Project) for a Bulk Test Pit (Stage 1) and Direct Shipping Ore (DSO) (Stage 2) in the Barkly Tableland of the Northern Territory (NT) and have contracted SLR Consulting Australia Pty Ltd (SLR) to provide an Air Quality and Dust Management Plan (AQDMP) for the construction and operation of the Project.

This AQDMP has been prepared to provide a framework for air quality and dust management in the vicinity of the Project Area, and to reduce likelihood of negative impact on the surrounding environment. This AQDMP has been developed in accordance with the relevant legislation, industry best practices and guidelines (see Section 1.4).

It is noted that this report is considered to be a working document designed to be updated and revised as needed during the life of the Project.

1.1 Project Setting and Proposed Activities

As shown in **Figure 2** the Project is located approximately 240 km east of Tenant Creek and directly south of the Barkly Highway on the current Mineral Lease (ML) application ML33344 (the Site). The Project area (shown in **Figure 1**) will include the Site and accommodation camp.

Key activities associated with the Project are:

- Construction of mine infrastructure involving clearing.
- Infrastructure maintenance including road maintenance.
- Mining (drilling, blasting and extracting), crushing and screening of phosphate rock ore at the Arruwurra Site.
- Sewage treatment and landfilling operations occurring at the Site.
- Transport of the crushed and screened phosphate rock along the Barkly Highway to the Stuart Highway then north to the Threeway intersection and rail siding (Route 1 shown in **Figure 3**).

It is noted that handling at the transfer hub and onward transport from this location are not included within the scope of this AQDMP.

1.2 NT EPA Recommendations

The following recommendations relating to air quality/dust were made by the NT Department of Natural Resources, Environment, The Arts and Sports (DNREAS)[1] after review of the Wonarah DSO Project EIS submitted in 2010 and listed in Assessment Report 64 (DNREAS 2010).

Recommendation 19

Minemakers (Avenira) shall continue to seriously consider measures to reduce greenhouse gas emissions from the Project through identification of further opportunities to improve energy efficiency and utilise alternative, lower emission energy options.

Minemakers shall consult with DNRETAS[1] *on opportunities to offset greenhouse gas emissions in the Northern Territory*.

Recommendation 25

Minemakers[2] *shall investigate opportunities to maximise the efficient use of water on site including reusing treated effluent; minimising sources of dust generation to reduce requirements for dust suppression; and using any stored water in pits as a seasonal supplement. Proposed measures are to be included in the Mining Management Plan for the Project.*

1.3 Objectives

This management plan aims to minimise any potential impacts on the environment and human health due to emission of dust or pollutants from the site activities. The objective of the AQDMP is to ensure that appropriate mitigation fugitive emissions are implemented during the development of the mine and its operations by:

- To recognise the NT EPA's Recommendations from the 2010 EIS (Assessment Report 64).
- Identify environmental values of the Project.
- Complying with all legislated requirements and all relevant corporate requirements and policies.
- Operating and leaving the Wonarah Project area in a stable condition that minimises long-term environmental impacts, liabilities, and maintenance.
- Characterise the existing air quality environment, including sensitive receptors and local meteorology.
- Identify key dust generating activities associated with the construction, extraction operations and haulage activities.
- Provide management, monitoring, and mitigations measures on site in compliance with relevant policies and guidelines.
- Implement corrective actions where necessary.
- Provide details on roles and responsibilities, incident reporting and complaints procedures.

1.4 Guideline and Policy

Dust nuisance is governed under the *Waste Management and Pollution Control Act* (*WMPC Act*). Section 83 of the *WMPC Act* provides for general environmental offences, including that a person must not create an environmental nuisance. Section 4 of the Act defines environmental nuisance as:

- *An adverse effect on the amenity of an area that:*
    - *is caused by noise, smoke, dust, fumes or odour; and*

[1] Now Department of Environment, Parks and Water Security (DEPWS)

[2] Avenira to take over the construction and operation of the Project.

- *unreasonably interferes with or is likely to unreasonably interfere with the enjoyment of the area by persons who occupy a place within the area or are otherwise lawfully in the area.*

In the absence legislative dust level limits prescribed by local regulatory bodies, criteria set out by the NSW Environment Protection Agency (EPA) has been applied to assess the long-term effects of annual average deposited dust:

- 2 g/m^2/ month (maximum increase in deposited dust level), and
- 4 g/m^2/month (maximum total deposited dust level).

However, these guidelines are not applicable for application to arid zones in the NT, as base line data shows that the maximum dust deposition recorded at the site was 7 g/m^2/ month. Therefore, the Site data will be compared to the background monitoring site data point and the 2 g/m^2/ month maximum increase will be applied to the monthly data for site monitoring points for reporting and interpretation of data.

1.4.1 Legislation

- *Waste Management and Pollution Control Act 1998*
- *Mining Management Act 2001*
- National Environmental Protection (Ambient Air Quality) Measure 2021
- *Public and Environmental Health Act 2011*
- *Soil Conservation and Land Utilisation Act 1969*

1.4.2 Guidelines and Standards

- Australia/New Zealand Standard (AS/NZS) 3580.1.1:2016: *Methods for Sampling and analysis of ambient air Part 1.1: Guide to siting air monitoring equipment*.
- Australian Standard (AS) 3580.10.1:2016: *Methods for sampling and analysis of ambient air; Method 10.1: Determination of Particulates - Deposited Matter - Gravimetric Method*.
- AS/NZS3580.9.11:2016: *Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{10} beta attenuation monitors* (to be confirmed once equipment selected).
- AS3580.14-2014: *Methods for sampling and analysis of ambient air - Part 14: Meteorological monitoring for ambient air quality monitoring applications*.
- AS3640–2009: *Workplace atmospheres - Method for sampling and gravimetric determination of inhalable dust*.
- AS2985-2009 *Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Respirable Dust*.
- NOHSC: 1003 *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment*.

2.0 Existing Environment

2.1 Climate

There is currently no publicly available data for meteorological monitoring conducted in the vicinity of the site. However, the climate of the region was summarised in the DRAFT EIS (Coffey 2009) based on a meteorological station that was installed at the project area in May 2008 and Bureau of Meteorology (BoM) stations located at Wonarah (10 km east of the Site and which ceased operation in 1974); Brunette Downs (145 km north of the Site) and Ranken River rainfall station (68 km northeast of the Site). Based on the EIS report the climate in the region was characterised as semi-arid with well-defined wet and dry seasons. Mean maximum and minimum temperatures in the wet seasons (November to March) range from 38°C to 25°C while for the rest of the year maximum and minimum temperatures range from 25°C to 12°C on average. The annual average rainfall has been reported to range from 300 to 400 mm with January and February receiving most of the rain.

2.2 Predominant Wind Conditions

The wind conditions in the area were presented in the DRAFT EIS (Coffey 2009) for data recorded between January 1957 and August 1974 for Wonarah (note - this data is not currently publicly available for review). The EIS study summarises the wind conditions in the area as shown in **Table 1**.

Table 1 Summary of Seasonal Wind Conditions

Season	Summary of Wind Condition
Dry Season (April-July)	Predominately calm to moderate south easterly winds throughout the season.
Build up to the wet season (September-November)	Predominantly strong south-easterly and moderate southerly winds throughout the season, with calm to mild winds varying in direction from east to north-west
Wet Season (December – March)	Predominantly calm to moderate south-easterly winds with calm winds varying in direction from east to north-west

Source - (Coffey 2009)

2.3 Surrounding Land Uses

The project is located wholly within enhanced freehold Aboriginal land owned by the Arruwurra Aboriginal Corporation. Land use mapping for the region indicates that surrounding areas are predominantly utilised for traditional indigenous use, such as hunting and gathering and access to and use of sacred sites. Beside traditional Indigenous use, the other main land use for the area is mineral exploration.

2.4 Historical Dust Monitoring

Background dust levels were measured by deposition gauges at eight locations within the Project area and surrounds during 11 sampling periods, from June 2008 to September 2009. The dust monitoring results indicate that the background dust fall ranges from around of 0.7 to 7.0 g/m^2/month, with an overall average of 2.6 g/m^2/month.

3.0 Sensitive Receptors

Land use immediately adjacent to the Project area is predominantly utilised for traditional indigenous use. The Wunara community is the closest populated area to the Project located adjacent to the Barkly Highway and is approximately 34 km to the north-east of the Arruwurra deposit. The community has four houses and associated buildings and an Indigenous population that fluctuates from 2 to 30 people according to the season (**Figure 4**).

Additionally, a 16km section of the Barkly Highway immediately north of the Project area has also been identified as a sensitive receptor due to proximity of the road users in this section to the Project. A number of identified sensitive receptors are listed in **Table 2.**

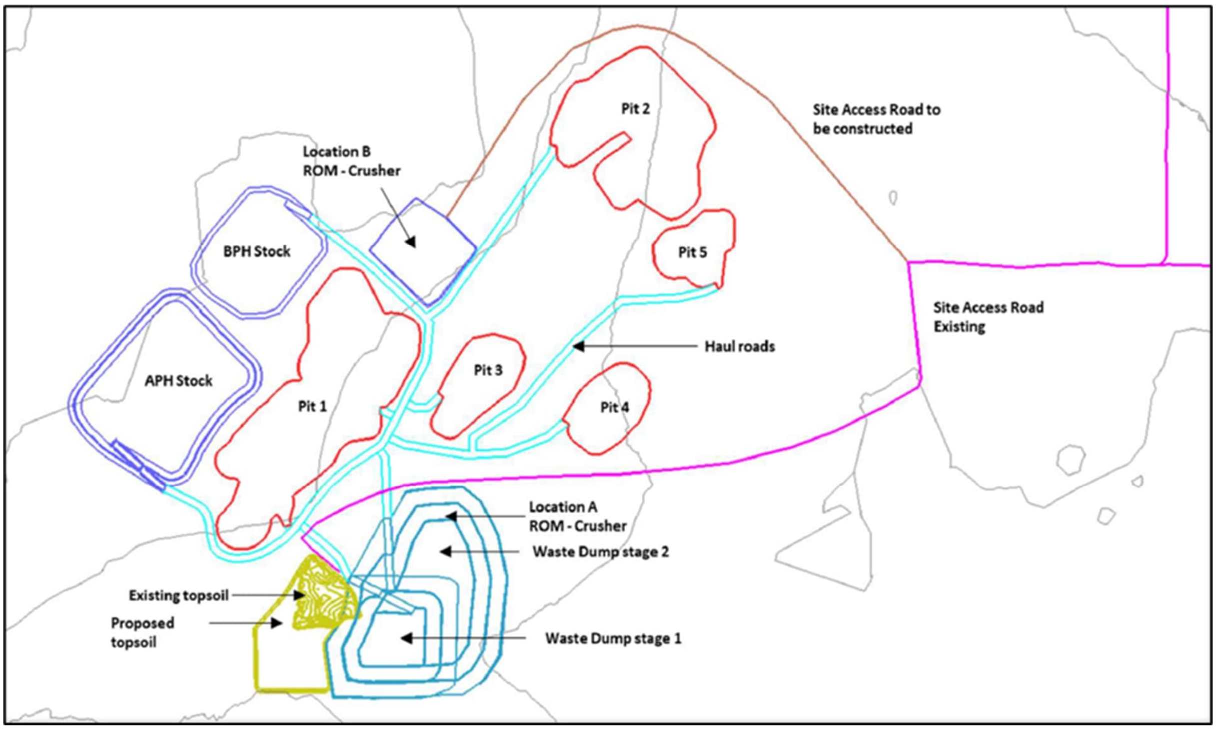
Table 2 Sensitive Receptors

Sensitive Receptors	Distance
Accommodation Facility	2 km
On site workers and contractors	On site and surrounding [B]
Flora and fauna	On site and surrounding
Waterways and aquatic environments	On site and surrounding
Wunara community	10 km from the Project site
Barkly Roadhouse	Along of the ore transport route
Five rest areas including campsites	Along of the ore transport route
Five houses	0.5 km and 7 km from the ore transport route
Motorists	Along of the ore transport route
Tennant Creek Abattoir/Holding Pens[A]	280 km from the Project site
Tennant Creek Telegraph Station[A]	285 km from the Project site
Tennant Creek Pistol Club[A]	296 km from the Project site

[A] Not permanently occupied.

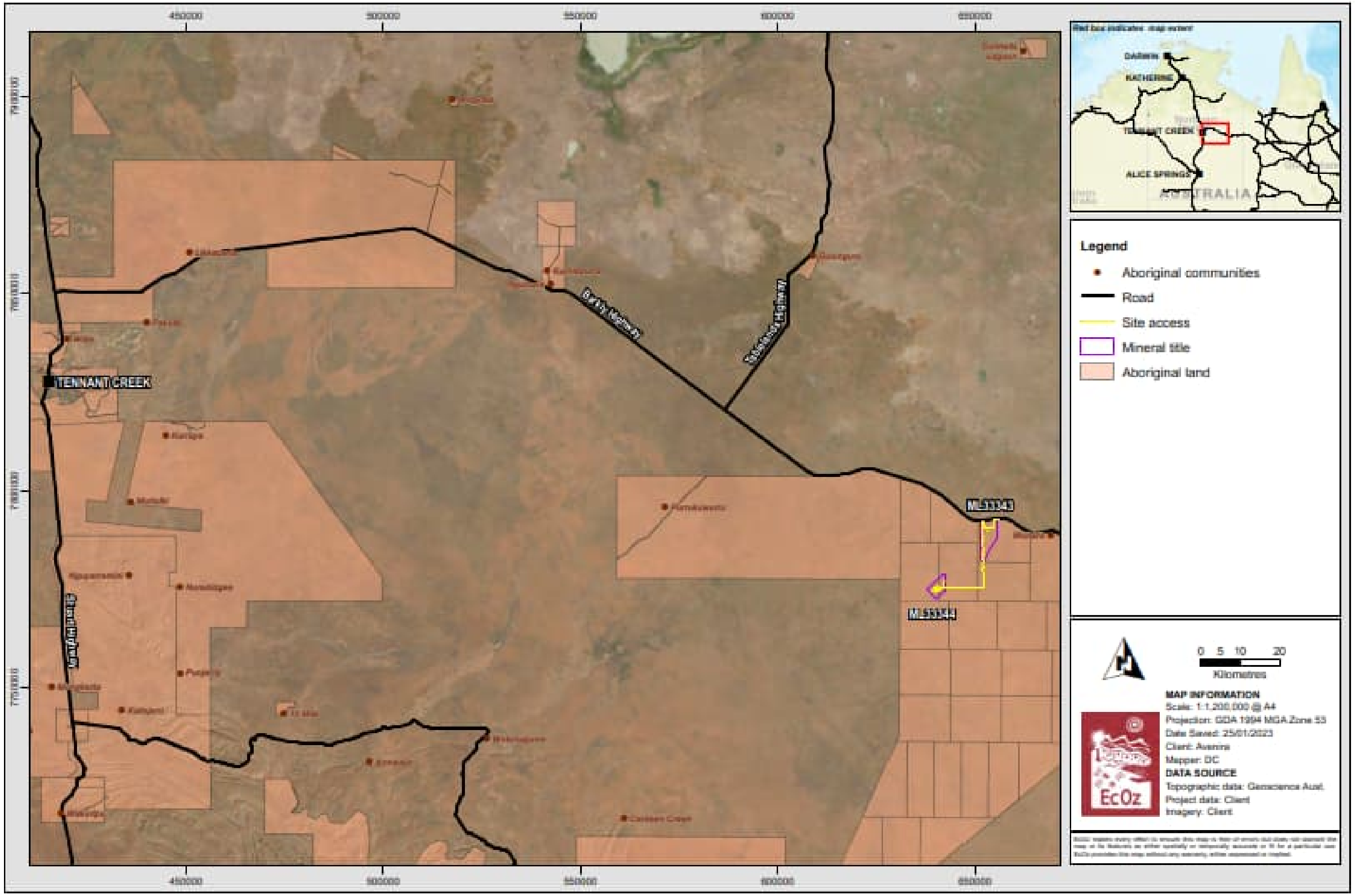
[B] Refer to AV-HSE-SMP-003 Operations Mine Safety Management Plan V1.1 2023 for personal safety procedures.

Figure 1 Project Area



Source - (Mining Plus 2023)

Figure 2 Site Location

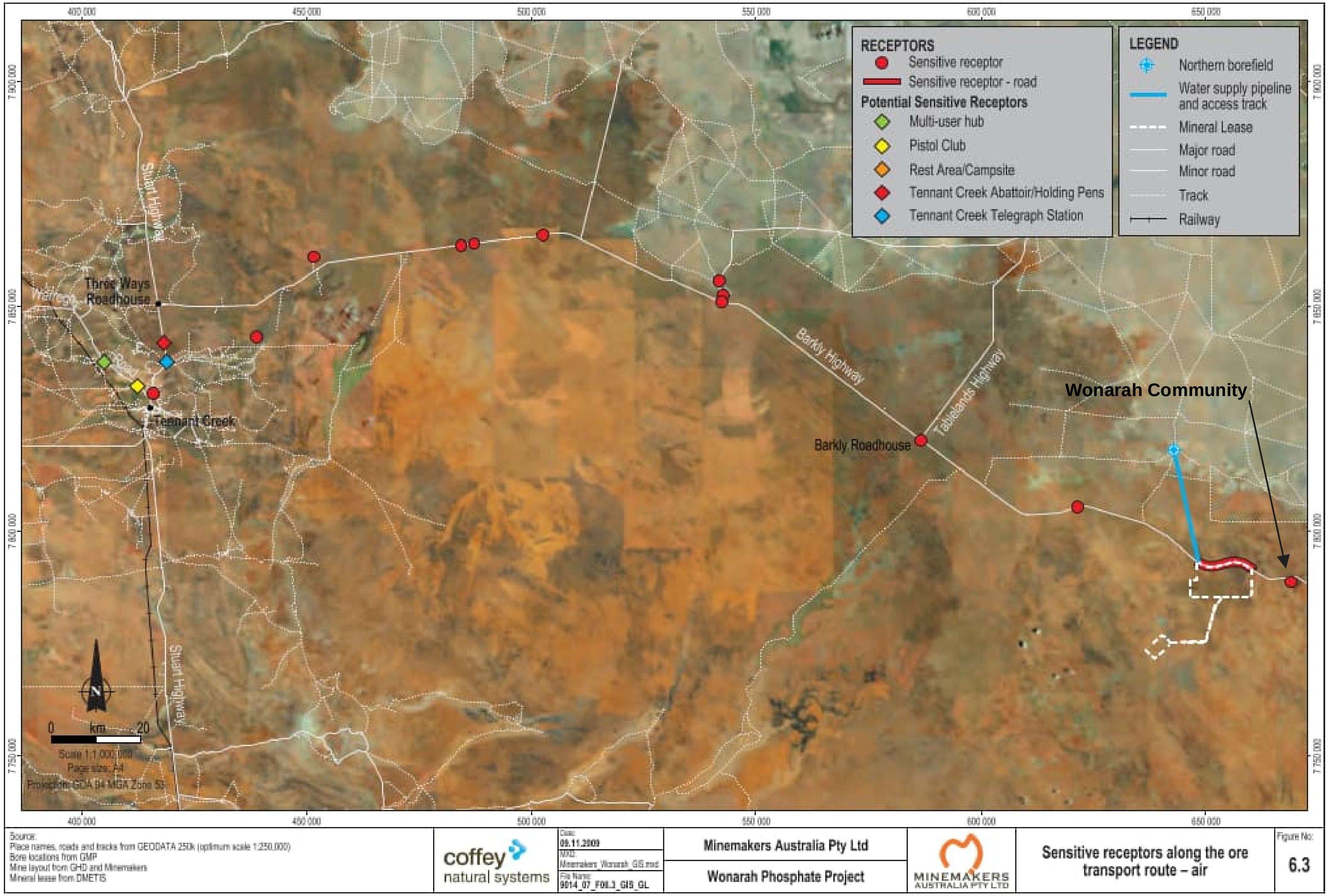


Source - (Coffey 2009)

Figure 3 Proposed Transport Route to Tenant Creek

Source - (ARCCOS 2023)

Figure 4 Sensitive Receptors



Source - (Coffey 2009)

4.0 Types and Sources of Air Emissions

4.1 Particulate Matter

The key air emissions from the Project would be fugitive emissions of particulate matters associated with the construction and mining activities, including drilling and blasting, bulldozer operation and handling and transport of waste rock and ROM. Wind erosion of pit and waste rock dump areas and ROM stockpile also has the potential to generate dust emissions under dry and windy conditions.

These emissions are classified primarily by size, as TSP (total suspended particulates), PM_{10} (particulate matter with an aerodynamic diameter up to 10 µm) and $PM_{2.5}$ (particulate matter with an aerodynamic diameter up to 2.5 µm). Human health effects of dust tend to be associated with particles with an aerodynamic diameter of 10 µm or less (≤ PM_{10}). These smaller particles tend to remain suspended in the air for longer periods and can penetrate into the lungs. The $PM_{10\text{-}2.5}$ fraction (coarse fraction) is termed “thoracic particles”. These particles are inhaled into the upper part of the airways and lung. $PM_{2.5}$ particles are fine particles that are inhaled more deeply and lodge in the gas exchange region (alveolar region) of the human lung and are termed “respirable dust”.

Emissions of TSP also have the potential to result in nuisance impacts due to increased rates of dust deposition in the surrounding area. Additionally, it is noted that fugitive particulates may lead to reduced visibility in the immediate surroundings of the Site.

4.2 Other Air Quality Emissions

Other air pollutants that have the potential to be generated as a result of the Project include products of fuel combustion from the on-site vehicles and mobile/fixed equipment, the most significant of these being:

- oxides of nitrogen (NO_x)
- particulate matter
- sulphur oxides (SO_x)
- carbon monoxide (CO)
- volatile organic compounds (VOCs)

These emissions are predominantly emitted from mobile sources and will be emitted over a large area (as opposed to a single point source emission). Given this, the Project is not expected to result in any significant change in ground level concentrations of these pollutants at surrounding receptors and therefore they have not been investigated further in this assessment.

Additionally, the Project area will also include sewage treatment and landfilling operations to service personnel at the Site. These operations may lead to the release of odours. However, odour impacts are mainly associated with amenity issues only. Considering the nearest human receptor is approximately 10 km away any odours released from the Site are not likely to lead to amenity impacts at sensitive receptors.

Combustion emissions from bushfires can also contribute to the degradation of air quality.

The dominant emission sources associated with the Wonarah Project’s activities are presented in **Table 3** below.

Table 3 Emissions Sources from Proposed Site Activities

Emission Source	Activities
Dust	
Vegetation clearing	Vegetation grading
	Topsoil removal
Drilling and blasting	Waste rock and ore
Vehicle movements	Wheel-generated dust from light vehicle and truck movements on sealed and unsealed roads
	Hauling ore to Run of Mine (ROM)
	Hauling waste rock to the waste rock stockpiles.
	Hauling ore along the transport route
Aircraft	Planes' movements.
Materials handling and processing	Trucks loading and unloading
	Ore dumping onto the ROM stockpiles or crusher
	Crushed stockpile operations
	Crushing and screening
Waste Rock Dump	Dozer pushing
	Truck tipping
Waste handling operations	Dozer pushing
	Truck tipping
Rehabilitation operations	Reshaping dumps
	Topsoil relocation
Wind erosion (dust lift off) from work areas	Wind erosion from stockpiles
	Wind erosion from site
	Wind erosion from cleared areas
Potential Pollutants	
Vehicles' exhausts: NO_x, CO, SO_x, VOCs	Vehicle use
	Blasting
Vehicles' exhausts: PM_{10}	Vehicle use

4.3 Environmental Factors

In addition to any surrounding activities being carried out at any point in time, a number of environmental factors may also affect the generation, dispersion, and cumulative impacts of dust emissions from the site including:

- Wind erosion of exposed surfaces
- Combustion emissions from bushfires
- Minor emissions from vehicles travelling along the Barkly Highway
- Wind direction

5.0 Management

5.1 Roles and Responsibilities

Avenira are responsible for the implementation of, and compliance with, this AQDMP. All staff, contractors, and consultants will complete a site induction that includes information on air quality issues and dust management prior to gaining access to site.

The Site Manager will be responsible for ensuring that all activities associated with the Project are undertaken in full compliance with statutory regulations and non-statutory obligations and are consistent with Avenira's Environmental Policy[3]. Avenira will ensure that the environmental approval conditions are accessible to senior management and other personnel on request at all times. All personnel are responsible for ensuring that their work complies with these conditions and the described environmental management measures. Individual accountability will be defined through conditions of contracts of employment.

Responsibilities of the various personnel involved in the Project are outlined in **Table 4.**

Table 4 Environmental Management Responsibilities

Personnel	Responsibilities
Site Manager	Overall responsibility for the project. Overall responsibility for site-specific implementation of the accepted EIS, including: environment policy, systems, and management measures.
Environmental Officer	Reports to the Site Manager. Ensures EMS is implemented uniformly, revised, and maintained. Assesses the suitability and effectiveness of the EMS. Ensures that contractors fulfil their contractual obligations. Implements induction procedures and appropriate training. Ensures compliance with licence conditions and company policy via the establishment and maintenance of appropriate reporting systems and databases. Participates with personnel to improve work practices on site. Undertakes internal site environmental audits. Provides advice as required to other project personnel. Liaison with Northern Territory regulatory authorities. Liaises with stakeholders. Ensures implementation and regular review of environmental management measures. Follows Emergency Incident Reporting Procedures (MMP Appendix M) for reporting incidents to Site Manager, HSE Manager, NT EPA and DITT.
Contractors	Fulfil contractual obligations.

[3] AV-HSE-POL-005 - Environmental Policy Version 1.0 2023

5.2 Performance Evaluation Criteria

With no currently prescribed legislative dust level limits for mine sites in the NT there are no defined assessment criteria for the Project to evaluate compliance.

With no compliance criteria the purpose of the dust monitoring is to inform and evaluate the performance of the Site dust management practices. To do this dust deposit gauge monitoring in conjunction with visual inspections are recommended (refer **Section 5.5** for monitoring plan).

To evaluate dust deposition around the operations the suggested performance evaluation criterion is 4 g/m^2/month as referenced by the NSW assessment and performance criteria (see **Table 5**). It is recognised that this limit is intended for nuisance purposes for primarily residential sensitive receptors and that the applicability to the Project may be limited. However, in the absence of other dust deposition guidelines and considering that the limit is introduced as a performance evaluation indicator – not a compliance criterion, it is considered to be applicable to the Project.

As noted in Good Practice Guide for Assessing and Managing Dust (MfE 2016), hereafter referred to as the GPG, background dust can be as high as 10 g/m^2/day whilst measurements in the vicinity of industrial sources can be as high as 20 g/m^2/day. Additionally, dust deposition monitoring in the vicinity of the Site has indicated that background dust of up to 7.0 g/m^2/month (refer **Section 2.4**) was measured which is well above the cumulative evaluation criterion of 4 g/m^2/month. Therefore, in situations where the this criterion is being exceeded incremental dust deposition shall be derived by comparison with background monitoring site (refer **Section 5.6** for monitoring locations) and compared with the 2 g/m^2/month incremental criterion (see **Table 5**) referenced by NSW assessment and performance criteria.

Table 5 shows the adopted performance criteria for the Project for deposited dust.

Table 5 Deposited Dust Performance Evaluation Criteria

Pollutant	Averaging Period	Criterion
Deposited dust	Annual	[a, b] 4 g/m^2/month
	Annual	[c, b] 2 g/m^2/ month

Source : NSW Department of Environment and Conservation (NSW EPA 2022)

a Cumulative impact (i.e. increase in concentrations due to the Project plus background concentrations due to all other sources).

b Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposition Matter – Gravimetric Method.

c Incremental impact (i.e. increase in concentrations due to the Project only).

5.3 Key Activities and Impacts

The key activities and potential environmental impacts identified on the air and dust quality in the Risk Register (**Appendix A** of the MMP) are listed in **Table 6**. Assessment of residual air quality impacts was based on the baseline data for dust deposition and emission rates of similar operations in similar environments. Residual impacts after implementation of the management and mitigation measures are also summarised in the table.

Table 6 Key Activities and Impacts

Activities	Potential Impact	Residual Risk level		
		Likelihood	Consequence	Risk
Land clearing: Dust Emission	Decrease in air quality at Wunara due to dust emissions from land clearing activities.	Rare	Minor	Low
	Decrease in air quality for motorists travelling along Barkly highway due to dust emissions from land clearing activities.	Unlikely	Minor	Low
Construction of infrastructure: Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions.	Unlikely	Insignificant	Low
Mining operation, including management of waste rock, ore and topsoil storage: Dust emissions	Decrease in air quality at Wunara due to dust emissions from mining activities.	Unlikely	Insignificant	Low
	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from mining activities	Unlikely	Minor	Low
Drilling activities: Dust emissions	Decrease in air quality - visual amenity, dust impacts to vegetation.	Possible	Insignificant	Low
General vehicle movement: Dust emissions	Decrease in air quality at Wunara due to dust emissions from vehicle movement on unsealed roads within the mineral lease.	Unlikely	Insignificant	Low
	Decrease in air quality for motorists travelling along Barkly Highway due to dust emissions from vehicle movement on unsealed roads within the mineral lease.	Rare	Moderate	Low
Haulage (including loading and unloading) of ore: Dust emissions	Decrease in air quality due to heavy vehicles travelling along the ore transport route, for people using rest stops, the Barkly Roadhouse, and residences along the transport route.	Unlikely	Insignificant	Low
Power generation and use: Exhaust emissions and diesel fuel consumption	Decrease in air quality due to combustion emissions.	Unlikely	Insignificant	Low
Non-ore waste management: Disposal of waste	Decrease in air quality due to odour from sewage treatment plant and putrescible waste landfill causing nuisance for sensitive receptors (mainly residents of Wunara community).	Unlikely	Insignificant	Low
Blasting and vehicle use: Chemical compounds and diesel hydrocarbons	Decrease in air quality due to odour from blasting activities and vehicle movements with fumes.	Likely	Insignificant	Low

5.4 Greenhouse Gas Emissions

Avenira are aware that greenhouse gases (GHG) will be created during construction and operations of the Project. Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia[4]. Vehicles and

[4] https://dieselnet.com/standards/au/

machinery will be fitted with the appropriate emission control equipment and maintained and serviced frequently. Avenira will conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions.

Avenira's Greenhouse Gas Assessment Report for the Arruwurra DSO project is located in **Attachment 2**.

5.5 Management Objectives

A summary of the AQDMP objectives with targets and indicators are presented in **Table 7** below.

Table 7 Management Objectives

Objective	Target	Indicator
Minimise dust impacts at the Project site and the surroundings. Ensure the health and well-being of site personnel. Protect the amenity of persons who live and work in the vicinity of the Project area. Reduce likelihood of negative impact on the surrounding environment	No reports of dust impacts from the site at sensitive receptors.	• Number of incidents of dust deposition at selected receptor sites. • Complaint register to show no reasonable complaint unaddressed. • Compliance with annual average dust deposition rate does not exceed 2 g/m^2/month above baseline dust deposition rate as measured at the background site outside of the Mineral Lease.
Minimise dust impacts along the Haul transport route	No decrease in air quality or visual amenity due to dust emissions along the Haul transport route.	• Number of incidents of dust deposition at selected receptors. • Complaint register to show no reasonable complaint unaddressed • Compliance with annual average dust deposition rate does not exceed 2 g/m^2/month above baseline dust deposition rate as measured at the background site outside of the Mineral Lease .
Minimise air pollutant impact at the Project.	No reports of pollutant impact from the Project at sensitive receptors.	• Maintenance records show regular servicing of vehicles and plant.

5.6 Monitoring Plan

Ongoing monitoring and management of dust, particularly in disturbed areas is a high priority. The focus will be areas of disturbance/earth works, access tracks, and native vegetation on site. It is recommended that monitoring of the Wonarah Project area be undertaken throughout the year, especially during the dry season. Monitoring is an essential component of any AQDMP as it provides a means of identifying the following:

- Decline in air quality.
- Decline in air visibility.
- Impact on site workers health.
- Decline in vegetation health.

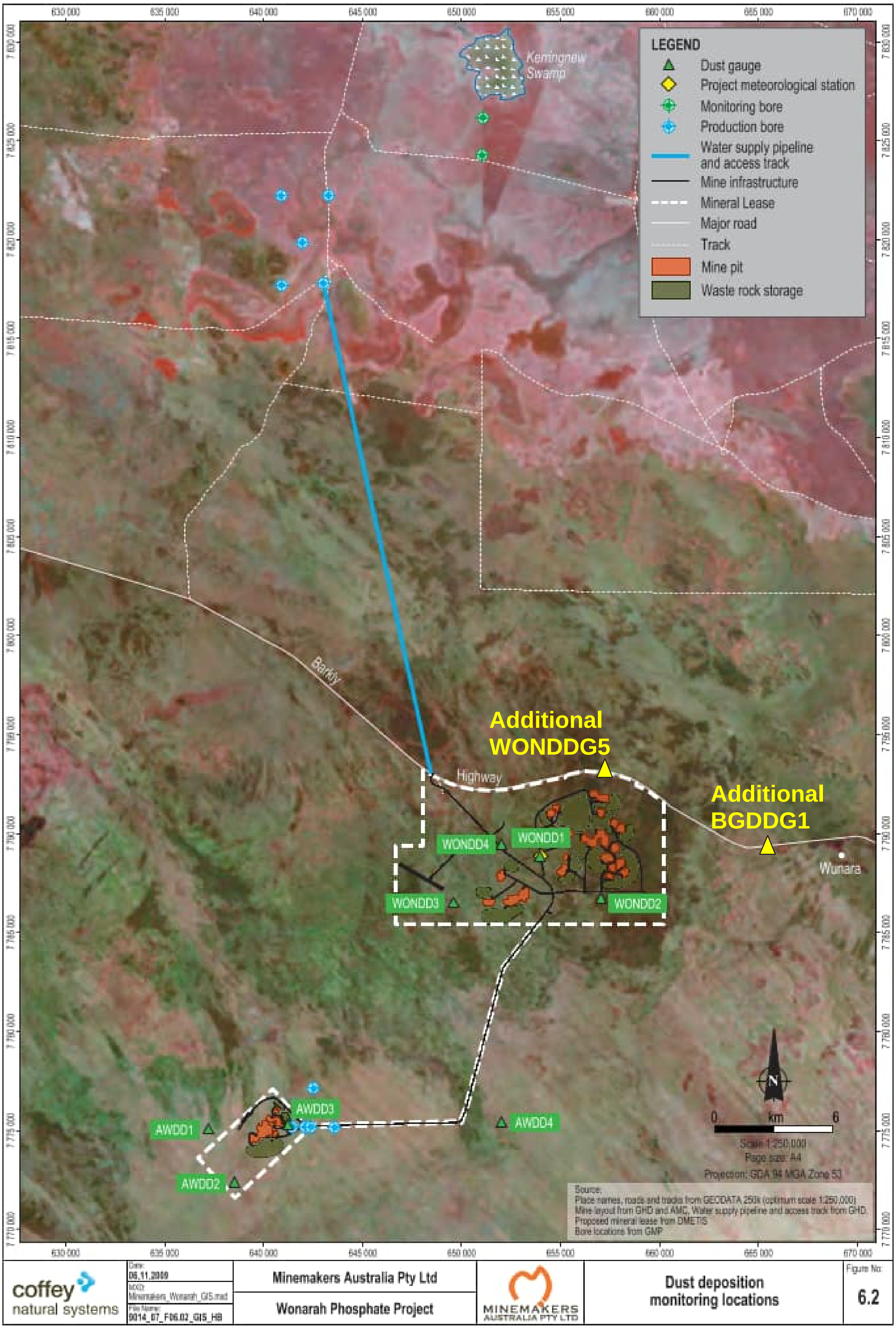
Daily visual assessments will be made of effectiveness of dust mitigation measures and changes made as required (e.g. increased water truck movements). Dust deposition monitoring will also be undertaken in accordance with *AS/NZS 3580.10.1:2016: Methods for sampling and analysis of ambient air Determination of particulate matter - Deposited matter - Gravimetric method* to evaluate the performance of dust management practices undertaken on Site.

Figure 5 shows dust deposition gauge locations recommended for the Project. The green triangle markers in this figure represent existing monitoring locations and represent dust deposition within the Project Area. The triangle markers in yellow show two additional monitoring locations (WONDDG5 – to represent dust deposited offsite in the northern direction & BGDDG1 – approximately 5km from the ML boundary to represent background dust deposition level) recommended for this Project.

It is noted that the performance evaluation criteria presented in **Table 5** are applicable to WONDDG5 only.

The dust deposition gauges will monitor deposited particulate matter over the life of the Project. During the life of the project the monitoring locations at the mine site may need to be revised as the operations progress and areas of activity may change.

Figure 5 Dust Deposition Monitoring Locations



Note – Original (Coffey 2009) was modified to represent two additional monitoring locations.

5.7 Mitigation Actions and Controls

Mitigation measures have been developed to minimise potential impacts associated to air quality and dust emissions. The Trigger, Action and Response Plan (TARP) provides an outline of remedial actions and responses to the situation. The TARP provides guidance on the TARP Level of operations due to conditions on Site (see **Table 8**).

Table 8 Trigger Action Response Plan (TARP)

TARP Level	Description	TARP Level Indicator	Actions
Level 1	Normal operations	Normal conditions without excessive dust emissions.	Standard operation procedures.
Level 2	Operations in adverse conditions for dust generation.	Dust lift off or excessive visible dust plumes from work areas.	Additional controls and actions as indicated by the Level 2 actions in the dust control activities tables. Regular review and monitoring of operations and conditions.
Level 3	Operations with restrictions to reduce activity to the point where ceasing of operations may be required.	Operations in conditions with sustained higher wind speeds and visible significant plumes of dust from site activities and dust lift off due to insufficient effect of Level 1 and Level 2 dust control and mitigation actions.	Additional controls and actions as indicated by the Level 3 actions in the dust control activities tables. Ceasing of operations if conditions deteriorate or if applied controls are insufficient to achieve an acceptable outcome.

Dust control and mitigation activities for the site activities for each TARP level are presented in **Table 9** to **Table 12**. Notes of operational responses in TARP Level 2 and Level 3 conditions are to be recorded and referred to for any complaint investigation.

Table 9 Dust Control Activities for Vehicle Movements

Dust Generating Activity	Issue	TARP level	Dust Control Activity
Wheel-generated dust from vehicle and truck movements on site.	Dust generated from vehicle movements. Dust emissions can be further exacerbated by dry conditions, surface conditions and excess silt build up.	Level 1	Watering of roads and work areas. Watering frequency to be adjusted to achieve effective dust suppression.
		Level 1	Speed restrictions as applicable in work areas.
		Level 1	Heavily trafficked areas are to be maintained at higher frequency.
		Level 1	Restriction of non-essential vehicles access to non-essential areas.

Dust Generating Activity	Issue	TARP level	Dust Control Activity
		Level 1	Limiting parking of vehicles to designated parking areas to minimise soil disturbance.
		Level 1	If material is being tracked out onto public roads install a wheel wash and / or a speed bump.
		Level 1	Cover of loads always carried by trucks.
		Level 1	Spray water and dust suppressant agent on unsealed trafficked areas and other dust generating areas. Avenira will keep daily records of the following: • Operational hours of all water trucks. • Amount of water and dust suppressant used. • Numbers of water trucks in operation. • Time any mining operations are ceased due to severe meteorological conditions.
		Level 2	Increased water spray frequency. Additional water truck on site if required.
		Level 2	Reduction of activities, if required.
		Level 3	Further increased water spray frequency.
		Level 3	Further restrictions of activities.
		Level 3	Temporarily cease activities observed to generate excessive dust despite controls.

Table 10 Dust Control Activities for Materials Handling including Crushing, Screening and Handling Operations

Dust Generating Activity	Issue	TARP Level	Dust/Air Quality Control Activity
Materials handling including loading, unloading and placement of materials.	Dust emissions can be further exacerbated by low material moisture content, large drop heights and windy conditions.	Level 1	Water sprays on materials handling and processing to provide dust suppression and to raise/control material moisture content.
		Level 1	Water sprays on active work areas.

Dust Generating Activity	Issue	TARP Level	Dust/Air Quality Control Activity
		Level 1	Minimising drop heights for materials handling when loading and unloading.
		Level 1	Avoidance of material transfer during high wind conditions (> 60 km/h - as measured at the site weather station).
		Level 1	Positioning the stockpiles lengthways to the predominant wind direction.
		Level 1	Veneering of stockpiles where appropriate with special water additives.
		Level 1	Opened trailers to be sprayed with dust suppressant prior to leaving site or being taken over long distance inside the ML.
		Level 2	Increased water sprays.
		Level 2	Loading from other stockpile with better material moisture content.
		Level 2	Restrictions on handling activities.
		Level 3	Further restrictions of activities.
		Level 3	Temporarily cease activities observed to generate excessive dust despite controls.

Table 11 Dust Control Activities for Ore Resource Extraction and Vegetation Clearing

Dust Generating Activity	Issue	TARP Level	Dust Control Activity
Blasting, drilling, excavating, bulldozing, grading, crushing, screening and clearing.	Fugitive dust emissions from ore extraction and vegetation clearing activities. Dust emissions can be further exacerbated by insufficient water sprays, dust extraction and/or windy conditions.	Level 1	Installing a windsocks for wind predictions.
		Level 1	Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion.
		Level 1	Prewetting of work area.
		Level 1	Blasting only when there is little or low wind at site.
		Level 1	Material moisture control (at levels to suppress dust generation). Including pre-wetting of material before moving.

Dust Generating Activity	Issue	TARP Level	Dust Control Activity
		Level 1	Removal of topsoil to be kept to a minimum depth as far as practicable.
		Level 1	Dust hooding and misting/sprays at transfer points during ore crushing and screening.
		Level 1	Avoidance of material transfer during high wind conditions (> 60 km/h - as measured at the site weather station).
		Level 2	Use of personal respiratory protection devices where necessary.
		Level 2	Increased water sprays on work areas and material.
		Level 2	Spotting to pick up excessive dust generation.
		Level 3	Continuous spotting/visual monitoring of performance conditions
		Level 3	Temporarily cease activities observed to generate excessive dust despite controls.
		Level 3	Stopping of operations, if required.

Table 12 Dust Control Activities for Open Areas Wind Erosion

Dust Generating Activity	Issue	TARP Level	Dust/Air Quality Control Activity
Wind erosion from storage and site. Land clearing activities. Areas of exposed topsoil prior to vegetation cover. growth.	Wind erosion from site and exposed ground surface. Wind erosion from stockpiled materials Dust emissions can be further exacerbated by low material moisture content, windy conditions and surface silt deposits.	Level 1	Monitor revegetation until site has established full ground cover.
		Level 1	Water exposed areas when dust lift off is observed.
		Level 1	Keep active work areas and site roadways clean.
		Level 1	Material moisture control (at levels to suppress dust generation). Water sprays on stockpiles.
		Level 1	Avoidance of on-site materials stockpile storage.
		Level 1	All spoil materials to be loaded directly from excavator/profiler into trucks and disposed of offsite.

Dust Generating Activity	Issue	TARP Level	Dust/Air Quality Control Activity
		Level 1	Keep the disturbance area to a minimum and prioritise a blade up technique during clearing (leaving the grass roots intact and therefore providing cover).
		Level 2	Prewetting of areas ahead of time as indicated by forecast conditions.
		Level 2	Further water sprays of work areas.
		Level 3	Further water spray activities to supress dust emissions.
		Level 3	If operations at site have been stopped, maintain water truck operations during site shut down to provide ongoing control of areas.

5.8 Reporting

The Site will organise for the recording, compilation and storage of the following for no less than five years:

- Complaints Register and investigation records.
- Monitoring records and analytical data.
- Dust monitoring results and report.

The following information will be included in an annual report:

- A review of the trigger levels.
- A review of the effectiveness of all action and response strategies.
- A trend analysis of data collected.
- A review and analysis of any community complaints.
- Opportunities for improvement in dust management.

5.9 Review

The Air and Dust Management Plan will be reviewed and updated consequent to a material change in risk, operational activities, legal requirements, or an incident relevant to dust management.

Field and reporting systems and processes may be reviewed if non-conformances continue to be recorded.

6.0 Incident Reporting and Complaints

In the event of an environmental incident or serious environmental incident, the DNREAS will be notified as soon as practicable, as per Section 29 of the *Mining Management Act 2001*. Initial contact will be made verbally, followed by notification in writing as soon as possible after the incident. A subsequent report will be submitted to DITT (within ten (10) business days of the initial notification of the incident or receipt of monitoring results, whichever is the latter). The report will detail all pertinent details of the investigation carried out, results and interpretations of any monitoring, outcomes of actions taken at the time to prevent or minimise unlawful environmental harm, and actions taken to prevent further incidents from occurring (to be determined in consultation with relevant parties).

Any complaints received during the Project will be reported through the *Dust Incident Report Form* (**Attachment 1**).

A Complaints Register will be established prior to the commencement of operations and will be maintained until decommissioning. The register is to include the following details:

- Complainants contact information
- Time and date of complaint
- Reasons for complaint
- Investigations undertaken
- Conclusions formed
- Actions taken to address complaints
- Abatement measures implemented
- Person responsible for resolving the complaint
- Feedback provided to the complainant.

Upon notification, the Site Manager will investigate the event and coordinate the implementation of corrective or preventative action. The Site Manager is also responsible for reporting of significant incidents to DEPWS and DITT and for ensuring that corrective action is taken to prevent recurrence.

Avenira will ensure that the procedure for incident reporting is being complied with and that the procedure allows for the timely reporting, investigation, and mitigation of incidents, hazards, and near misses.

Avenira will record, compile, and store all monitoring results for no less than five years.

7.0 References

AS/NZS 3580.10.1. 2016. "Methods for Sampling and Analysis of Ambient Air, Method 10.1: Determination of Particulate Matter-Deposited Matter-Gravimetric Method, Australian/New Zealand Standard TM."

Coffey. 2009. "Draft Environmental Impact Statement, Wonarah Phosphate Project."

DNREAS. 2010. "Wonarah Phosphate Project , Assessment Report 64."

MfE. 2016. *Good Practice Guide for Assessing and Managing Dust.* Wellington: Ministry for the Environment/Manatū Mō Te Taiao.

NSW EPA. 2022. "Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales." August.

Attachment 1 Dust Incident Report Form

Air Quality and Dust Management Plan

Wonarah DSO Phosphate Project

Avenira Limited

Avenira Dust Incident Report Form

Date and time of complaint.	
The method by which the complaint was made (i.e. verbal, telephone, written).	
Vehicle description / ID / Persons involved	
Any personal details of the complainant which were provided by the complainant, or if no such details were provided, a note to that effect.	
Whether the dust was visible (airborne) or deposited.	
The location of the nuisance observation.	
Wind speed and direction prior to, and at the time the complaint was received.	
Site activities at the time of the complaint (and the period leading up to).	
The action taken by the Site in relation to the complaint, including any follow up contact with the complainant.	
If no action was taken, the reason(s) why no action was taken.	
Complaint and follow up correspondence reported to Stakeholder Engagement Team for Consultation Manager	
Complaint received by:	

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