BLACK CAT SYNDICATE
KAL EAST PROJECT

FINGALS TAILINGS STORAGE FACILITY RAISE

WORKS APPROVAL APPLICATION SUPPORTING DOCUMENT

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1 INTRODUCTION

1.1 BACKGROUND

Black Cat Syndicate Limited ("Black Cat") purchased a portion of Silver Lake Resources (SLR) Mt Monger tenement package in July 2020 which included the Imperial-Majestic, Fingals, Wombola Dam and Hammer-Tap gold deposits which are collectively referred to as the 'Kal East Project'.

The overall Kal East Project was first identified near Mount Monger in 1896 by local prospectors, following the major discovery of gold at Kalgoorlie in 1893.

The Project has been subject to land degradation as a result of extensive historic mining activities (both mining and processing), and rangeland grazing. The Mount Monger area has and continues to be used for pastoral activities (i.e. grazing) for more than 100 years.

Mining and mineral processing activities commenced at Fingals (formerly referred to as Mt Monger South) in 1991 with the development of open pit mining and construction of the treatment plant and paddock tailings storage facility (TSF). Ore was first treated in 1992. Four open pits (Fingals Fortune (also referred to as 'Fingals'), Bagus, Futi Bagus and Sibu) were mined from 1991 to 1994. The majority of the Project area was rehabilitated and no mining has occurred since that time.

Ore from Randall's was carted and treated through the Fingals plant. Tailings from both areas were deposited in the above ground Fingals TSF, northern part of the Fingals pit, and three in-pit TSF's (Bagus, Futi Bagus and Sibu). These pits were mined entirely above the water table and remain dry.

No mining activities have been undertaken within the Fingals area since mining ceased in 1997. Progressive rehabilitation works across the project area were undertaken from 1993-1997 by General Gold. Bagus, Futi Bagus, Sibu and Fingals waste rock dumps were rehabilitated from 1993 until 1997 and partial rehabilitation of the TSF batters was undertaken. It is not known when this work was completed.

The three in-pit TSF's (Futi Bagus, Bagus, Sibu) have been rehabilitated. In 2012 the plant and majority of the infrastructure was removed from the site and the plant area rehabilitated.

Black Cat now intends to recommence mining activities at the Fingals Project area ('Project').

Black Cat proposes to commence mining activities at the Project with expansion of the existing Fingals, Bagus and Futi Bagus open pits. This will require excavation of dry historic tailings deposited and retained in the Fingals, Fingals East-1, Fingals East-2, Bagus and Futi- Bagus pits which will then be disposed of on top of the existing Fingals TSF.

1.2 OBJECTIVE

The objective of this document is to provide supporting information for Black Cat's Works Approval (WApp) application for the excavation of approximately 1.3 Mt of dry historic tailings from the open pits and disposal on top of the existing Fingals TSF.

1.3 OWNERSHIP AND TENURE

The Project is 100% owned by Black Cat (Kal East) Pty Ltd. The tenements which are part of this WApp are listed in Table 1 and presented in Figure 2.

The Project is located on the Mt Monger Pastoral lease within the City of Kalgoorlie-Boulder.

The Majestic Timber Reserve is located approximately 3 km north of the Project.

Table 1: Tenements part of this WApp

Tenement	Tenement Holder
M26/148	Black Cat (Kal East) Pty Ltd
M26/197	Black Cat (Kal East) Pty Ltd
M26/248	Black Cat (Kal East) Pty Ltd
M26/357	Black Cat (Kal East) Pty Ltd
M26/364	Black Cat (Kal East) Pty Ltd
M26/409	Black Cat (Kal East) Pty Ltd
M26/440	Black Cat (Kal East) Pty Ltd
M26/635	Black Cat (Kal East) Pty Ltd

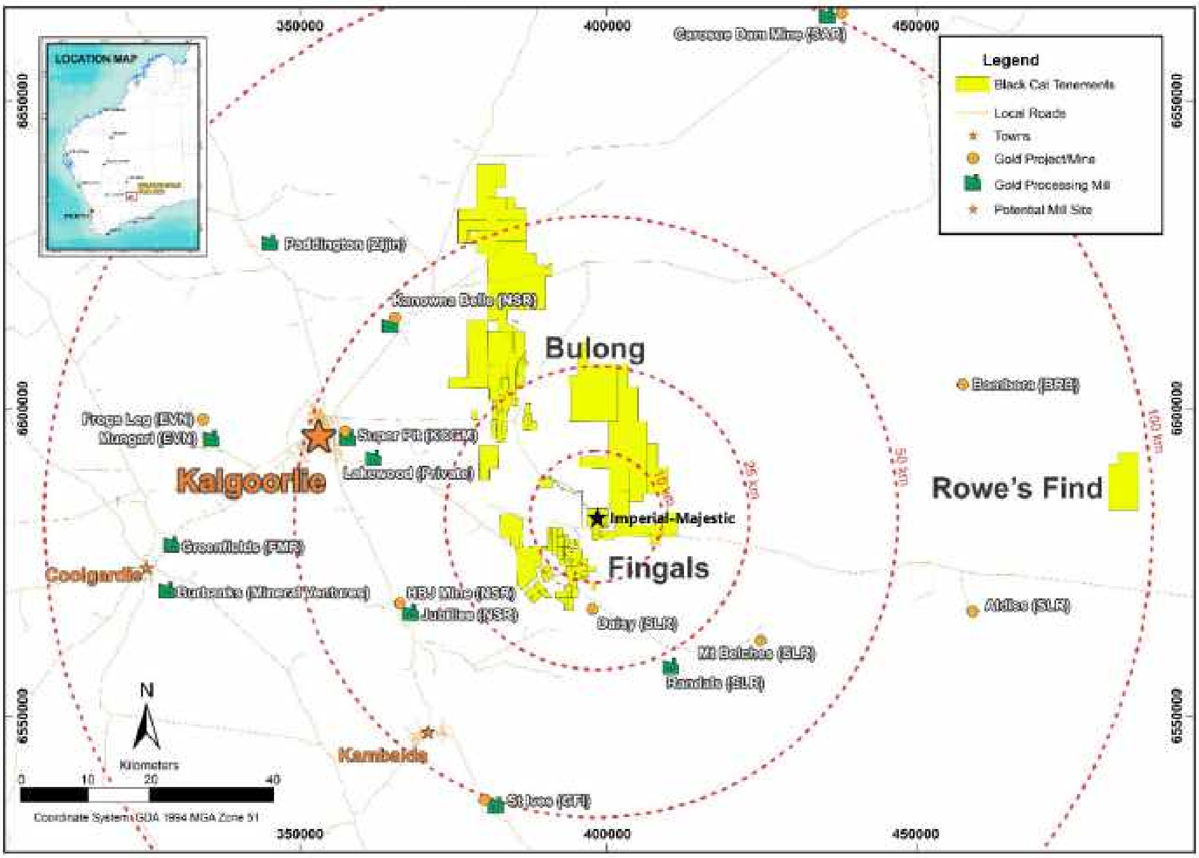

Figure 1: Location of Project

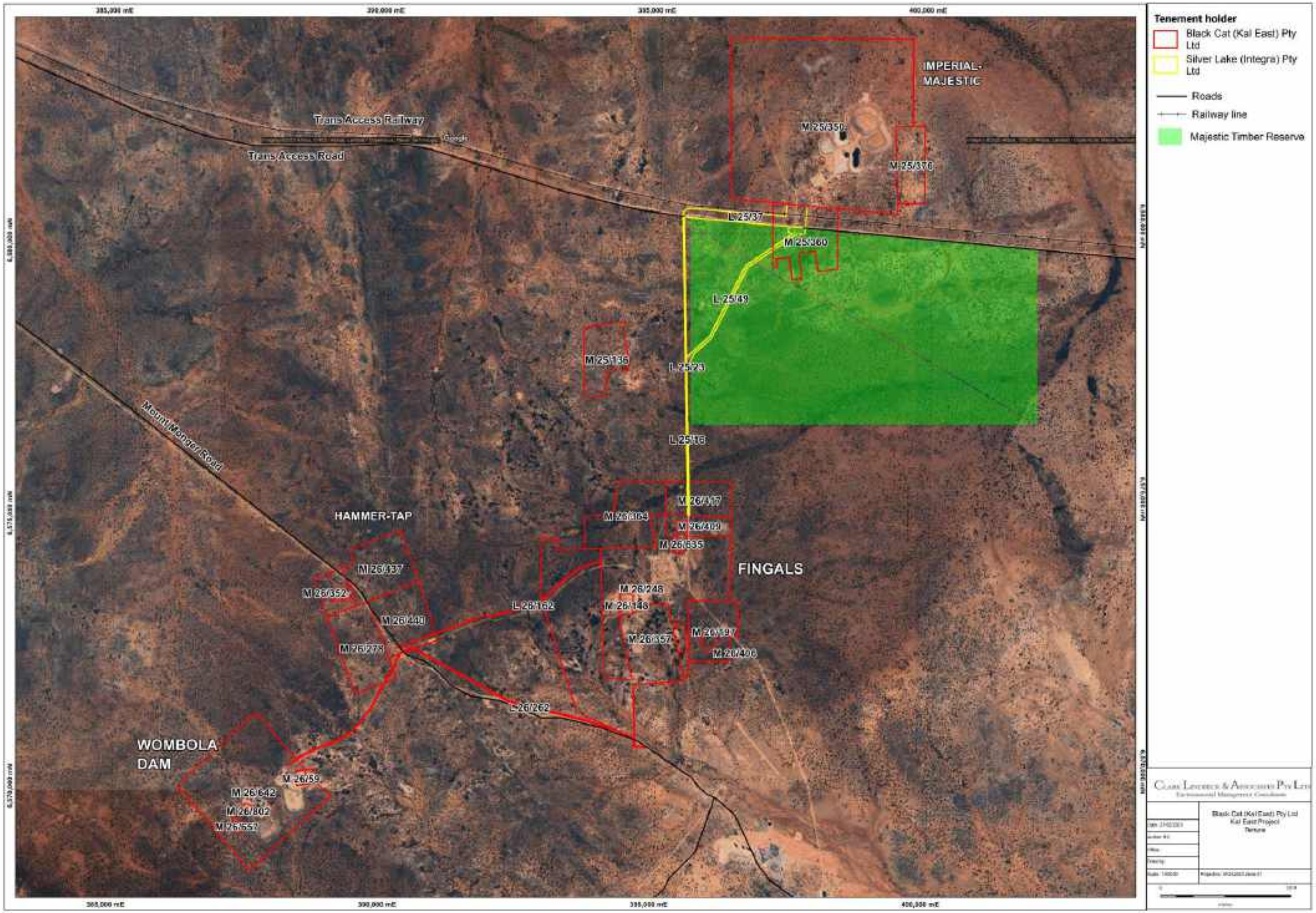

Figure 2: Project Tenure

4 ATTACHMENT 4 – SITE PLAN

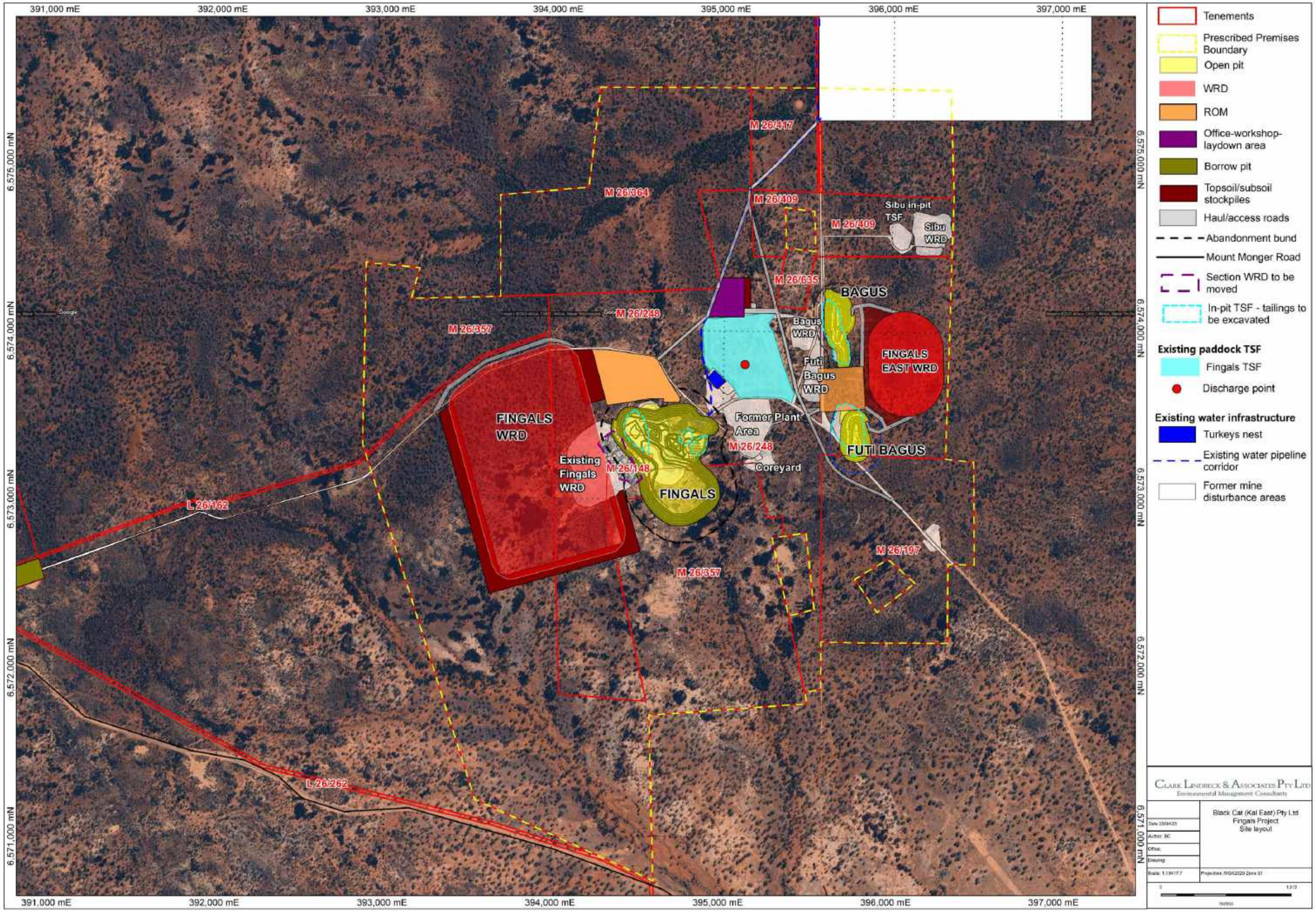

Figure 3: Fingals site plan

5 ATTACHMENT 3B – PROPOSED ACTIVITIES

5.1 PRESCRIBED PREMISES

The proposed excavation and disposal of dry historic tailings on the existing Fingals paddock TSF are part of the following prescribed category:

- Category 5: Processing or beneficiation of metallic or non-metallic ore.

Black Cat proposes that 750,000 m^3 of dry historic tailings will be disposed on top of the existing Fingals TSF which equates to a maximum of 1.3 Mt of dry historic tailings.

The disposal of dry historic tailings will occur in Stages:

- Stage 1: Stage 1 - Fingals - 115,200 m^3 – 200,000 t (Year 1).
- Stage 2: Bagus-and Futi Bagus 667,900 m^3 - 1.15 Mt (Year 2).

5.2 PROJECT INFRASTRUCTURE

Black Cat intends to recommence mining activities at the Project with expansion of the existing Fingals, Bagus and Futi Bagus open pits and construction of associated mine infrastructure (Figure 3). Table 2 provides a summary of the elements proposed for the overall Project.

Black Cat proposes to develop the Project in two stages:

1. Mining of Fingals pit to just above the water table (MP currently under assessment) – requires excavation and disposal of dry historic tailings from Fingals pits
2. Mining of the Fingals pit below the water table; and mining of Bagus and Futi Bagus pits (subject of a future MP) – requires excavation and disposal of dry historic tailings from Bagus and Futi Bagus pits.

This application covers both Stages of development requiring disposal of excavated dry historic tailings to the existing Fingals TSF (prescribed activity).

Table 2: Works proposed at Fingals

Item	Description
Fingals Fortune Pit	Expansion of Fingals Fortune pit and excavation of dry historic tailings stored in the northwest section of the Fingals pit (and smaller Fingal East-1 and Fingals East-2 pits) and disposal onto the existing Fingals TSF.
Bagus and Futi Bagus Pits (Fingals East)	Excavation of dry historic tailings contained in the Bagus and Futi Bagus pit and relocation to the top of the Fingals TSF. Expansion of the Bagus and Futi Bagus pits (Fingals East).
Fingals TSF	The existing TSF will be raised by approximately 7.5 m by stacking dry historic tailings removed from the Fingals, Bagus and Futi Bagus pits with the dry historic tailings deposited on top of the existing TSF. This will be undertaken in 2 stages in progressive 0.5m lifts: 1. Stacking dry historic tailings removed from the Fingals pits on top of the TSF. 2. Stacking dry historic tailings from Bagus and Futi Bagus. The total height of the finished facility will be 10-15 m (estimated 13m).
Fingals WRD	Expansion of the existing Fingals WRD to store waste from the pit expansion.
Fingals East WRD	Development of the Fingals East WRD to store waste from Bagus and Futi Bagus pits

Item	Description
Turkeys nest dam (former Process water dam)	The existing dam will be HDPE lined and fenced.
ROM	Establishment of ROM north of the Fingals pit and in between Futi Bagus and Bagus pits to temporarily store ore mined prior to haulage offsite to the Lakewood processing plant.
Mine services area	Provision for office, workshop, fuel storage and associated laydown/hardstand areas.
Borrow pit	Expansion of the existing borrow pit on M26/440 to access construction/sheeting material as required.
Haul road	New haul and access roads for transport within the site.
Topsoil/subsoil storage	Provision for topsoil and subsoil storage areas for use in rehabilitation.

5.3 EXISTING TSF

The existing paddock style Fingals TSF is approximately 5 m high.

The surface is internally-draining and rehabilitation has been completed to varying levels of success. All infrastructure such as decants and pipes have been removed or buried, a crest bund has been installed so that the TSF is internally draining.

5.4 FINGALS TSF RAISE

The existing Fingals TSF will be raised by approximately 7.5 m by stacking the dry historic tailings removed from the Fingals, Bagus and Futi Bagus pits on top of the existing TSF.

Black Cat estimates the following dry historic tailings material volumes for relocation onto the existing TSF landform:

- Fingals - 115,200 m^3
- Bagus- 301,700 m^3
- Futi-Bagus - 356,200 m^3.

The overall density is estimated at around 1.6 to 1.65 t/m^3.

Based on the above, an estimated 750,000 m^3 will be disposed on top of the TSF or 7.5 m x 100,000 m^2. This equates to approximately 1.23 Mt of dry historic tailings.

Non-acid forming fresh basalt rock will be used in the covering of the final TSF landform. It is understood that the Stage 3 pit development will produce a total of 1,294,600 bcm or 3,624,880 tonnes of mine waste material.

CMW (2022) completed a geotechnical investigation of the TSF and this report is attached as Appendix A.

The new TSF landform will have a downstream slope of 1(V):3(H) and be capped with a 0.5m thick rockfill mine waste layer on the top surface and 1 m thick on the downstream slopes and a total height of the finished facility will be approximately 13 m in height (above ground surface).

Based on CMW (2022) recommendations, the following works will be undertaken on the Fingals TSF landform:

- As part of preparation works, the surface of the TSF will be stripped of any deleterious material and proof rolled as directed by a Geotechnical Engineer.
- The ‘dry historic tailings stack’ is then constructed by paddock dumping dry historic tailings on the surface of the TSF.

- The dry historic tailings material is then spread and placed in 0.5 m layers with a dozer and traffic compacted with the servicing mine fleet. Water is added as necessary for compaction and dust suppression. A water cart will be available to conduct dust suppression.
- Initial standard compaction and in situ moisture content of the dry historic tailings will be established early on the project using compaction trials to confirm that the targeted dry density is reached. The stacked dry historic tailings will be tested for insitu density early in the landform construction to ascertain whether the dry historic tailings have received sufficient compaction using the work methods proposed. The target dry density is a minimum of 1.6 t/m^3 (dry) (i.e. approximately 95% of SMDD).
- A 1.0 m thick rockfill mine waste will be progressively used as a batter capping layer to create a robust and structure that is not susceptible to erosion. A minimum thickness of 0.5 m of mine waste will be placed on the top of the TSF landform. Approximately 100,000 m^3 of mine waste capping will be required.

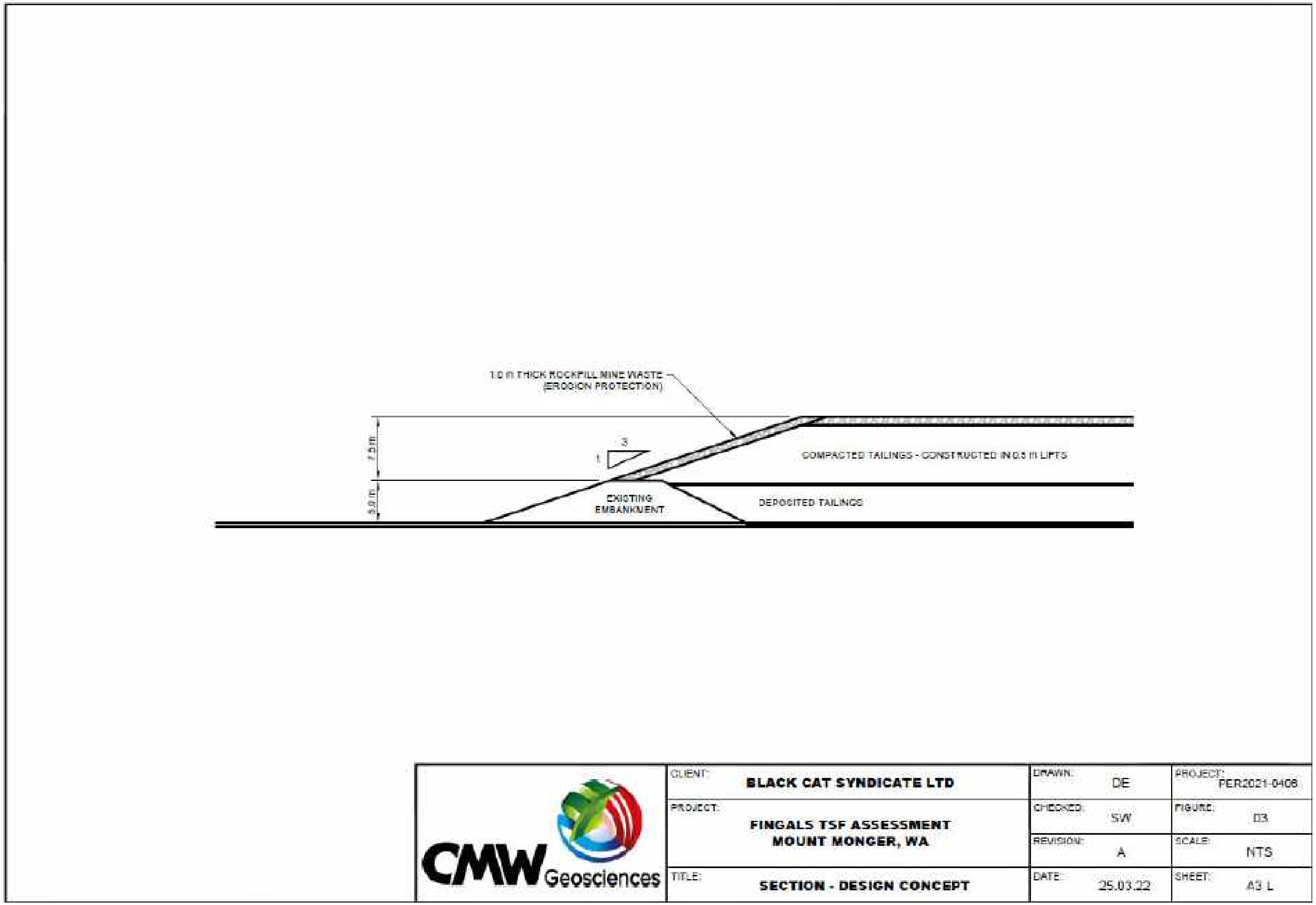

Figure 4: Proposed Fingals TSF design

5.5 CONSTRUCTION WORKS

There is minimal construction work required for the new Fingals TSF landform.

Site preparation works will involve stripping any deleterious material from the surface which will then be proof rolled as directed by a Geotechnical Engineer.

Construction works are expected to take 1 week and planned to commence in Q3 2025. An assessment of the potential risks associated with the construction phase and proposed management measures to be implemented is included in Section 8.2.

5.6 GEOTECHNICAL ASSESSMENT

Stability analyses were undertaken to assess the new TSF landform with a nominal height of 12.5 m (5 m of existing embankment and 7.5 m of stacked mine waste). The analyses were undertaken in general accordance with ANCOLD (2019).

The stability analyses indicate adequate factors of safety were achieved for the drained and post-seismic conditions when compared with the recommended minimum factors of safety in ANCOLD (2019).

5.7 DRY HISTORIC TAILINGS CHARACTERISATION

5.7.1 Physical characterisation

As part of the CMW (2022) geotechnical assessment, the tailings in the current TSF were assessed via sampling from two test pits (TP02 and TP05). The results indicate the tailings are a low to medium plasticity silt (ML) and are further described in Appendix A (Section 5.4, pp 5-7).

Appendix B (Section 3.2) contains further detail on the in-situ dry historic tailings properties at Futi Bagus.

5.7.2 Geochemical characterisation

Geochemical characterisation of tailings during previous mining in the 1990’s was not undertaken. Given the continuity of the deposits with Imperial-Majestic deposits (located ~8km to the north), it is considered the tailings at Fingals are consistent with Imperial-Majestic which are summarised below:

- Both tailings-solids samples are classified as Non-Acid Forming (NAF). The NAF classification for the Oxide-Ore-Tailings sample, reflects 'negligible sulphides', corresponding to a Cr(II)-Reducible-S (CRS) value less than 0.005%. The Primary-Ore-Tailings sample recorded a CRS value of 0.741 % (as pyrite-S) in a gangue that is appreciably calcareous associated with dolomites, with the tailings-gangue having an excess of 'carbonate-alkalinity' forms for circum-neutral buffering as the pyrite decomposes over time during weathering (GCA 2021).
- Both tailings-solids samples were characterised by major/minor-element contents either less than, or close to, those typically recorded for soils, regoliths and bedrocks derived from non-mineralised terrain with slight enrichments recorded for As and Cr for the Oxide-Ore-Tailings sample (GCA 2021).

Six dry historic tailings samples were collected from Fingals (2014) and eight dry historic tailings samples from CPTu testing conducted by Black Cat at Futi Bagus (2025) and the results are included in

Table 3. The COA and head assay results from the recent Futi Bagus analyses is provided in Appendix C. The average crustal abundance is presented in Table 3 and shows, consistent with GCA (2021) shows enrichments for As and Cr. The remaining are consistent with or less than ACA.

5.7.3 Moisture content

The moisture content of the sampled dry historic tailings is presented in Table 3. The Futi Bagus dry historic tailings, which were sampled from the rehabilitated in-pit TSF where the dry historic tailings had an appropriate cover established over the top of, had a low moisture content compared with the Fingals dry historic tailings which there is no cover material.

Table 3: Fingals and Futi Bagus dry historic tailings analyses results

Sample ID LOR	Unit		FINGALS - 2014						FUTI BAGUS - 2025								ACA
			PE089143.001	PE089143.002	PE089143.003	PE089143.004	PE089143.005	PE089143.006	FB1-9m	FB1-13m	FB1-19m	FB1-19m	FB2-15.50m	FB2-21m	FB2-21m	FB3-19m	
% Moisture	%	0.5	18	11	7.4	7.4	6.4	8.8	0.88	0.76	0.20	0.16	8.76	0.26	0.52	0.12	
Total Cyanide	mg/kg	0.5	6.2	5.7	5.4	51	69	62	48	133	88	78	217	100	75	62	
Weak Acid Dissociable CN	mg/kg	0.5	2.3	0.7	1.2	1.1	1.3	1.1	<1	<1	<1	<1	<1	<1	<1	<1	
Antimony, Sb	mg/kg	2	5	4	3	4	4	4	1.5	1.5	1.1	1.2	1.1	1.0	1.0	1.0	0.2
Arsenic, As	mg/kg	1	840	970	700	1100	970	1900	3140	2100	2330	1880	2070	1460	1740	1840	1.5
Barium, Ba	mg/kg	0.5	160	210	210	170	150	190	400	300	300	300	400	300	300	300	500
Beryllium, Be	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	<5	<5	<5	<5	<5	2.8
Boron, B	mg/kg	5	19	14	14	16	21	18	<50	<50	<50	<50	<50	<50	<50	<50	10
Cadmium, Cd	mg/kg	0.3	0.7	0.6	0.6	0.7	0.7	0.8	<5	<5	<5	<5	<5	<5	<5	<5	0.11
Cobalt, Co	mg/kg	0.5	18	23	33	15	12	11	25	25	20	20	20	20	20	15	20
Copper, Cu	mg/kg	0.5	36	31	26	33	36	41	90	78	48	50	92	58	46	52	50
Chromium, Cr	mg/kg	0.5	77	60	54	64	89	72	88	95	53	56	89	66	55	55	950
Lead, Pb	mg/kg	1	5	4	4	5	5	5	20	25	10	20	15	<5	10	10	14
Nickel, Ni	mg/kg	0.5	66	63	73	51	42	40	185	165	115	140	130	95	90	110	80
Selenium, Se	mg/kg	<2	<2	<2	<2	<2	<2	<2	<5	<5	<5	<5	<5	<5	<5	<5	0.05
Vanadium, V	mg/kg	0.5	45	36	35	39	48	41	88	82	64	54	80	60	56	54	160
Phosphorus, P	mg/kg	10	370	350	290	390	380	420	800	800	700	700	800	700	700	800	1,050
Mercury	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.085
Hexavalent Chromium, Cr^{6+}	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Trivalent Chromium, Cr^{3+}	mg/kg	0.5	77	60	54	64	89	72	88	95	53	56	89	66	55	55	

5.8 EMBANKMENT MATERIAL

5.8.1 Source

Materials for the TSF batter and capping layer will be sourced from Fingals with provision for use of fresh waste rock from Imperial-Majestic (currently being developed).

5.8.2 Materials characterisation

5.8.2.1 Fingals

Waste characterisation work completed at Fingals identified the following (SWC 2022; Environmental Innovations 2022):

- The loose sediment and ferruginous laterite and basement fresh rock material are neutral to slightly alkaline and the entire profile displays generally low to moderate levels of salinity.
- Basalt/mafic samples (fresh rock) all contained low sulfur contents (<0.3%) with acid neutralising capacity (ANC) potential of all basalt samples tested from Fingals report an average of 67 kg H_2SO_4/t i.e. Non-acid forming (NAF).
- Multi-element composition and leaching trials have reported generally low concentrations both within the solid materials phase and the bottle test leachate. Concentrations of Arsenic were elevated in several samples and are expected to be present as trace arsenopyrite, whilst concentrations of Manganese were slightly above the guidelines for long term irrigation water use. Consequently the risk of Metalifferous Drainage following disturbance of waste materials is considered to be low.

5.8.2.2 Imperial-Majestic

Waste characterisation work at the Imperial-Majestic deposit which was completed by Environmental Inorganic Geochemistry Group (EIGG) (2012) and the results of the assessment as they relate to fresh competent rock revealed:

- Samples neutral to alkaline
- Material has low %S and ANC exceeded acid generating potential i.e. samples NAF.

6 ATTACHMENT 3A – COMMISSIONING PLAN AND TIME LIMITED OPERATIONS

6.1 COMMISSIONING

No commissioning works are required.

6.2 TIME-LIMITED OPERATIONS

Time limited operations are proposed to commence immediately upon the completion of TSF surface preparation work and will continue until the DWER Licence is granted.

An assessment of the potential impacts resulting from Time-limited operations and management measures to be implemented to ensure the risks are reduced to ALARP is included in Section 8.2.

6.3 MANAGEMENT AND MONITORING

6.3.1 Time-Limited Operations

Daily inspections of the TSF will be undertaken during disposal to the facility and inspections around the perimeter of the landform will be undertaken following heavy rainfall.

6.3.2 Environmental targets

Black Cat have the following targets during time-limited operations:

- No release of tailings outside of the TSF landform.
- No visual evidence of generation of tailings dust.

6.3.3 Emissions and Discharges

The potential emissions and discharges relating to time limited operations, with the proposed controls are provided in Attachment 6A, Section 8.

6.4 REPORTING

All environmental incidents will be recorded and investigated under Black Cat's incident reporting system. Reporting of incidents other than minor incidents shall follow the requirements set out in s72 of the *Environmental Protection Act 1986*.

7 ATTACHMENT 5 – OTHER APPROVALS AND CONSULTATION / ENVIRONMENTAL LEGISLATIVE FRAMEWORK

7.1 OTHER STATUTORY APPROVALS

Table 4 summarises the statutory approvals required for the proposed TSF works

Table 4: Environmental Legislative Framework for the activities outlined in this Supporting Document

RELEVANT LEGISLATION	ENVIRONMENTAL FACTOR REGULATED/AFFECTED	RELEVANT APPROVAL REQUIREMENT
APPROVALS		
Aboriginal Heritage Act 1972	Aboriginal heritage	Nil – no known Aboriginal sites impacted.
Environment Protection and Biodiversity Conservation Act 1999	Biodiversity Land and Soils	Not required – no clearing or triggers for referral.
Environmental Protection Act 1986 (EP Act) Part IV (and Administrative Procedures 2012)	Biodiversity Land and Soils	No significant impact to any environmental factors resulting from the Project.
Environmental Protection Act 1986 (Part V) - Licensing	Water Resources Land and Soils	This Works Approval application is to obtain approval for the excavation and disposal of excavated dry historic tailings on top of the existing Fingals TSF.
Environmental Protection Act 1986 (Part V); Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Biodiversity	A clearing permit for the required clearing of native vegetation for expansion of the open pits and associated infrastructure at the Project (up to 260 ha) has been submitted concurrently with this WApp. No clearing is required for the TSF.
Mining Act 1978 and Mining Regulations 1981	Biodiversity Land and Soils Rehabilitation and Mine Closure	An MP for the Stage 1 works has been submitted to DEMIRS. An MP for Stage 2 (which includes Bagus and Futi Bagus dry historic tailings excavation) will be submitted in the future.
Rights in Water and Irrigation Act 1914	Water resources	Black Cat has two licenses to take water, GWL 176418(6) and 181140 (5). Black Cat will ensure the GWL are amended (where required) to include the use of water for dust suppression on the Fingals tenements part of the MP.
Biodiversity Conservation Act 2016	Biodiversity	No approvals required.

7.2 CONSULTATION

Consultation with stakeholders is continuous and undertaken to discuss identified issues or concerns over the life of the operation.

Black Cat’s strategy is to identify and annually review key stakeholders for the operations. Regular contact is maintained to discuss current or future proposals that may cause impact requiring stakeholder input. Plans are presented and discussed to obtain relevant feedback. The aim is to communicate appropriately and reach understanding in order to proceed with agreeable and suitable options for both parties.

Advice was sought from DWER to confirm that the proposed dry historic tailings excavation and disposal (where to the TSF or to WRD) required Part V approval under the EP Act.

On 10 October 2024 DWER confirmed that “both disposal options (including both aspects described under Option 2) meet the description of category for Category 5 under Schedule 1 of the *Environmental Protection Regulations 1987”* (*pers. comm.* Kang Tam, A/Manager Resource Industries).

8 ATTACHMENT 6A – EMISSIONS, DISCHARGES AND WASTE

8.1 POTENTIAL EMISSIONS

Potential emissions arising from the construction and time-limited operation of the prescribed premises are:

- Noise during construction activities
- Dust generated during time-limited operations
- Potentially contaminated runoff from dry historic tailings to the surrounding area
- Seepage from TSF facility.

The management measures and controls to be implemented are summarised in the risk assessment presented in Table 5.

8.2 RISK ASSESSMENT AND MANAGEMENT SUMMARY

A summary of the potential environmental risks relevant to the Works Approval application and the associated environmental management measures to be implemented to reduce these risks to an acceptable level, are summarised in Table 5.

The residual risk assessment ratings are consistent with the risk assessment matrix used by DWER as shown in Table 6.

Table 5: Risk assessment and management summary for the proposed Fingals Dry Dry historic tailings Deposition

Activity	Potential Emission Type and Source	Potential Receptors	Potential Pathway	Potential adverse Impacts	Impact Assessment/ Proposed Controls	Residual Risk		
						LIKELIHOOD	CONSEQUQ	PRIORITY
CONSTRUCTION								
TSF preparation works	Noise – Equipment, machinery and vehicles used during construction works	Local fauna Residential – Mt Monger homestead – >3.5 km.	Air / wind dispersion	Amenity impacts	Any noise generated during construction will be short term and unlikely to result in significant emissions above that already generated by the operations. Operations will comply with the Environmental Protection (Noise) Regulations 1997.	Unlikely	Slight	Low
	Dust generation from site preparation works on the TSF surface. Vehicle movements	Soils and vegetation surrounding TSF – area to the south of TSF comprises former mine disturbance. Residential – none.	Air / wind dispersion	Adverse impacts to human health and amenity; vegetation health	Water trucks will be utilised during construction activities to control dust as required.	Unlikely	Slight	Low
	Light emissions	Local fauna Mt Monger homestead – >3.5 km.	Air dispersion.	Light spill may disrupt nocturnal foraging behaviour: Amenity impacts	Construction activities will occur only during dayshift.	Unlikely	Slight	Low
	Hydrocarbons - hydraulic equipment failure and spills	Flora and vegetation.	Direct discharge to land and infiltration to soil	Soil contamination inhibiting vegetation growth and survival, and health impacts to fauna.	Hydrocarbon spills will be removed by absorbent material (liquid phase) and/or excavation. Contaminated soils will be removed offsite to a licensed facility for treatment or disposal. Contaminated waste materials from spill clean ups (filters, rags, hydrocarbon absorbent materials) will be collected in appropriately labelled waste containers and will be removed from site by a licensed contractor for recycling/disposal at an appropriate facility.	Unlikely	Slight	Low
OPERATIONS (INCLUDING TIME-LIMITED OPERATIONS)								
Excavation and disposal of dry historic tailings	Noise – Equipment, machinery and vehicles used during operation	Local fauna Mt Monger homestead – >3.5 km.	Air / wind dispersion	Amenity impacts	Operations will comply with the *Environmental Protection (Noise) Regulations 1997*.	Unlikely	Slight	Low
	Dry historic tailings dust generated during excavation from the Fingals, Bagus and Futi Bagus pits and transfer to the Fingals TSF. Uncapped dry historic tailings on Fingals TSF drying out and generating dust Windblown dry historic tailings to surrounding areas resulting in soil contamination, reduction in vegetation health and habitat.	Soils and vegetation surrounding TSF – area to the south of TSF comprises former mine disturbance.	Air / wind dispersion	Soil contamination inhibiting vegetation growth and survival, and health impacts to terrestrial fauna.	A water cart will be available for dust suppression during excavation of dry historic tailings. The dry historic tailings material will be spread and placed in 0.5 m layers with a dozer on the Fingals TSF and traffic compacted with the servicing mine fleet. Water will be added as necessary for compaction and dust suppression. Initial standard compaction and in situ moisture content of the dry historic tailings will be established to confirm that the targeted dry density is reached. The stacked dry historic tailings will be tested for in-situ density early in the landform construction to confirm whether the dry historic tailings have received sufficient compaction using the work methods proposed. The target dry density is a minimum of 1.6 t/m3 (dry) (i.e. approximately 95% of SMDD). Progressive capping of the dry historic tailings.	Unlikely	Moderate	Medium

Activity	Potential Emission Type and Source	Potential Receptors	Potential Pathway	Potential adverse Impacts	Impact Assessment/ Proposed Controls	Residual Risk LIKELIHOOD	Residual Risk CONSEQUQ	Residual Risk PRIORITY
	TSF dry historic tailings and runoff overtopping embankments and releasing to surrounding areas of native vegetation (towards end of pit life).	Soils and vegetation surrounding TSF – area to the south of TSF comprises former mine disturbance.	Direct discharge to land and infiltration to soil	Soil contamination inhibiting vegetation growth and survival, and health impacts to fauna.	TSF is surrounded largely by disturbed areas. TSF constructed to CMW design which includes 1 m waste batter capping layer and a minimum 0.5m layer mine waste on the TSF surface. Progressive capping of dry historic tailings. Provision for installation of a bund/drain around the perimeter of the TSF to capture any potential runoff prior to capping. Daily inspections (at least once per shift) of the facility during operations. Inspection around the perimeter of the TSF landform following heavy rainfall. Annual Geotechnical assessment of the TSF.	Unlikely	Moderate	**Medium**
	Seepage of dry historic tailings leachate from the base of the TSF with infiltration to groundwater or surrounding soils.	Groundwater of beneficial use – none, groundwater is ~90m bgl and is saline, no local bores or users	Seepage to ground adjacent to the TSF and seepage from the base of the TSF with infiltration to groundwater	Groundwater mounding resulting in reduced vegetation health. Contamination of groundwater with impacts on beneficial users. Soil contamination inhibiting vegetation growth and survival, and health impacts to fauna.	Existing TSF has not been used in >25 years so it is expected the dry historic tailings have consolidated and are dry. Further disposal of dry excavated dry historic tailings to raise the TSF landform is not expected to result in seepage from the dry historic tailings. Progressive capping of dry historic tailings between Stage 1 and Stage 2. Annual Geotechnical assessment of the TSF Rehabilitation of the TSF surface at completion of Stage 2.	Unlikely	Moderate	**Medium**
	Hydrocarbons - hydraulic equipment failure and spills	Soils and vegetation surrounding TSF – area to the south of TSF comprises former mine disturbance.	Direct discharge to land and infiltration to soil	Soil contamination inhibiting vegetation growth and survival, and health impacts to fauna.	Hydrocarbon spills will be removed by absorbent material (liquid phase) and/or excavation. Contaminated soils will be removed offsite to a licensed facility. Contaminated waste materials from spill clean ups (filters, rags, hydrocarbon absorbent materials) will be collected in appropriately labelled waste containers and will be removed from site by a licensed contractor for recycling/disposal at an appropriate facility.	Unlikely	Slight	**Low**

Table 6: Risk Criteria

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Likelihood	
The following criteria has been used to determine the likelihood of the risk / opportunity occurring.	
Almost Certain	The risk event is expected to occur in most circumstances
Likely	The risk event will probably occur in most circumstances
Possible	The risk event could occur at some time
Unlikely	The risk event will probably not occur in most circumstances
Rare	The risk event may only occur in exceptional circumstances

Consequence		
The following criteria has been used to determine the consequences of a risk occurring:		
	Environment	Public Health* and Amenity (such as air and water quality, noise, and odor)
Severe	• on-site impacts: catastrophic • off-site impacts local scale: high level or above • off-site impacts wider scale: mid-level or above • Mid to long term or permanent impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are significantly exceeded	• Loss of life • Adverse health effects: high level or ongoing medical treatment • Specific Consequence Criteria (for public health) are significantly exceeded • Local scale impacts: permanent loss of amenity
Major	• on-site impacts: high level • off-site impacts local scale: mid-level • off-site impacts wider scale: low level • Short term impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are exceeded	• Adverse health effects: mid-level or frequent medical treatment • Specific Consequence Criteria (for public health) are exceeded • Local scale impacts: high level impact to amenity
Moderate	• on-site impacts: mid-level • off-site impacts local scale: low level • off-site impacts wider scale: minimal • Specific Consequence Criteria (for environment) are at risk of not being met	• Adverse health effects: low level or occasional medical treatment • Specific Consequence Criteria (for public health) are at risk of not being met • Local scale impacts: mid-level impact to amenity
Minor	• on-site impacts: low level • off-site impacts local scale: minimal • off-site impacts wider scale: not detectable • Specific Consequence Criteria (for environment) likely to be met	• Specific Consequence Criteria (for public health) are likely to be met • Local scale impacts: low level impact to amenity
Slight	• on-site impact: minimal • Specific Consequence Criteria (for environment) met	• Local scale: minimal to amenity • Specific Consequence Criteria (for public health) met

9 ATTACHMENT 7 – SITING AND EXISTING ENVIRONMENT

9.1 OVERVIEW

A summary of the siting and relevant existing environment aspects is provided in the sections below.

9.2 RECEPTORS

The nearest residence is the Mt Monger Homestead located approximately 3.6 km south of Fingals.

9.3 SPECIFIED ECOSYSTEMS

DWER's Guidance Statement: Environmental Siting (DWER, 2016) lists Specified Ecosystems and Designated Areas and relevant databases which are considered in risk assessments undertaken by DWER. The distances to specified ecosystems are summarised in Table 7.

Table 7: Specified Ecosystems and Designated Areas

Specified ecosystems	Distance from the Premises
Ramsar Sites	None identified within 500 km.
DBCA Managed Lands and Water	Majestic Timber Reserve is located approximately 3 km north of the Project.
Ecological communities (TECs and PECs)	Nil.
Biological Component	**Distance from Premises**
Threatened/ Priority Flora	No Threatened or Priority flora recorded recorded at the Project.
Threatened /Priority Fauna	No evidence of fauna of conservation significance recorded at the Project.
Hydrography WA 250K – Surface Water Polygons	No drainage lines that could cause flooding of the area.
Contaminated Sites	None recorded in DWER's Contaminated Sites database.
Groundwater and water sources	**Distance from the Premises**
Public Drinking Water Source Areas	None within 100 km.
RIWI Act	Premises is located within the Goldfields Groundwater Management Area. Premises is not located within a Proclaimed Surface Water Management Area.

9.4 CLIMATE

The climate of the Eastern Murchison subregion is characterised as an arid climate with mainly winter rainfall and annual rainfall of approximately 200 mm (Beard, 1990; Cowan, 2001). The nearest weather station is the Kalgoorlie-Boulder Airport weather station (#12038), which is located approximately 45 km west of the survey area and commenced operation in 1939. Relevant metrological data from the Kalgoorlie-Boulder Airport weather station is summarised below and in Table 8 (BoM, 2025).

The mean annual maximum temperature is 25.3°C and mean annual minimum 16.7°C. Daily maximums above 30°C are usual from December to February. Diurnal temperature variations are commonly high throughout the year (Table 8).

The area is semi-arid and has an average annual rainfall of 266.4 mm. Most of the rain falls from January to March but the amount varies greatly both seasonally and annually. The highest daily rainfall recorded was 177 mm in February 1948. The region can receive high intensity rainfall from degenerating cyclonic low pressure systems and thunderstorms.

The low, highly erratic rainfall provides many challenges for the successful rehabilitation of disturbed areas. Even during the latter part of the dominant winter growing season, there is still less than a 40% chance (i.e. less than 4 out of 10 years) of receiving sufficient rainfall to generate a significant germination event.

The average wind speeds at Kalgoorlie-Boulder vary throughout the year from 11.8–17.1 km/h in the morning to 13.7-17.8 km/h in the afternoon (Table 8 and Figure 5 and Figure 6). Morning wind is predominantly from the east (NE-SE) varying in direction in the afternoon (Figure 5 and Figure 6).

Evaporation is high, particularly in the summer months (December to February inclusive) and the average mean daily evaporation rate is 7.2 mm (annual calculated rate is 2,628 mm) (Table 8).

Humidity levels vary considerably both daily and yearly (Table 8). The mean monthly 9.00 am relative humidity varies from a low of 43% in December to a high of 74% in June. The mean monthly 3.00 pm relative humidity varies from a low of 24% in December and January to a high of 48% in June.

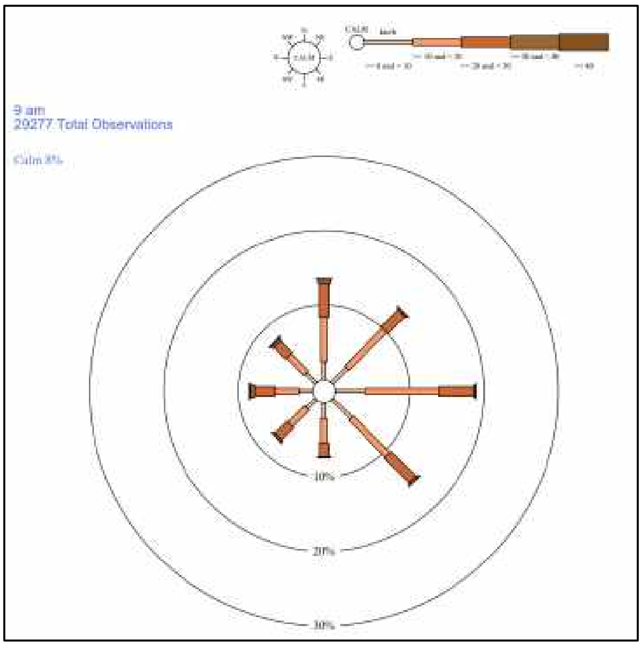

Figure 5: Kalgoorlie-Boulder annual 9 am wind roses

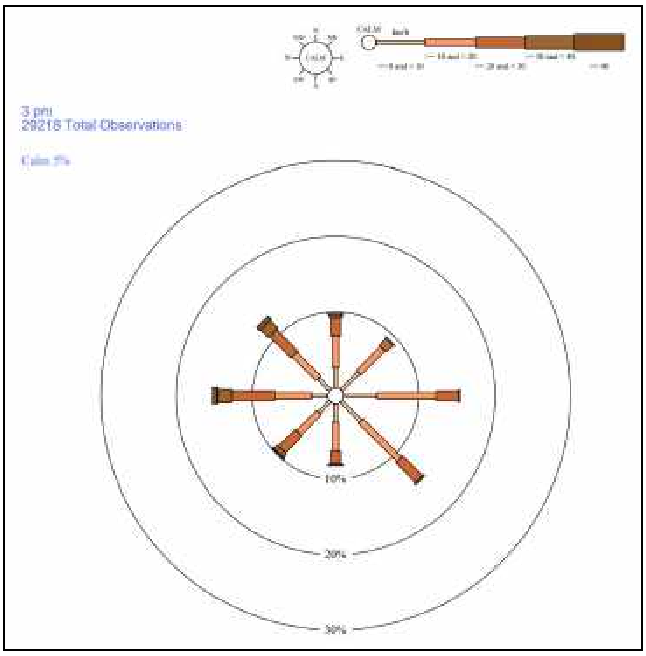

Figure 6: Kalgoorlie-Boulder 3 pm wind roses

Table 8: Meteorological data for Kalgoorlie-Boulder Airport (Station Number 12038) (BOM 2025)

Statistic Element	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	33.7	32.1	29.5	25.3	20.7	17.6	16.8	18.7	22.4	26	29.1	32.1	25.3
Mean minimum temperature (°C)	18.3	17.9	16.1	12.7	8.7	6.3	5.1	5.7	8.1	11.2	14.2	16.7	11.8
Mean rainfall (mm)	27.4	31.6	25	20.2	24.6	27.1	24.2	21.3	13.7	15.8	18.7	16.5	266.1
Highest rainfall (mm)	185.9	307.8	197	98.6	110.2	185.7	82.6	74	98.3	84.4	115.4	88.6	530.8
Highest daily rainfall (mm)	154.4	177.8	70	49.8	45.2	57.2	28.6	49.6	44.2	45.6	77	50.6	177.8
Decile 1 (median) rainfall (mm)	0.6	1.2	0.6	1.3	2.4	5.2	5.4	4.1	1.5	1.1	0.5	1.3	149.3
Decile 5 (median) rainfall (mm)	11.2	14.5	10.1	12.7	18.6	18.6	20	16.2	10.7	10.2	15.3	12.4	254
Decile 9 (median) rainfall (mm)	83.2	79.2	68.5	54.6	47.3	54.6	49	44	29.5	34	40.4	39.9	395.1
Mean number of days of rain ≥ 1 mm	2.5	3.1	2.7	3.3	3.8	4.7	4.8	4	2.9	2.7	2.6	2.5	39.6
Mean number of days of rain ≥ 10 mm	0.7	0.9	0.6	0.6	0.7	0.7	0.6	0.5	0.3	0.4	0.5	0.6	7.1
Mean number of clear days	15.7	13.1	13.4	10.2	10.3	9.1	10.1	12.8	14.1	13.9	12.9	15.5	151.1
Mean number of cloudy days	5.6	6.3	6.9	9.2	10.2	10.4	9.7	7	6.2	5.9	6.5	5.3	89.2
Mean 9am temperature (°C)	23.8	22.8	21	17.9	13.9	11	9.9	11.6	14.8	17.9	20.6	22.7	17.3
Mean 9am relative humidity (%)	45	51	54	60	67	74	73	65	54	47	45	43	57
Mean 9am wind speed (km/h)	16.6	16.4	15.7	14.4	11.8	11.8	12.4	14.3	16.2	17.1	17.1	16.3	15
Mean 3pm temperature (°C)	32.3	30.9	28.6	24.3	19.9	16.8	16	17.8	21.3	24.7	27.8	30.7	24.3
Mean 3pm relative humidity (%)	24	30	32	38	44	48	46	39	31	27	25	24	34
Mean 3pm wind speed (km/h)	15.1	15.1	14.2	13.7	14.1	15.7	16.6	17.2	17.8	17.6	17.2	16	15.9
Mean daily evaporation (mm)	12.5	10.8	8.6	5.8	3.6	2.6	2.8	3.8	5.8	8.4	10.3	12	7.2

9.5 GEOLOGY

The Project area contains a wide range of Archean rocks, including ultramafic, mafic, felsic and intermediate igneous rocks as well as intrusive rocks occupying sills, dykes and veins. The succession is essentially divisible into two parts: a lower unit of felsic to intermediate volcanic, volcanogenic and intrusive rocks; and an upper unit of high magnesium basalt containing numerous units of fine-grained clastic sediment. The upper unit is intruded by ultramafic and mafic sills and irregular bodies of quartz feldspar porphyry. A higher unit of clastic sediments containing BIF occurs to the east of the area. Most aspects of the structural geology are related to the Bulong Anticline, the axial trace of which trends southwest through the centre of the Project area. This major fold is right, upright, upward facing, and plunges at 40^{o} to 60^{o} towards the south-southeast.

The geological sequence at Fingals Fortune is comprised of mafic units of High-Mg basalts to pyroxenite gabbro composition, with intrusive dolerite sills running parallel to bedding with the whole sequence cross-cut by quartz-feldspar porphyries. A deep weathering profile exists across the area extending down to ~60 m in places.

The main mineralisation targeted by the proposed development within the Fingals Fortune area is hosted by the sheared basalt within quartz veins which are structurally controlled and occur as a series of stacked west dipping lodes containing nuggetty gold mineralisation. The shear zones display intense hydrothermal alteration with bleached sericite and pyrite associated with silicification and carbonate alteration. In contrast the mineralisation within the satellite pits to the east of the main deposit area occur parallel to bedding as porphyry hosted mineralisation (SWG 2022a).

9.6 LANDFORM & SOILS

9.6.1 IBRA Region

The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Australian continent into 89 bioregions and 419 subregions (DAWE, 2020a). The project is located within the Eastern Goldfields Subregion and the Eastern Murchison Subregion.

As defined in the IBRA, the Project is located in the Eastern Goldfields, a subregion of the Coolgardie bioregion, within south-western Australia (McKenzie *et al.* 2003). The Project lies within the Archaean Yilgarn Craton, characterised by gently undulating topography. Surface material is deeply weathered, with scattered breakaways, dry creeks and low-lying hills of relatively fresh rock (Clarke 1994). Topographic lows are marked by salt lakes and associated dune systems, the largest being Lake Lefroy (Clarke 1994).

Many of the soil and vegetation descriptions of the north-east Goldfields are similar to those that occur in the southern Goldfields (Pringle *et al.* 1994). Dominant vegetation comprises woodlands and shrublands with ancient drainage valleys, low-lying chenopods along salt lakes, low or mid shrublands on hillsides and, stony plains and hardpan plains with *Eucalyptus* and *Acacia* woodlands. Soil types found in this region include calcareous loamy earths, red loamy earths associated with salt lakes and some red to brown hard pan shallow loams and red sandy duplexes (Tille 2006).

9.6.2 Soil-Landscape Zone

The project is located within the Kambalda soil-landscape zone of the Kalgoorlie Province) (Tille 2006). This zone covers 35,825 km^2 and comprises flat to undulating plains (with hills, ranges and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton. Calcareous loamy earths and red loamy earths with salt lakes soils and some red-brown hardpan shallow loams and red sandy duplexes.

9.6.3 Overall Project Soils

The Project area is situated near the eastern margin of the salt lake or salinaland physiographic division. This division is characterised by an 'old' and 'new' plateau surface. The new plateau surface is represented by fresh bedrock and extensive tracts of superficial deposits derived from the old plateau surface. The old plateau surface is characterised by laterite, sand and gravel plains. This surface occurs in elevated country that separates major drainage basins.

The Project is situated on a topographic high which separated two major drainage systems. The drainage to the north flows to Lake Yindarlgooda while that in the south drains into Lake Lefroy. The divide is characterised by lateritic ridges with minor outcropping basalts.

The Project area soils are classed as the Mx43 soil group (Northcote *et al.,* 1968) comprising gently undulating valley plains and pediments; some outcrop of basic rock: chief soils are alkaline red earths with limestone or limestone nodules at shallow depth on gently sloping slightly concave plains with low gentle rises of soils. Associated are clay plains flanking ultrabasic rock outcrop.

9.6.4 Fingals Soils

Consistent with the time of the original approvals, no topsoil characterisation was undertaken prior to commencement of the former mine operations at Fingals.

Environmental Innovations (EI 2022a) were commissioned by Black Cat to undertake a surface soil characterisation for the Fingals Project.

In addition to chemical analyses undertaken, laboratory-scale erosion tests were undertaken on material existing, and, expected to be located on the outside of the closure landforms and erosion modelling assuming slope angles of 15° with lift heights of 10m.

Two Soil Management Units (SMU's) were identified at the Project by Environmental Innovations (EI) (2022):

- SMU1 – gravelly loamy sand – top 1m of soil across the Project area.
- SMU2 – calcareous loam and clay.

Generally, there is little to no evidence of surface organic accumulation, with most profiles lacking a defined topsoil or 'A' horizon. The top 10-30 cm generally have some structure with larger soil particles partially indurated and forming a surface crust, likely the result of eluviation of finer clay particles over time. This partially structured upper zone quickly disappears, becoming an unstructured friable loamy sand unit with moderate to high gravel content. This unit generally extends to a depth of 80-100 cm.

Underlying the gravelly loamy sand is an abrupt transition to a heavier clay unit which varies from a talcy earthy fabric to medium textured stiff red clays. Where the earthier fabric exists, it is usually a discrete layer above the underlying stiffer clays and is often associated with calcareous mottling.

Further detail on the soils is provided in Table 9.

Table 9: Soil characteristics of Fingals SMU's

SMU	Soil Characteristics
SMU1	Thickness of the gravelly loamy sands varies from 70 to 100 cm, typically containing gravel contents of 20‑40% loosely held by a loamy sand matrix. These soils have a relatively high saturated permeability (averaging slightly over, 1.8 m/day) which is due to the moderate clay and silt content within the < 2 mm fraction. The soils are calculated to contain a good capacity to store available water. All soils within SMU 1 are moderately alkaline to alkaline, with an average pH of 8.2. The soils range from non-saline to moderately saline, with the salinity generally increasing slightly with depth. The soils within the SMU have an average EC of 55 mS/m (slightly saline). Soils are nutrient poor. Soils are non-sodic and with a low CEC.

SMU2	Soils typically contain ~ 10% gravel, with gravel content generally decreasing with depth. The fine fraction (i.e. < 2 mm) is generally classified as a clay to sandy clay loam with an average of 68% sand and 32% silt + clay. Most of the soils in SMU 2 are macro-structurally unstable (i.e. slake when rewet). Some of these soils also appear to be susceptible to surface hard-setting when disturbed. The pH of the soils within the lower subsoil unit averaged 8.6 (slightly alkaline) whilst the EC was slightly higher than that of SMU 1 with an average of 90 mS/m (slightly saline). Display moderate nutrient levels for subsoils. Soils are generally considered non-dispersive, although some dispersion may occur if these soils are disturbed when wet.

9.7 VEGETATION AND FLORA

A Level 1 flora and vegetation study of the Fingals area including and proposed access track north on L25/23, was conducted in July 2012 by Botanica Consulting (Botanica) which identified seven vegetation communities:

- Open low woodland of *Eucalyptus salmonophloia* over dwarf scrub of *Maireana sedifolia* and *Tecticornia disarticulata*;
- Low woodland of *Eucalyptus stricklandii* over scrub of *Melaleuca sheathiana*;
- Low forest of *Eucalyptus ravida* over dwarf scrub of *Maireana triptera*;
- Open low woodland of *Eucalyptus lesouefii*, *E. salmonophloia* and *E. salubris* over dwarf scrub of *Tecticornia disarticulata*;
- Open low woodland of *Eucalyptus lesouefii* over low scrub of *Senna artemisioides subsp. filifolia* and dwarf scrub of *Maireana triptera*;
- Scrub of *Acacia sp.* narrow phyllode over dwarf scrub of *Maireana triptera*; and
- Forest of *Casuarina pauper* over low scrub of *Eremophila decipiens* and dwarf scrub of *Maireana triptera*.

More recently a reconnaissance flora/vegetation survey (and basic fauna survey) was undertaken by Botanica (2021) in November 2020 within the Fingals Project area. A copy of the survey report is attached as Appendix D.

Botanica (2021) identified five broad-scale vegetation communities within the survey area (Figure 9):

- DD-CF1: *Casuarina pauper* low forest over *Eremophila decipiens* open shrubland over *Maireana triptera* low sparse shrubland.
- CLP-EW1: *Eucalyptus lesouefii* low open woodland over *Senna artemisioides* subsp. *filifolia* and *Maireana triptera* low open shrubland.
- CLP-EW2: *Eucalyptus ravida* low open woodland over *Maireana triptera* low open shrubland.
- RS-EW1: *Eucalyptus lesouefii, E. salmonophloia* and *E. salubris* woodland over *Tecticornia disarticulata* low open shrubland.
- RS-EW2: *Eucalyptus stricklandii* low woodland over *Melaleuca sheathiana* shrubland.

This vegetation is not considered to be of high biological diversity and is well represented outside of the survey area (Botanica 2021).

The field survey identified 67 flora taxa within the survey area, representing 38 genera across 19 families.

No Threatened or Priority flora species were recorded within the survey area.

No Threatened or Priority ecological communities or otherwise significant vegetation were identified within the survey area.

The general area has been markedly affected by mining and pastoral activities over an extended period of time. Grazing by feral animals as well as stock is also apparent. This has resulted in a loss of tree cover and a reduction in the diversity of understorey species.

Although the area was heavily disturbed by mining activities in the 1990's, all remaining vegetation communities were described as being in 'good' health (Botanica 2021).

Six weed species were identified at Fingals by Botanica (2022):

- *Centaurea melitensis* (Maltese Cockspur).
- *Dittrichia graveolens* (Stinkwort).
- *Nicotiana glauca* (Tobacco Plant).
- *Oligocarpus calendulaceus.*
- *Salvia verbenaca* (Wild Sage).
- *Solanum nigrum* (Deadly Nightshade).

None of these species are listed as Declared pest under the *Biosecurity and Agriculture Management Act 2007*.

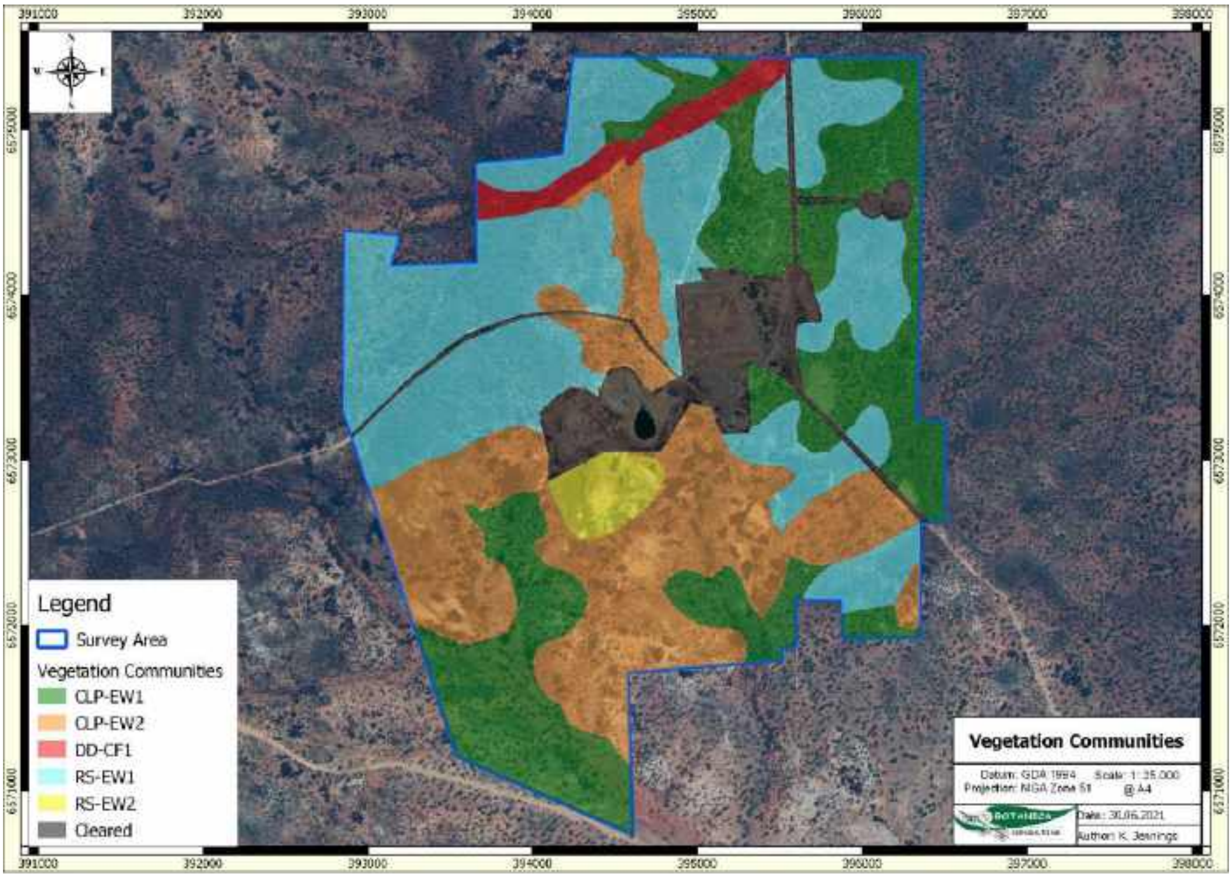

Figure 7: Vegetation communities in Fingals Project area (from Botanica 2021)

9.8 FAUNA

9.8.1 Terrestrial Fauna

A Level 1 fauna risk assessment was completed in 2012 by Terrestrial Ecosystems for the Fingals area which identified one broad fauna habitat type of open eucalypt woodland with a mixed understorey of scattered shrubs and chenopods. Habitat quality varied from very good to completely degraded (goat grazing and historical mining activity). It was considered the habitat represented many square kilometres of adjacent habitat with the resulting conclusion that clearing was unlikely to have a significant impact on vertebrate fauna. The study area did not represent any conservation significant ecosystems.

A basic fauna survey was undertaken by Botanica (2021) in November 2020 within the Fingals Project area (Appendix D). Habitat and distribution data was used to determine the likelihood of occurrence of significant fauna species at the Project, for which Botanica identified two species as potentially occurring:

- Grey Falcon (*Falco hypoleucos*)
- Malleefowl (*Leipoa ocellata*).

No evidence of significant fauna species were observed during the survey, including no evidence of Malleefowl nesting mounds or other activity. Botanica (2021) considered suitable habitat may be present for the Grey Falcon at the Project but is unlikely to represent critical habitat. Botanica (2021) noted that while habitats onsite for the species listed above are considered possibly suitable, some or all may be marginal in extent/quality and therefore the fauna species considered as possibly occurring may in fact only visit the area for short periods as infrequent vagrants.

Based on vegetation and associated landforms identified during the Botanica (2021) flora and vegetation assessment, three broad scale terrestrial fauna habitats were identified as occurring (Figure 8):

- *Eucalyptus* woodland on clay-loam plain
- *Eucalyptus* woodland on rocky slope
- *Casuarina* forest in drainage depression.

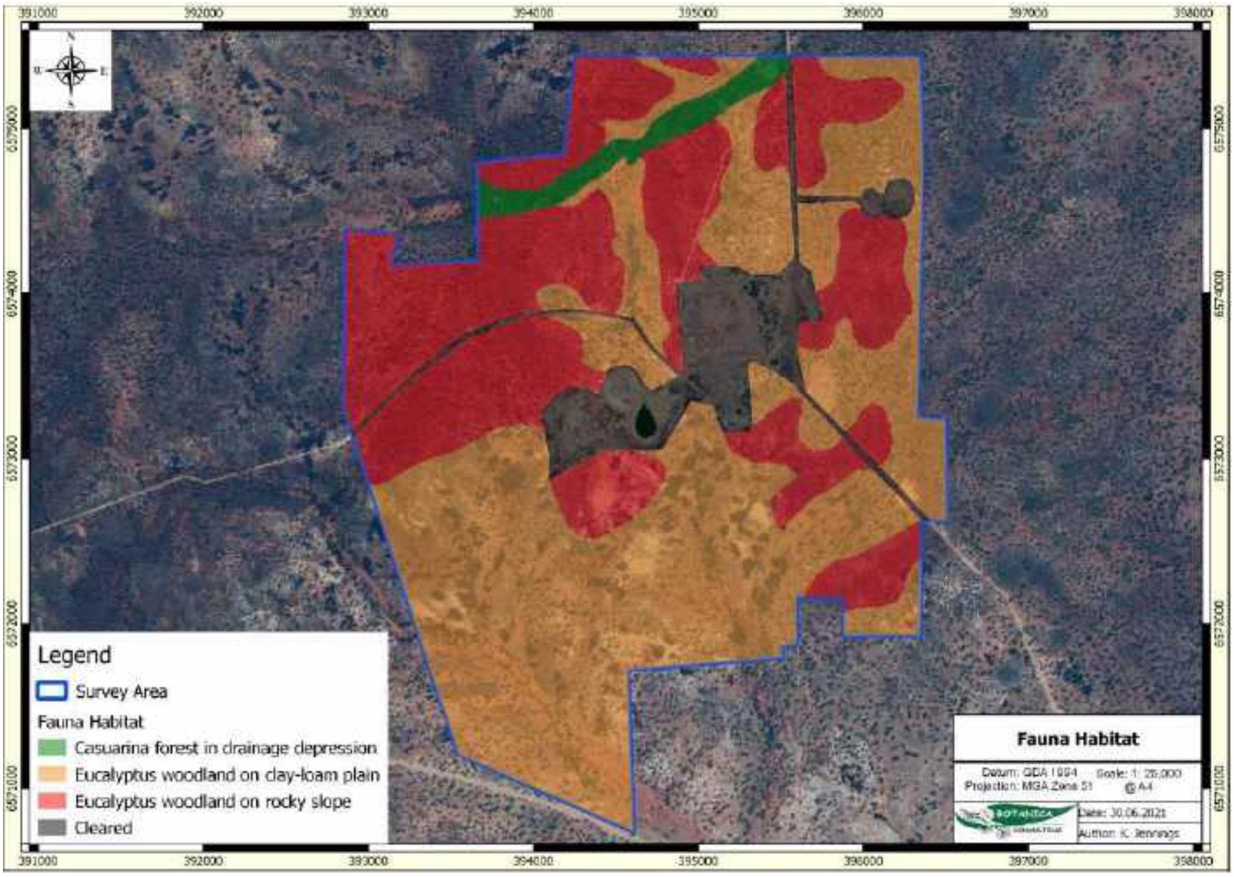

Figure 8: Fauna habitats in Fingals Project area (from Botanica 2021)

9.8.2 Short Range Endemic and Subterranean Fauna

9.8.2.1 Overall

Bennelongia (2022a) completed a desktop assessment for the Fingals Project area to assess the potential occurrence of SRE invertebrate species. Based on the desktop assessment, 63 species from SRE Groups have been recorded in the search area with relatively little sampling effort. The fauna surrounding the sampling area includes 21 species of mygalomorph spiders, two species of araneomorph spiders, five species of pseudoscorpion, 12 species of scorpion, four species of centipede, two species of millipede and 15 species of land snail (Bennelongia 2022a).

The Project area contains many prospective habitats for SRE groups including, *Eucalyptus* woodland on rocky slopes and *Eucalyptus* woodland on clay-loam plain although these habitat types appear to be well connected and extend beyond the Project area. Bennelongia (2022a) determined that of the 61 SRE group species in the search area, there was only one Confirmed SRE, one Potential SRE, 35 Data deficient SRE's and 25 Widespread species and Bennelongia considers the distribution of species in these SRE categories is more likely to reflect lack of information rather than providing a reliable guide to the pattern of species distributions.

Bennelongia (2022a) noted that two listed butterflies could potentially occur at the Project, the Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*) and the Inland Hairstreak (*Jalmenus aridus*). This was further assessed by Botanica (2022) (Section 9.8.2.2).

While the Fingals Project area appears to be prospective for SRE Group species, Bennelongia (2022a) concluded that due to the relative size of the disturbance footprint and the extensiveness of connected habitat outside of the Project area, the threat to SRE species from the Project is low.

9.8.2.2 ABAB & Inland Streak

Botanica subsequently completed a desktop assessment of the Fingals Project area to assess the potential occurrence of the Arid Bronze Azure Butterfly (ABAB) (*Ogyris subterrestris petrina*) and the Inland Hairstreak (*Jalmenus aridus)* following the results of the Bennelongia (2022a) assessment which identified these species could be present (Appendix E).

The ABAB has an obligate association with a sugar ant *Camponotus* sp. nr. *terebrans* and the most critical factor for habitat occupancy by the butterfly is the presence of large colonies of the host ant, i.e. presence of ant used as indication of ABAB occurrence. The host ant colonies occur at the base of mature smooth-barked eucalypts and on soils/landscapes described as sand clay textured soil on a flat plain (Botanica 2022).

Of these five vegetation communities identified in the Fingals area, only two were considered possible to suit the soil type where the *Camponotus sp. nr. terebrans* are likely to be found. These were the two Eucalypt woodland communities growing on clay loam plain (CLP-EW1, CLP-EW2), and only one (CLP-EW2) contained smooth bark Eucalypts. Botanica (2022) considered that it is unlikely the CLP-EW2 community support *Camponotus sp. nr. terebrans*, or the ABAB as:

"*only two species of smooth bark Eucalypts were identified in this vegetation community, and E. ravida was listed as the dominant tree in this community. Although a smooth bark Eucalypt, E. ravida is not mentioned in any literature indicating that it supports colonies of Camponotus sp. nr. terebrans. E. salmonophloia was present but in low numbers*".

In relation to the Inland Hairstreak, known habitat trees for this species are *Acacia tetragonophylla* and *Senna artemisioides* subsp. x *coriacea*. Of these species only one, *A .tetragonophylla* is located at the Project in the '*Casuarina* low forest in a drainage channel' vegetation community. While Botanica (2022) considers they could potentially be present (low probability) in this community, this vegetation community is not proposed to be disturbed.

9.8.3 Subterranean Fauna

Bennelongia (2022b) completed a desktop review of habitat information and relevant biological records to appraise the conservation values of subterranean fauna in the Fingals Project and surrounds and to assess the level of possible threat to subterranean fauna.

A desktop search of 200km x 200 km around the Project returned limited records of subterranean fauna, with nine species of troglofauna and seven species of stygofauna. This is partly a reflection of low sampling effort but is also likely to show there are relatively unsuitable habitats for subterranean fauna present Bennelongia (2022b).

The gold bearing lithology of the Project and results at Goongarrie where the geology is analogous suggests that the subterranean community present is likely to be similarly depauperate. The relatively deep water table present at the Project also significantly reduces the likelihood of a stygofauna community being present. Therefore, it is unlikely that pit expansion at the Project will have a significant impact on subterranean fauna Bennelongia (2022b).

9.9 SURFACE WATER HYDROLOGY

The Project area is located in the Raeside-Ponton catchment (area = 115,965 km^2) of the Salt Lake Basin (Basin No. 024). Lake Yindarlgooda is located 7 km to the north. The site is located in the catchment of Lake Yindarlgooda and watercourses in the vicinity of the site drain to the north. There is one significant river system/ watercourse approximately 5.5 km east of the Project with a catchment area of 114 km^2. This water course drains to the north into Lake Yindarlgooda.

Runoff in the Project areas is generally associated with storm conditions, with high intensity rainfall events forming most of the annual rainfall. Most of the catchments' runoff is associated with these events (Davies and Associates, 1996).

GRM (2021a) completed a hydrometeorological and surface water assessment at Fingals (Appendix F). The Fingals deposit areas are situated on a topographic high which separates two major drainage systems (Figure 9). The drainage to the north flows to Lake Yindarlgooda while that in the south drains into the Lake Lefroy system located 15 km south-southwest of the Project area. The divide is characterised by lateritic ridges with minor outcropping basalts. Nominal surface elevations in the vicinity of the FMC range between about 390 and 400 mAHD. Natural ground gradients in the vicinity of the FMC are relatively flat with average slopes in the order of 1.0% to 1.5% (GRM 2021a).

DWER's regional watershed divide between Lake Raeside-Ponton and Lake Lefroy Catchments passes through the Fingals area (Figure 9), along with existing landforms from previous mining activities. As a result the FMC has no discernible upstream catchment area and proposed surface water management measures need only to be designed for runoff resulting from direct precipitation, i.e. no surface water runoff is expected to report to the proposed project facilities from upstream areas.

GRM (2021a) inspection of the available topographical mapping and aerial photography indicate that the only credible flood risks to the Project area relates to potential flooding of the open pits from direct precipitation. The fact that the project site straddles the regional catchment divide means that no runoff will report from upstream catchment areas and Black Cat considers that there is no significant risk to post-closure landforms from flooding from the upper catchments.

There are so surface water drainage lines in the disturbance footprint or in close proximity to the TSF.

9.10 GROUNDWATER

GRM (2022) completed a hydrogeological study to review and characterise the local groundwater environment in the Fingals Project area (Appendix G).

Two hydrostratigraphic units have been identified in the Fingals project region:

- Fractured rock aquifers associated with the Archean greenstone rocks – dominant aquifer type and can extend to depth of ~120m.
- Palaeochannel aquifers associated with high permeability units at the thalweg of paleochannel systems – extends into the northeast area of Fingals.

As indicated in Section 9.9, the regional watershed divide (catchments) passes through the Project area and the proximity of the catchment divide contributes to the deep groundwater level in the Fingals area, with the groundwater flow direction either northward, towards Lake Yindarlgooda, or south towards Lake Lefroy.

The pre-mining groundwater level in the Fingals Fortune pit area is indicated from resource drilling to be around 90 m below surface (roughly 314mRL).

Groundwater quality is variable across the region ranging from saline to hypersaline. Fresh to brackish groundwater sources (<3,000 mg/L Total Dissolved Solids (TDS)) are rare and restricted to perched aquifers and soaks. Saline groundwater (3,000 to 30,000 mg/L TDS) is widely distributed and typically found in shallow pastoral boreholes within low-yielding surficial deposits and lateritic units. Hypersaline groundwater (>30,000 mg/L TDS) occurs mainly in palaeochannels and in bedrock aquifers below and adjacent to alluvial flats and playa lakes.

There are no groundwater users at the Project (either human, stock or groundwater dependent ecosystems). Groundwater is naturally saline and there are no stock watering bores.

9.11 REHABILITATION

Upon completion of dry historic tailings disposal to the Fingals TSF, the surface will be rehabilitated which will involve capping of the surface with:

- Suitable benign mine waste layer (0.5 m thick);
- Topsoil layer / growth medium for revegetation (nominally 0.1 m thick).

Black Cat has produced a Mine Closure Plan (MCP) to address the rehabilitation and closure works to return the area to its pre-mining land use (pastoral).

The MCP is currently being assessed by DEMIRS.

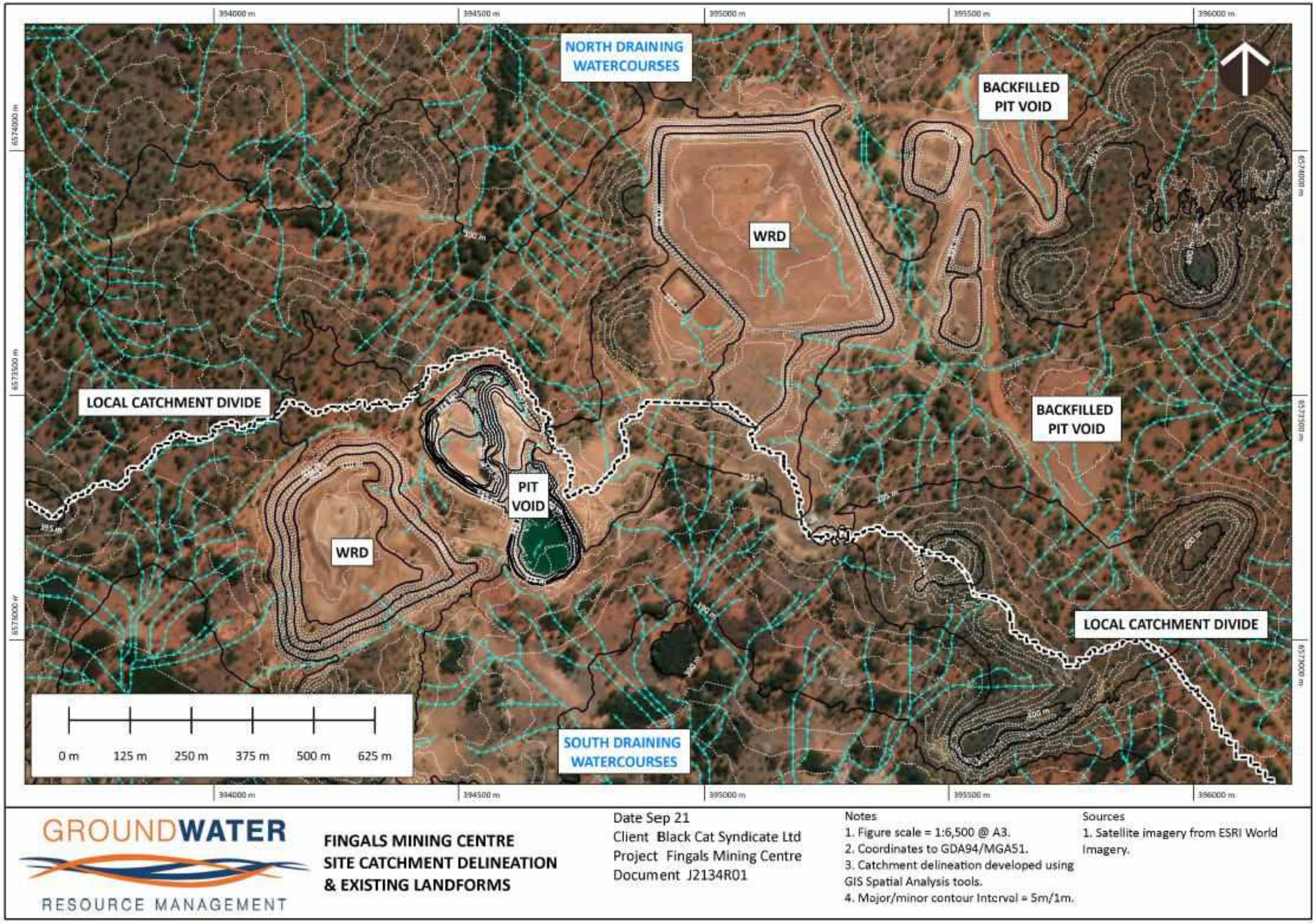

Figure 9: Site catchment and surface water flow (from GRM 2021a)

Figure 10: Drainage lines in proximity to the Project area

[redacted]

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Appendix A: Fingals TSF Geotechnical Investigation and Assessment Report

4 April 2022

FINGALS TAILINGS STORAGE FACILITY MOUNT MONGER, WA

GEOTECHNICAL INVESTIGATION AND ASSESSMENT REPORT

Black Cat (Bulong) Pty Ltd

PER2021-0406AB Rev 0

PER2021-0406AB		
Date	Revision	Comments
28 March 2022	A	Issued for Client's Review
4 April 2022	0	Final Report

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Figures

Appendices

1 INTRODUCTION

CMW Geosciences Pty Ltd (CMW) was authorised by Black Cat (Bulong) Pty Ltd (BC8) to carry out a geotechnical investigation of two former Tailings Storage Facility's located at Fingals Gold Mine, Mount Monger, WA. The work was commissioned by way of purchase order (PO #20500155 dated 27 January 2022). The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced PER2021-0406AA Rev 1 dated 27 January 2022.

From our understanding Black Cat wishes to relocate the tailings from two former In-pit Tailings Storage Facilities to an existing paddock TSF and cap the constructed landform with waste material. From Google Earth imagery, the tailings area on the paddock TSF is approximately 10 ha and the facility is nominally 5 m high. Pit cut-backs will be performed on the former in-pit TSFs (Bagus, Futi-Bagus, Fingals) with the waste from the cut-backs placed on top of an existing waste dump.

The purpose of this report is to describe the investigation carried out, the ground conditions encountered and to provide a geotechnical assessment of the proposed landform covered with waste, the concept design for tailings placement, capping of existing TSF, condition of existing TSF and stability analysis results.

2 SITE DESCRIPTION

The Fingals Mining Centre is located 40 km east of Kalgoorlie, and 8 km south west of the Majestic Mining area, at the southern end of the Kurnalpi Terrane, on the western limb of the regional Bulong Anticline. The main deposits within the area include Fingals Fortune and Fingals East and these lie at similar stratigraphic positions on either limb of the Mt Monger anticline. The host geology is basalt with mineralisation being controlled by NW structures and sericite altered felsic intrusions.

A site layout plan is displayed on Figure 1 below:

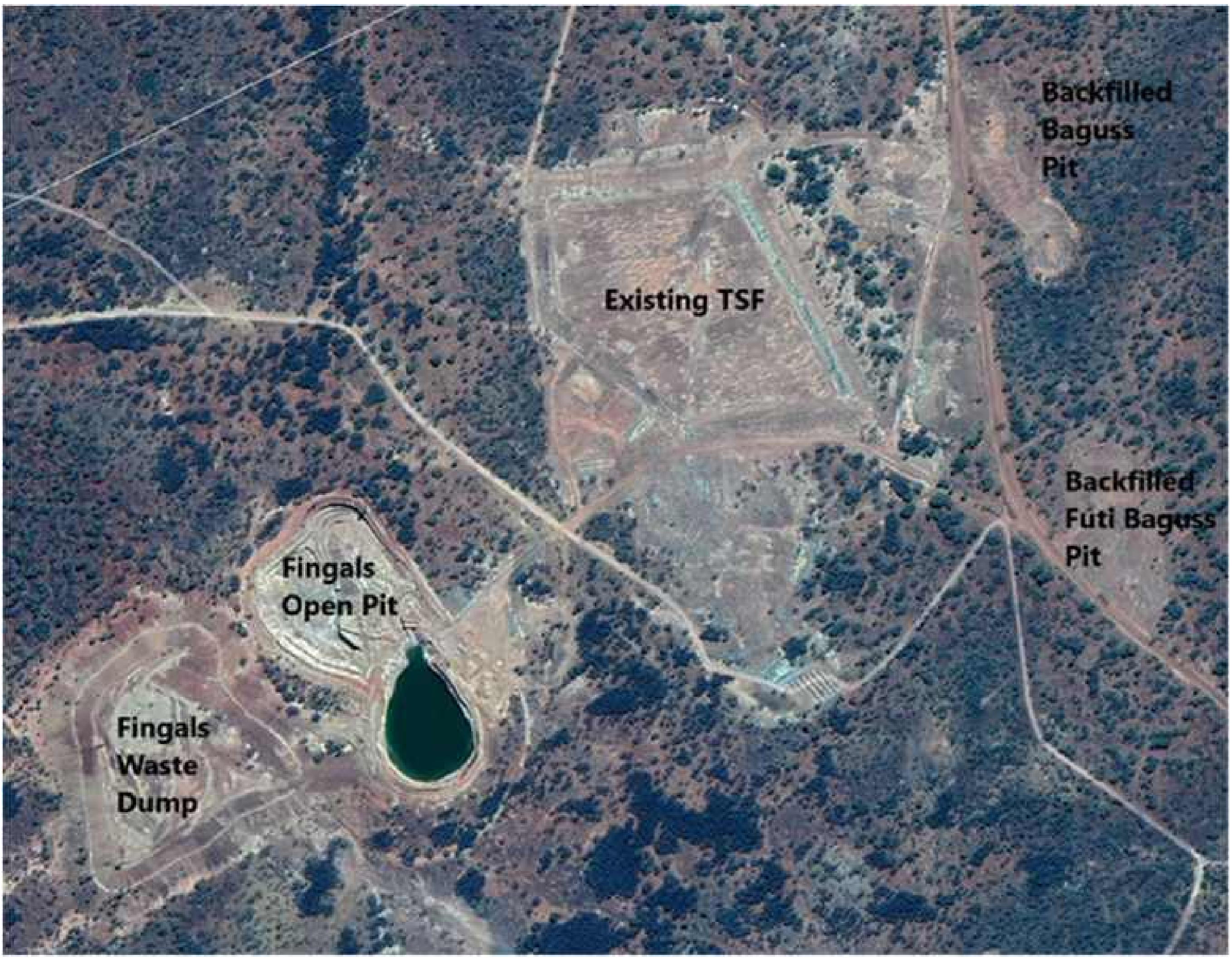


Figure 1: Fingals Open Pit Mine with the existing TSF in the northeast.

3 FIELD INVESTIGATION

3.1 General

The field investigation was carried out between 10th and 11th of February 2022. The fieldwork was carried out under the direction of CMW Geosciences Pty Ltd in general accordance with AS1726 (2017), Geotechnical Site Investigations. The scope of fieldwork completed was as follows:

- Undertake a walkover inspection of the site to assess the general landform and site conditions of the two former open pit mines, existing TSF and proposed waste material;
- Five test pits, denoted TP01 to TP05, were excavated in the location of the existing TSF using an 8 tonne CAT 308 excavator to depths of up to 4.0 m to assess the subsurface conditions. Representative bulk samples from excavated spoil were taken for subsequent laboratory testing. Engineering logs and photographs of the test pits are presented in Appendix B; and,
- An additional two test pits from within the “Waste Dump” were excavated to depths of up to 2.0 m to collect samples of ‘Mine Waste’ for further laboratory testing.

The approximate locations of the respective investigation sites referred to above are shown on the attached Site Plan (Figure No. 2). Test locations were measured using handheld GPS to an accuracy of ±5 m.

3.2 Fingals TSF Site Inspection

During the geotechnical investigation an inspection of the Fingals TSF was conducted. Observations included the TSF surface which was presumed to be in relatively good condition. There was no evidence of slumping or degradation of the TSF landform. There were sumps that had been excavated as part of a drilling program in the TSF area with some access tracks around the perimeter and in the centre of the TSF where a sump was located. A scattering of localised grasses and small trees were also identified.

The batters were also inspected. The northern batter had gravels and cobbles interbedded on the face of the batter, likely as an erosion protection measure. There were also localised grasses growing within the faces. No evidence of any major erosion was observed. The eastern, southern, and western batters had evidence of water flow with meandering erosion gullies running down the face of batters leading into a larger channel at the base that likely diverted water away from TSF. A grouping of localised grasses could be seen occupying this larger channel along the eastern batter (Photo 5). It is recommended that the erosion gullies are repaired by backfilling with competent waste rock to create ‘drop structures’ for drainage of the landform.

Site photographs of this inspection are presented in Appendix A.

3.3 Test Pits

Test pits were excavated using an 8 tonne CAT 308 excavator. Test pits were located at positions to provide a general coverage of the existing Tailings Storage Facility and to assess the mine waste material from the waste dump adjacent the open pit mine.

The purpose of the test pits was to provide a geotechnical assessment of the ground conditions underlying the existing paddock TSF and to identify possible capping material from the waste dump.

The test pits were also used to obtain bulk disturbed samples collected for laboratory testing. The test pits were backfilled with material excavated from the pits and compacted with the excavator bucket and tracks. Test pit logs and photographs are included in Appendix B.

4 LABORATORY TESTING

Laboratory testing were generally carried out in accordance with the requirements of the current edition of AS 1289 (where applicable). Where a test was not covered by an Australian standard, a local or international standard was adopted and noted on the laboratory test certificate.

All testing was scheduled by CMW and carried out by or under the direction of Western Geotechnical and Laboratory Services, a NATA registered Testing Authority.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Appendix C and summarised in Table 1.

Table 1: Laboratory Test Schedule Summary

Type of Test	Test Method	Quantity
Particle Size Distribution	AS1289.3.6.1	4
Atterberg limits	AS1289.3.1.1, 3.2.1, 3.3.1	4
Standard Compaction	AS1289.5.1.1	4
Triaxial Compression Test (CU)	AS 1289.6.4.2	1

5 TSF FOUNDATION GROUND MODEL

Published geological maps (Ref. Kurnalpi, Sheet SH 51-10: Geological Survey of Western Australia) depict the land as being underlain by a combination of colluvium gravels, sand, and silt as sheetwash or talus as well as laterite and other reworked materials. There is also potential for some basalt deposits including doleritic and feldspar-phyric layers and lenses and mafic schist.

5.1 Subsurface Conditions of TSF

The ground conditions encountered at the TSF can be generalised according to the following subsurface sequence:

MINE WASTE: SANDY CLAY	Dry, medium to high plasticity clay; red brown; sand, fine to medium grained, subangular to subrounded; trace to with gravel, fine to coarse grained, subangular to subrounded; trace roots and rootlets (capping layer); overlying,
TAILINGS: SILT	Less than to greater than plastic limit, low to medium plasticity silt; dark green/ dark brown; with gravel, fine to medium grained, subrounded to subangular; trace sand. With some interbedded dark green silty sand.

The distribution of these units is summarised in Table 2.

Table 2: Summary of Tailings Stratigraphy			
Description	Depth to base of layer (m BGL)		
	Minimum	Maximum	Average
MINE WASTE: SANDY CLAY	0.4	0.5	0.45
TAILINGS: SILT	>4.0		

Test pit logs and photographs along with summary information of each location is provided in Appendix B.

5.2 Mine Waste Material

During the field investigation, CMW assessed the waste dump material which Black Cat plans to use as capping material for the tailings once relocated. Two samples for laboratory testing were collected. A summary of the existing TSF test pits is presented in Table 3 below.

Table 3: Summary of Mine Waste Samples					
Location ID	Sample Depth	Material Description	Easting MGA1994 Zone50	Northing MGA1994 Zone50	Termination Depth (m)
Mine Waste 1	1.0 – 2.0	SANDY SILT	394317	6573121	2.0
Mine Waste 2	0.5 – 1.5	SANDY SILT	394200	6573214	2.0

5.3 Groundwater

Groundwater was not encountered during the investigation.

5.4 Laboratory Test Results

5.4.1 Soil Classification

Results of the soil classification laboratory tests for samples taken from TSF are presented in Appendix C and summarised in Table 4 below.

Table 4: Summary of Laboratory Tests Results				
Location ID	**TP02 (0.5 – 1.0m)**	**TP05 (1.5 – 2.0m)**	**Mine Waste 1 (1.0 – 2.0m)**	**Mine Waste 2 (0.5 – 1.5m)**
Gravel, %	0	16	17	27
Sand, %	7	4	27	23
Fines, %	93	80	56	50
LL, %	30	37	51	52
PL, %	25	26	33	34
PI, %	5	11	18	18
LS, %	2.0	3.0	6.0	5.0
OMC, %	26.0	21.5	18.5	16.5
SMDD, t/m^3	1.58	1.68	1.66	1.75
Note: Gravel, Sand and Fines percentages are by weight, LL = Liquid Limit, PL = Plasticity Limit, PI = Plasticity Index, LS = Linear Shrinkage, OMC = Optimum Moisture Content, OMC = optimum moisture content, SMDD = Standard Maximum Dry Density.				

The results of the testpit sampling (TP02 and TP05) indicate the tailings are a low to medium plasticity silt (ML). The sampling indicates the mine waste is a high plasticity sandy silt (MH). The sampled mine waste material will likely be susceptible to erosion if placed on external TSF batters. Erosion resistant materials will need to be located to cap the new TSF landform batters. The sampled mine waste material may be placed on the top surface of the new TSF as part of rehabilitation.

Reference to the GeoAnalytica (2021) report indicates that tailings sampled from the in-pit TSFs had similar properties to the tailings sampled by CMW. The maximum dry densities reported by GeoAnalytica were 1.51 $t/m^3$and 1.55 t/m^3, for coarse (sandy) tailings samples (21%-25% passing 75 micron).

5.4.2 Triaxial Test

Results from the single stage Consolidated Undrained (CU) Triaxial test from the sample taken from TP02 at the TSF are presented in Appendix C and summarised in Table 5 below. These results were utilised in the stability analyses.

The angle of internal friction of 30^o obtained from the CMW testing was between the interpreted angle of internal frictions report in the GeoAnalytica (2021) report of 26^o (fine tailings – 99% fines) and 40^o (coarse tailings - 21%-25% fines).

Table 5: Summary of Soil Triaxial Laboratory Test Result														
Location ID	**Depth Range (m)**	**Height (mm)**	**Diameter (mm)**	**L/D Ratio**	**Initial Moisture (mm)**	**Final Moisture (mm)**	**Bulk Density (t/m^3)**	**Dry Density (t/m^3)**	**Stage 1 & 2**		**Stage 1 & 3**		**Stage 2 &3**	
									C' (kPa)	**Φ (degrees)**	**C' (kPa)**	**Φ (degrees)**	**C' (kPa)**	**Φ (degrees)**
TP02	0.5 to 1.0	125.87	61.80	2.04	26.72	30.65	1.91	1.50	30.16	29.68	36.66	26.57	49.03	24.70

6 CONCEPT DESIGN

6.1 Design Criteria

BC8 estimates the following tailings material volumes for relocation onto the existing TSF landform: Bagus- 301,700 m^3; Futi-Bagus - 356,200 m^3; Fingals - 115,200 m^3. The overall density is estimated at around 1.6 to 1.65 t/m^3.

Based on the above, an estimated 750,000 m^3 will be disposed on top of the TSF or 7.5 m x 100,000 m^2.

Non-acid forming fresh basalt rock will be used in the covering of the final TSF landform. It is understood that the Stage 3 pit development will produce a total of 1,294,600 bcm or 3,624,880 tonnes of mine waste material.

6.2 Discussion and Recommendation

The tailings from the in-pit tailings storages will be relocated from the pit and placed on top of the existing above ground paddock TSF. The existing TSF will be raised by approximately 7.5 m by stacking the tailings on top of the existing TSF. The new TSF landform will have a downstream slope of 1(V):3(H) and be capped with 1.0 m thick rockfill mine waste layer on the top surface and downstream slopes. The total height of the finished facility will be between 10 m and 15 m high. Figure 2 attached at the back of this report shows the proposed construction details and design geometry of the new TSF landform.

The following works are recommended as part of construction of the new TSF landform:

- As part of preparation works, the surface of the TSF will be stripped of any deleterious material and proof rolled as directed by a Geotechnical Engineer.
- The ‘tailings stack’ is then constructed by paddock dumping tailings on the surface of the TSF.
- The tailings material is then spread and placed in 0.5 m layers with a dozer and traffic compacted with the servicing mine fleet. Water is added as necessary for compaction and dust suppression. A water cart should be available to conduct dust suppression.
- Initial standard compaction and in situ moisture content of the tailings should be established early on the project using compaction trials to confirm that the targeted dry density is reached. The stacked tailings should be tested for insitu density early in the landform construction to ascertain whether the tailings have received sufficient compaction using the work methods proposed. The target dry density is a minimum of 1.6 t/m^3 (dry) (i.e. approximately 95% of SMDD). At this stage use of vibratory rollers is not proposed.
- A 1.0 m thick mine rockfill mine waste is progressively used as a batter capping layer to create a robust and structure that is not susceptible to erosion. A minimum thickness of 0.5 m of mine waste should be placed on the top of the TSF landform. Approximately 100,000 m^3 of mine waste capping will be required.
- Timing of the works should be scheduled in order to meet the tailings storage volume requirements and integrated with the ongoing mine planning to ensure that adequate volumes of mine waste material for use in rehabilitation.
- The intent is that the placed tailings be capped progressively. Potentially the tailings could be exposed in the medium term (to several months). However it should not be exposed during wetter parts of the year (i.e. when high intensity rainfall occurs) in order to prevent erosion due to rainfall runoff.

7 STABILITY ANALYSIS

7.1 Method of Analysis

Stability analyses were undertaken to assess the stability of the new TSF landform with a nominal height of 12.5 m (5 m of existing embankment and 7.5 m of stacked mine waste). The analyses were undertaken in general accordance with ANCOLD (2019).

The computer software package ‘Slide’ was utilised to undertake the analyses. Slide is a two-dimensional slope stability program for evaluating the safety factor of circular and non-circular failure surfaces in soil and rock slopes. The stability of the slip surfaces for static and post-seismic cases were assessed using vertical slice limit equilibrium methods. The simplified Bishop method and GLE/Morgenstern-Price method was used in the analyses of the non-circular failures.

The following cases were examined in the stability analyses:

Case 1: Static Analysis - Downstream failure of the TSF with a 12.5 m embankment height under drained condition based on limit equilibrium method.

Case 2: Static Analysis – As for Case 1, but with undrained condition.

Case 3: Static Analysis – As for Case 1, but with post-seismic condition, with 20% reduction in strength parameters for the tailings and existing embankment.

The phreatic surface adopted in all cases were conservative, with the assumption that there is a phreatic surface that draws down to the upstream toe of the existing embankment.

It should be noted that the existing TSF embankments and foundations are considered to be resistant to liquefaction due to mechanical compaction of the former and sufficient foundation preparation of the latter. However, the newly placed tailings may be susceptible to liquefaction if not sufficiently compacted.

7.2 Parameters

The stability analyses of the embankment were carried out using the effective stress condition (c, φ) with a conservatively estimated piezometric line. The undrained parameters were estimated based on testpit observations. Table 3 provides a summary of the strength parameters used in the stability analyses.

Table 6: Summary of Strength Parameters

Material Type	Bulk Density (kN/m^3)	Drained Parameter		Undrained Parameters
		Cohesion c/ (kPa)	Friction Angle φ/ (degrees)	Cohesion Su/ (kPa)
Compacted Tailings	16	0	36	75
Mine Waste (Rockfill)	20	10	40	-
Deposited Tailings	15	0	30	0.2 σ'v
Existing Embankment	19	5	35	-
Foundation (Sandy Clay)	18	5	32	-
Foundation (Silt)	19	10	28	-

7.3 Results of the Stability Analyses

The results of the stability analyses for the various cases were examined with a conservative phreatic line and a summary is provided in Table 7 below. The computer printouts are presented in Appendix D.

Table 7: Results of Stability Analyses

Case	Factor of Safety	Recommended Minimum Factors of Safety*
1: Drained	2.11	1.5
2: Undrained	2.20	1.5
3: post-seismic	1.92	1.0-1.2

*Note: Recommended factors of safety in accordance with ANCOLD (2019).

The stability analyses indicate adequate factors of safety were achieved for the drained and post-seismic conditions when compared with the recommended minimum factors of safety in ANCOLD (2019).

The concept design for the TSF is robust with factors of safety against embankment failure likely to be greater than the minimum requirements (i.e. FoS around 1.5 or above for normal operating conditions).

8 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, can it be considered that these findings represent the actual state of the ground conditions away from our investigation locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

This report has been prepared for use by Black Cat (Bulong) Pty Ltd in relation to the Fingals TSF project in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than Black Cat (Bulong) Pty Ltd and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

For and on behalf of

[redacted]

Distribution: 1 copy to Black Cat (Bulong) Pty Ltd (electronic)
Original held by CMW Geosciences Pty Ltd

References:

GeoAnalytica (2021) report, *'Futi Bagus In-pit Tailings Storage Facility Geotechnical Cutback Design Assessment'*, prepared for Black Cat Syndicate Limited

ANCOLD (2019) '*Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure'*.

Figures

LEGEND:

- TP01 TEST PIT LOCATION
- MW01 MINE WASTE SAMPLE LOCATION

NOTES:

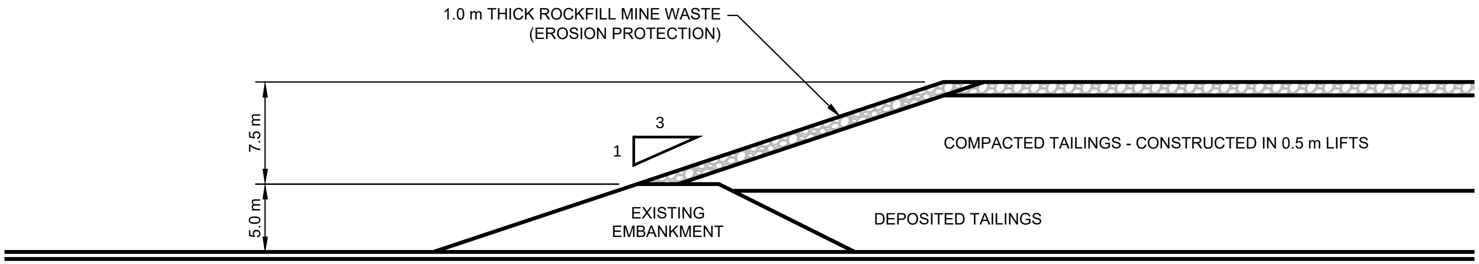
1. AERIAL FROM BING MAPS.

0 75 150 225 300 375 m

1:7500

CMW Geosciences

CLIENT: BLACK CAT SYNDICATE LTD		DRAWN: DE	PROJECT: PER2021-0406
PROJECT: FINGALS TSF ASSESSMENT MOUNT MONGER, WA		CHECKED: MO	FIGURE: 02
		REVISION: A	SCALE: 1:7500
TITLE: SITE INVESTIGATION PLAN		DATE: 15.02.22	SHEET: A3 L



CMW Geosciences

CLIENT: BLACK CAT SYNDICATE LTD		DRAWN: DE	PROJECT: PER2021-0406
PROJECT: FINGALS TSF ASSESSMENT MOUNT MONGER, WA		CHECKED: SW	FIGURE: 03
		REVISION: A	SCALE: NTS
TITLE: SECTION - DESIGN CONCEPT		DATE: 25.03.22	SHEET: A3 L

Appendix A
Site Photographs

Figure 3: Fingals TSF surface.

Figure 4: Fingals TSF looking North.

Figure 5: Fingals TSF looking East.

Appendix B
Test Pit Logs

TEST PIT LOG - TP01

Client: Black Cat Syndicate Ltd
Project: Fingals TSF Assessment
Location: Mount Monger, WA
Project: PER2021-0406
Date: 10/02/2022

1:30 Sheet 1 of 1

Logged by: Mitchell Owen	Position: E.395183m N.6573654m	Plant: 8t CAT 308 excavator	
Checked by:Chris Hogg	Elevation:	Contractor: Saltbush Contracting	Dimensions : 0.60m x 5.00m

Groundwater	Samples & Insitu Tests – Depth	Samples & Insitu Tests – Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Structure & other observations
						MINE WASTE: SANDY CLAY: medium to high plasticity; red brown; sand, fine to medium grained, subangular to subrounded; trace gravel; trace roots and rootlets.	D		
				1 2		FILL: SILT : low to medium plasticity; dark green; trace sand. With interbedded bands of dark brown silty sand.	<PL		
				3 4		Test pit terminated at 3.00 m			

Termination Reason: Target depth reached
Remarks: Backfilled.

TEST PIT LOG - TP02

Client: Black Cat Syndicate Ltd
Project: Fingals TSF Assessment
Location: Mount Monger, WA
Project: PER2021-0406
Date: 10/02/2022

CMW Geosciences

1:30 Sheet 1 of 1

Logged by: Mitchell Owen	Position: E.395262m N.6573860m	Plant: 8t CAT 308 excavator	
Checked by:Chris Hogg	Elevation:	Contractor: Saltbush Contracting	Dimensions : 0.60m x 5.00m

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
						MINE WASTE: SANDY CLAY: medium to high plasticity; red brown; sand, fine to medium grained, subangular to subrounded; with gravel, fine to coarse grained, subangular to subrounded; trace roots and rootlets.	D		
	0.5 - 1.0	B				FILL: SILT: low to medium plasticity; dark green; trace sand. With interbedded bands of dark brown silty sand.			
				1		*... from 1.00m to 1.30m, with interbedded pale grey*			
							<PL		
				2		*... at 2.00m, becoming dark brown with dark green*			
				3		Test pit terminated at 3.00 m			
				4					

Termination Reason: Target depth reached
Remarks: Backfilled.

TEST PIT LOG - TP03

Client: Black Cat Syndicate Ltd
Project: Fingals TSF Assessment
Location: Mount Monger, WA
Project: PER2021-0406
Date: 10/02/2022

1:30

Logged by: Mitchell Owen
Checked by:Chris Hogg
Position: E.394980m N.6573996m
Elevation:
Plant: 8t CAT 308 excavator
Contractor: Saltbush Contracting
Dimensions : 0.60m x 5.00m

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	0.0 - 0.4	B				MINE WASTE: SANDY CLAY: medium to high plasticity; red brown; sand, fine to medium grained, subangular to subrounded; with gravel, fine to coarse grained, subangular to subrounded; trace roots and rootlets.	D		
				1 2		FILL: SILT: low to medium plasticity; dark green; trace sand. With interbedded bands of dark brown silty sand.	<PL		
				3 4		Test pit terminated at 3.00 m			

Termination Reason: Target depth reached
Remarks: Backfilled.

TEST PIT LOG - TP04

Client: Black Cat Syndicate Ltd
Project: Fingals TSF Assessment
Location: Mount Monger, WA
Project: PER2021-0406
Date: 10/02/2022

CMW Geosciences

1:30

Logged by: Mitchell Owen	Position: E.394979m N.6573802m	Plant: 8t CAT 308 excavator	
Checked by:Chris Hogg	Elevation:	Contractor: Saltbush Contracting	Dimensions : 0.60m x 5.00m

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
						MINE WASTE: SANDY CLAY: medium to high plasticity; red brown; sand, fine to medium grained, subangular to subrounded; trace gravel; trace roots and rootlets.	D		
				1 2 3		FILL: SILT: low to medium plasticity; dark brown; trace sand. With interbedded bands of dark brown silty sand.	≈PL		
				4		Test pit terminated at 3.50 m			

Termination Reason: Target depth reached
Remarks: Backfilled.

TEST PIT LOG - TP05

Client: Black Cat Syndicate Ltd
Project: Fingals TSF Assessment
Location: Mount Monger, WA
Project: PER2021-0406
Date: 10/02/2022

1:30

Logged by: Mitchell Owen	Position: E.395133m N.6573841m	Plant: 8t CAT 308 excavator	
Checked by:Chris Hogg	Elevation:	Contractor: Saltbush Contracting	Dimensions : 0.60m x 5.00m

Groundwater	Samples & Insitu Tests - Depth	Samples & Insitu Tests - Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
						MINE WASTE: SANDY CLAY: medium to high plasticity; red brown; sand, fine to medium grained, subangular to subrounded; trace gravel.	D		
	1.5 - 2.0	B		1 2 3		FILL: SILT: low to medium plasticity; dark brown; with gravel, fine grained, subangular to subrounded; trace gravel. With interbedded bands of dark brown silty sand.	≈PL		
						... at 3.50m, becoming pale yellow brown	>PL		
				4		Test pit terminated at 4.00 m			

Termination Reason: Target depth reached
Remarks: Backfilled.

Appendix C
Laboratory Test Results

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2637_1_PI
Project:	Fingals TSF	*Sample No.*	WG22.2637
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 2 0.5 - 1.5m	*Date Tested:*	22/02/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**52**
AS 1289.3.2.1	**Plastic Limit (%)**	**34**
AS 1289.3.3.1	**Plasticity Index (%)**	**18**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**5.0**

AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

[redacted]

Date: 23/February/2022

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TEST REPORT - AS 1289.3.1.2, 3.2.1, 3.3.1 & 3.4.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2634_1_PI
Project:	Fingals TSF	*Sample No.*	WG22.2634
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP02 0.5 - 1.0m	*Date Tested:*	22/02/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.2	**Liquid Limit (%)**	**30**
AS 1289.3.2.1	**Plastic Limit (%)**	**25**
AS 1289.3.3.1	**Plasticity Index (%)**	**5**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**2.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen**	**Cracked**

Comments:

[redacted]

Date: 23/February/2022

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TEST REPORT - AS 1289.3.1.2, 3.2.1, 3.3.1 & 3.4.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2635_1_PI
Project:	Fingals TSF	*Sample No.*	WG22.2635
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP05 1.5 - 2.0m	*Date Tested:*	22/02/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.2	**Liquid Limit (%)**	**37**
AS 1289.3.2.1	**Plastic Limit (%)**	**26**
AS 1289.3.3.1	**Plasticity Index (%)**	**11**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**3.0**

AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen**	**Cracked**

Comments:

[redacted]

Date: 23/February/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2636_1_PI
Project:	Fingals TSF	*Sample No.*	WG22.2636
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 1 1.0 - 2.0m	*Date Tested:*	22/02/2022

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**51**
AS 1289.3.2.1	**Plastic Limit (%)**	**33**
AS 1289.3.3.1	**Plasticity Index (%)**	**18**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**6.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

[redacted]

Date: 23/February/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

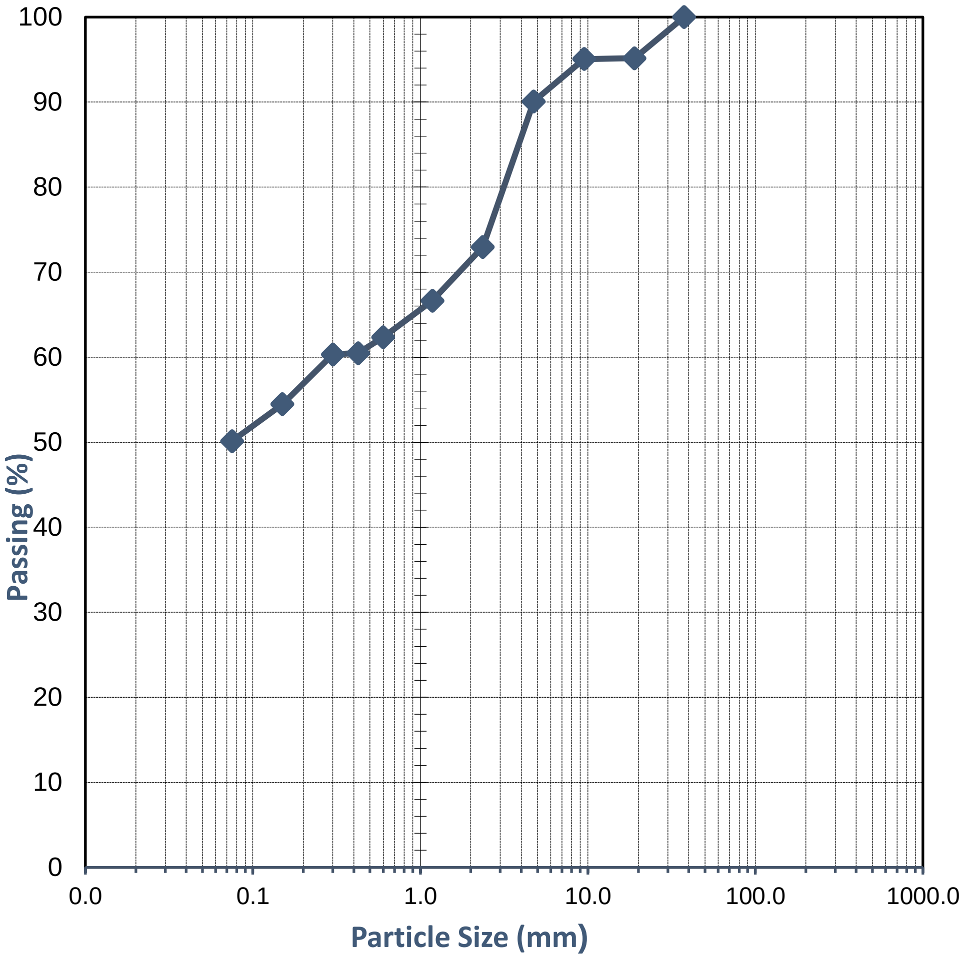
TEST REPORT - AS 1289.3.6.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2637_1_PSD
Project:	Fingals TSF	*Sample No.*	WG22.2637
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 2 0.5 - 1.5m	*Date Tested:*	17-02-2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	95
9.5	95
4.75	90
2.36	73
1.18	67
0.600	62
0.425	60
0.300	60
0.150	54
0.075	50



Comments:

[redacted]

Date: 18-February-2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

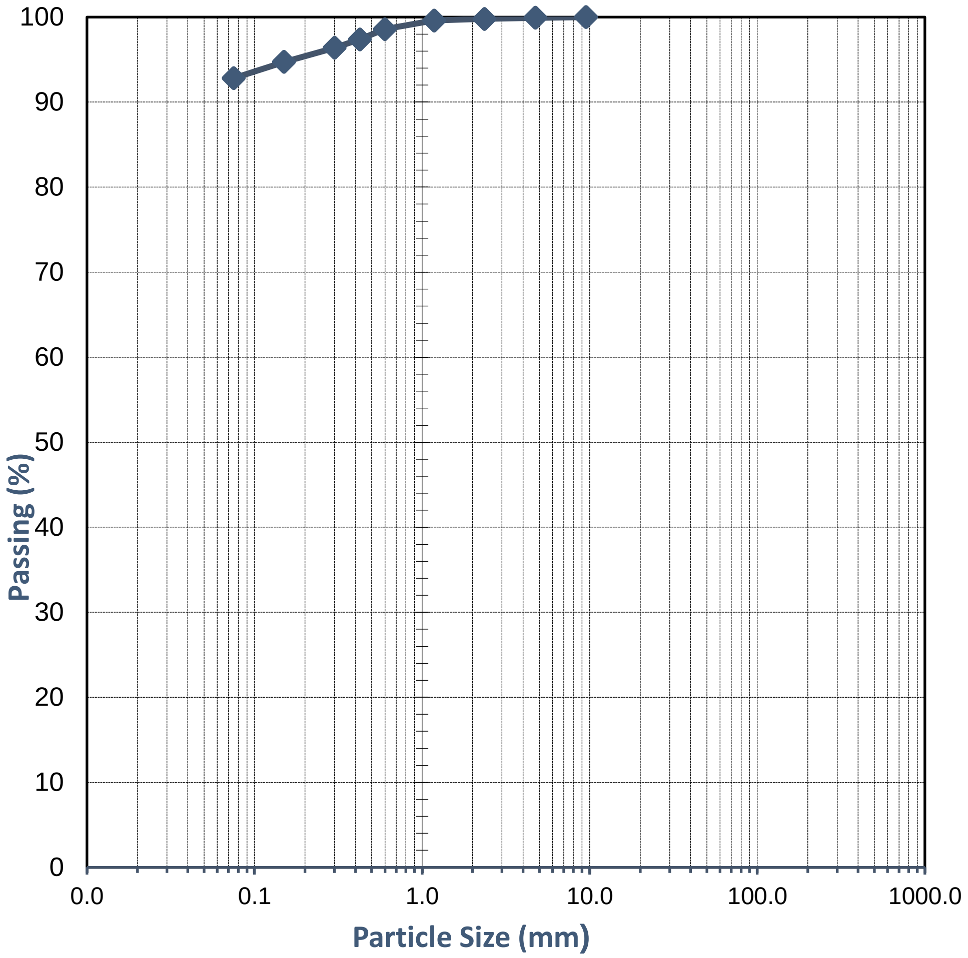
TEST REPORT - AS 1289.3.6.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2634_1_PSD
Project:	Fingals TSF	*Sample No.*	WG22.2634
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP02 0.5 - 1.0m	*Date Tested:*	21/02 - 22/02/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	99
0.425	97
0.300	96
0.150	95
0.075	93



Comments:

[redacted]

Date: 22/February/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

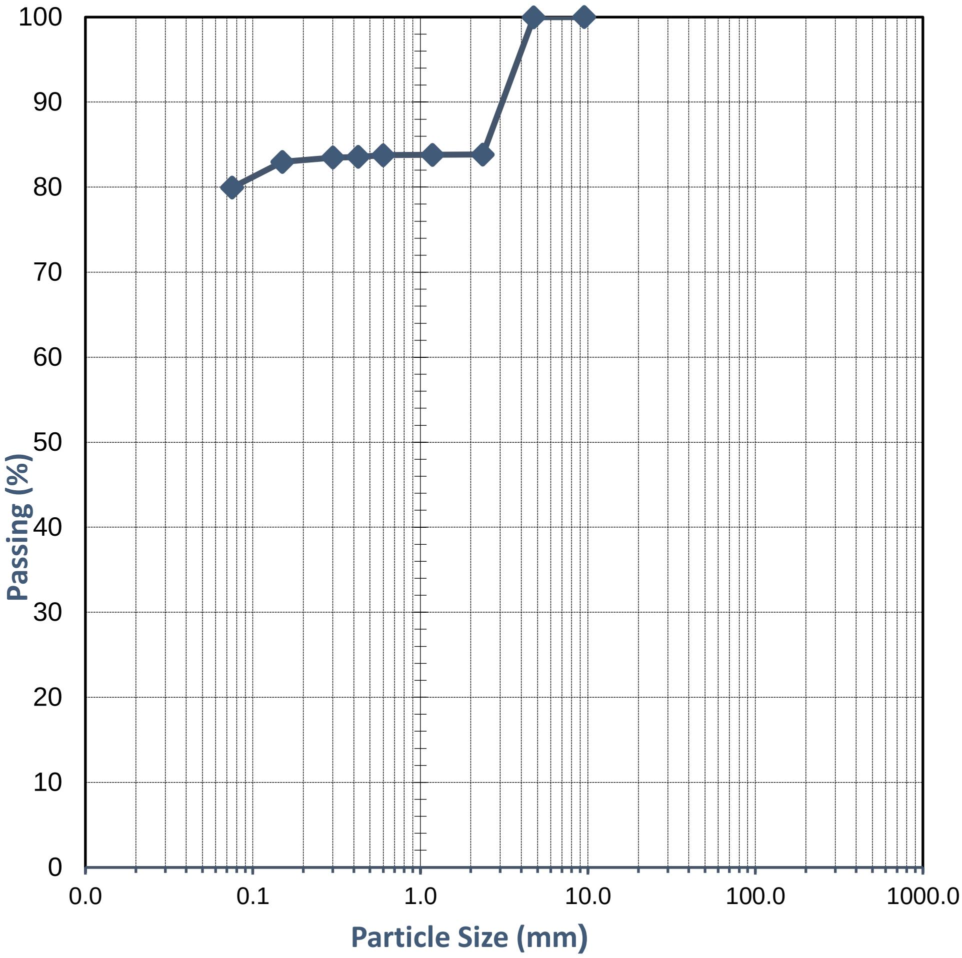
TEST REPORT - AS 1289.3.6.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2635_1_PSD
Project:	Fingals TSF	*Sample No.*	WG22.2635
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP05 1.5 - 2.0m	*Date Tested:*	21/02 - 22/02/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	84
1.18	84
0.600	84
0.425	84
0.300	83
0.150	83
0.075	80



Comments:

[redacted]

Date: 22/February/2022

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SOIL | AGGREGATE | CONCRETE | CRUSHING

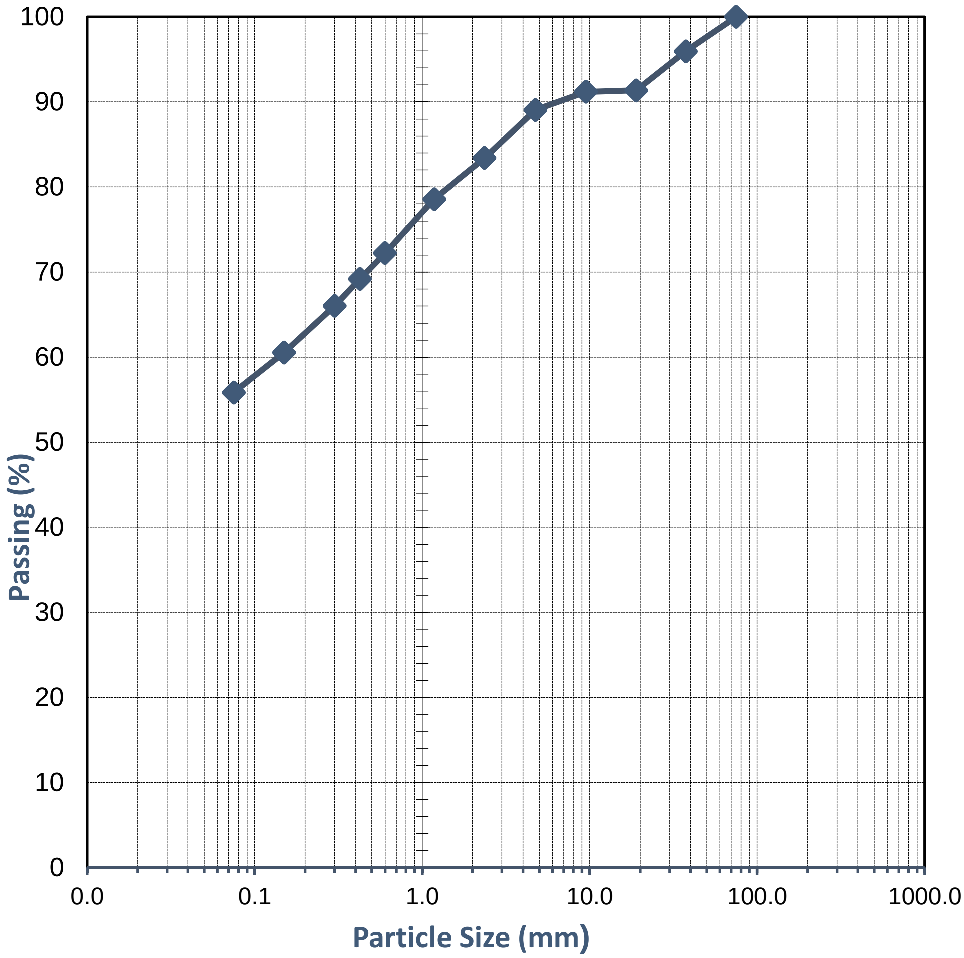
TEST REPORT - AS 1289.3.6.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2636_1_PSD
Project:	Fingals TSF	*Sample No.*	WG22.2636
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 1 1.0 - 2.0m	*Date Tested:*	21/02 - 22/02/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	100
37.5	96
19.0	91
9.5	91
4.75	89
2.36	83
1.18	79
0.600	72
0.425	69
0.300	66
0.150	61
0.075	56



Comments:

[redacted]

Date: 22/February/2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.1.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2637_1_SMDD
Project:	Fingals TSF	*Sample No.*	WG22.2637
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 2 0.5 - 1.5m	*Date Tested:*	17-02-2022

TEST RESULTS - Standard Maximum Dry Density

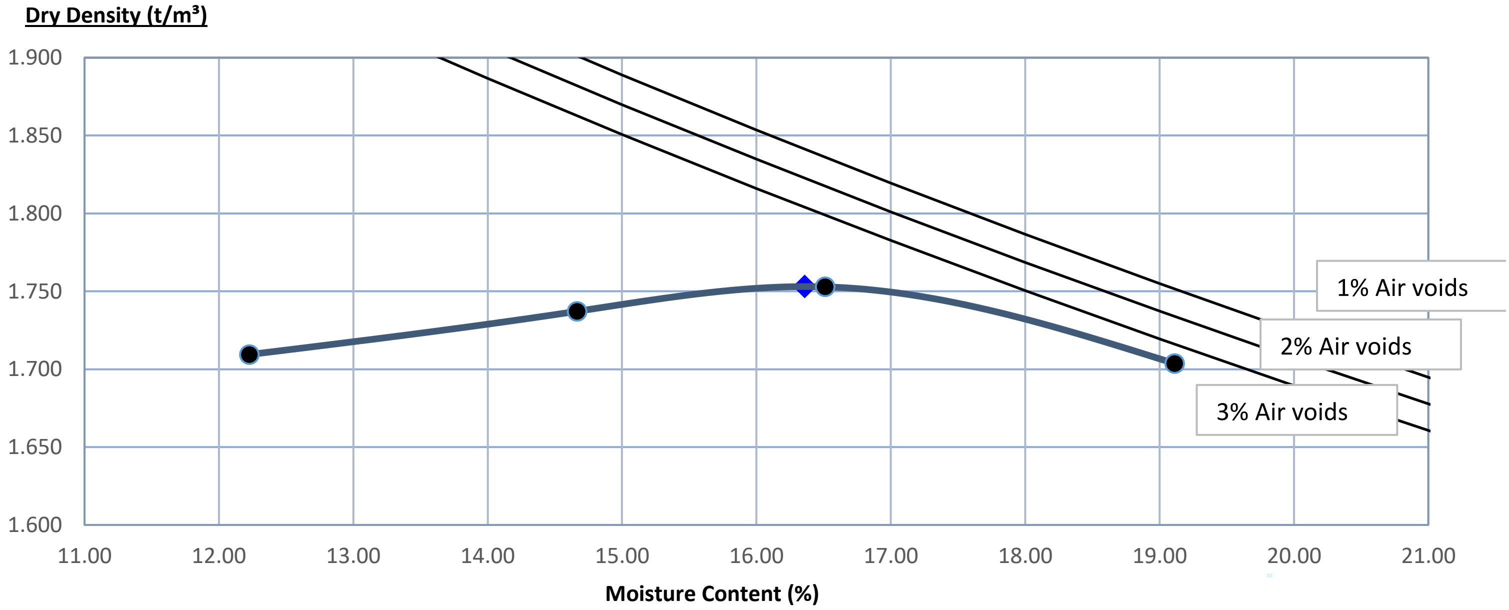
Sampling Method: Sampled by Client, Tested as Received

Sample Curing Time: 25 hrs

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**12.2**	**14.7**	**16.5**	**19.1**	
Dry Density (t/m^3)	**1.709**	**1.737**	**1.753**	**1.704**	



Standard Maximum Dry Density (t/m^3) **1.75**

Optimum Moisture Content (%) **16.5**

Comments: ***The above air void lines are derived from a calculated apparent particle density of 2.673 t/m^3***

[redacted]

Date: 18-February-2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.1.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2634_1_SMDD
Project:	Fingals TSF	*Sample No.*	WG22.2634
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP02 0.5 - 1.0m	*Date Tested:*	17-02-2022

TEST RESULTS - Standard Maximum Dry Density

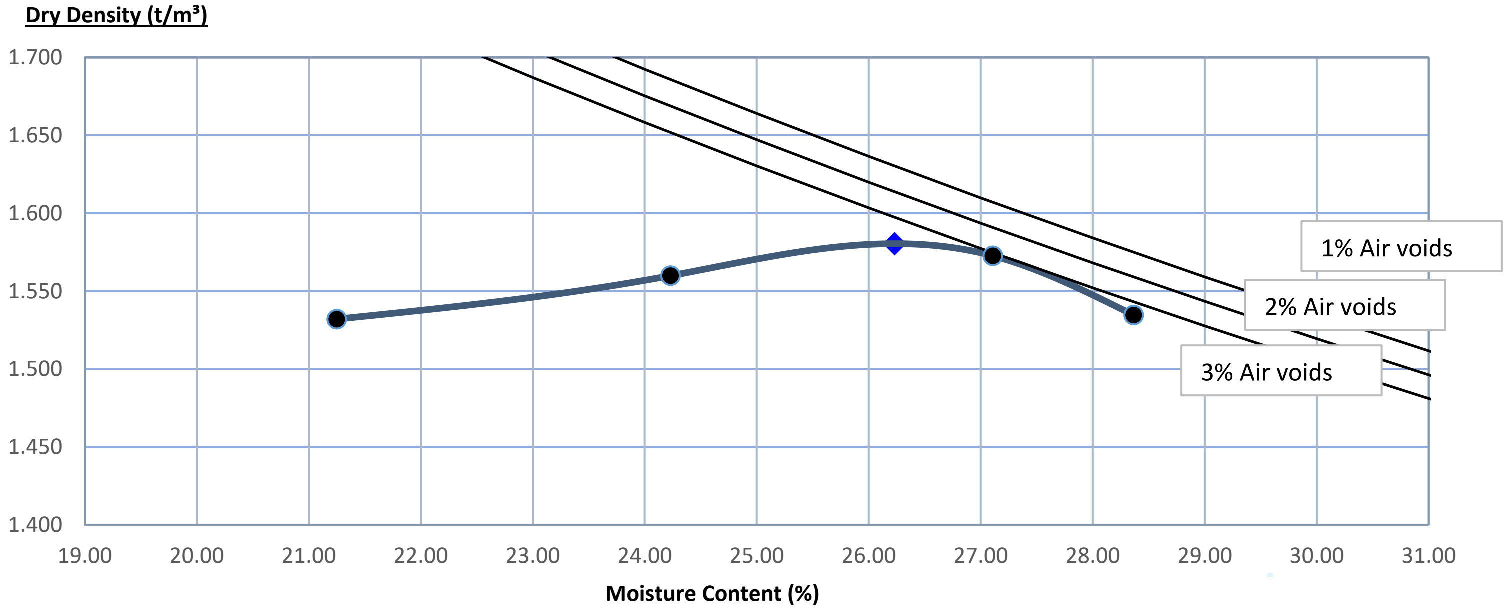
Sampling Method: **Sampled by Client, Tested as Received**

Sample Curing Time: **24 hours**

Method used to Determine Liquid Limit: **Visual / Tactile Assessment by Competent Technician**

Material + 19.0mm (%): **0** **Material + 37.5mm (%)** **-**

Moisture Content (%)	**21.2**	**24.2**	**27.1**	**28.4**	
Dry Density (t/m^3)	**1.532**	**1.560**	**1.573**	**1.535**	



Standard Maximum Dry Density (t/m^3) **1.58**

Optimum Moisture Content (%) **26.0**

Comments: ***The above air void lines are derived from a calculated apparent particle density of 2.899 t/m³***

[redacted]

Date: 18-February-2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.1.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2635_1_SMDD
Project:	Fingals TSF	*Sample No.*	WG22.2635
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	TP05 1.5 - 2.0m	*Date Tested:*	18-02-2022

TEST RESULTS - Standard Maximum Dry Density

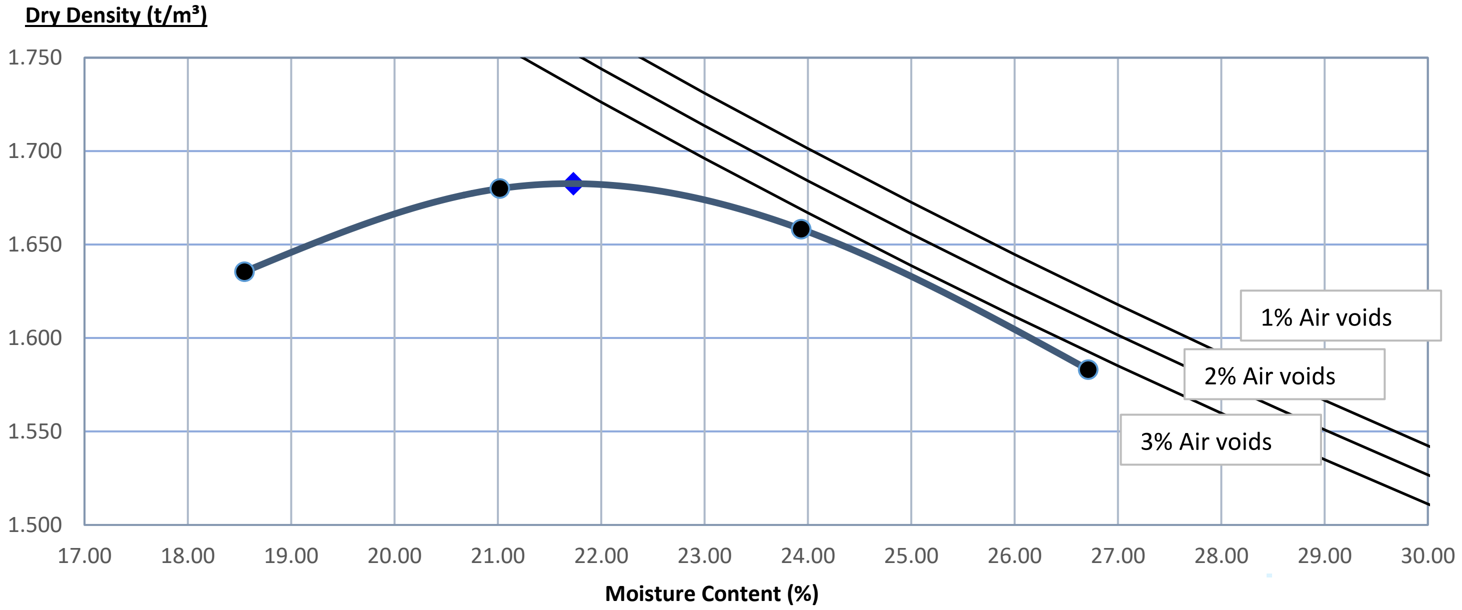
Sampling Method: **Sampled by Client, Tested as Received**

Sample Curing Time: **48 Hrs**

Method used to Determine Liquid Limit: **Visual / Tactile Assessment by Competent Technician**

Material + 19.0mm (%): **0** **Material + 37.5mm (%)** **-**

Moisture Content (%)	**18.5**	**21.0**	**23.9**	**26.7**	
Dry Density (t/m^3)	**1.635**	**1.680**	**1.658**	**1.583**	



Standard Maximum Dry Density (t/m^3) **1.68**

Optimum Moisture Content (%) **21.5**

Comments: ***The above air void lines are derived from a calculated apparent particle density of 2.925 t/m^3***

[redacted]

Date: 21-February-2022

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.1.1

Client:	CMW Geosciences	*Ticket No.*	S5508
Client Address:	Suite 1, Level 3/29 Flynn Street, Wembley WA	*Report No.*	WG22.2636_1_SMDD
Project:	Fingals TSF	*Sample No.*	WG22.2636
Location:	Not Specified	*Date Sampled:*	Not Specified
Sample Identification:	Mine Waste 1 1.0 - 2.0m	*Date Tested:*	17-02-2022

TEST RESULTS - Standard Maximum Dry Density

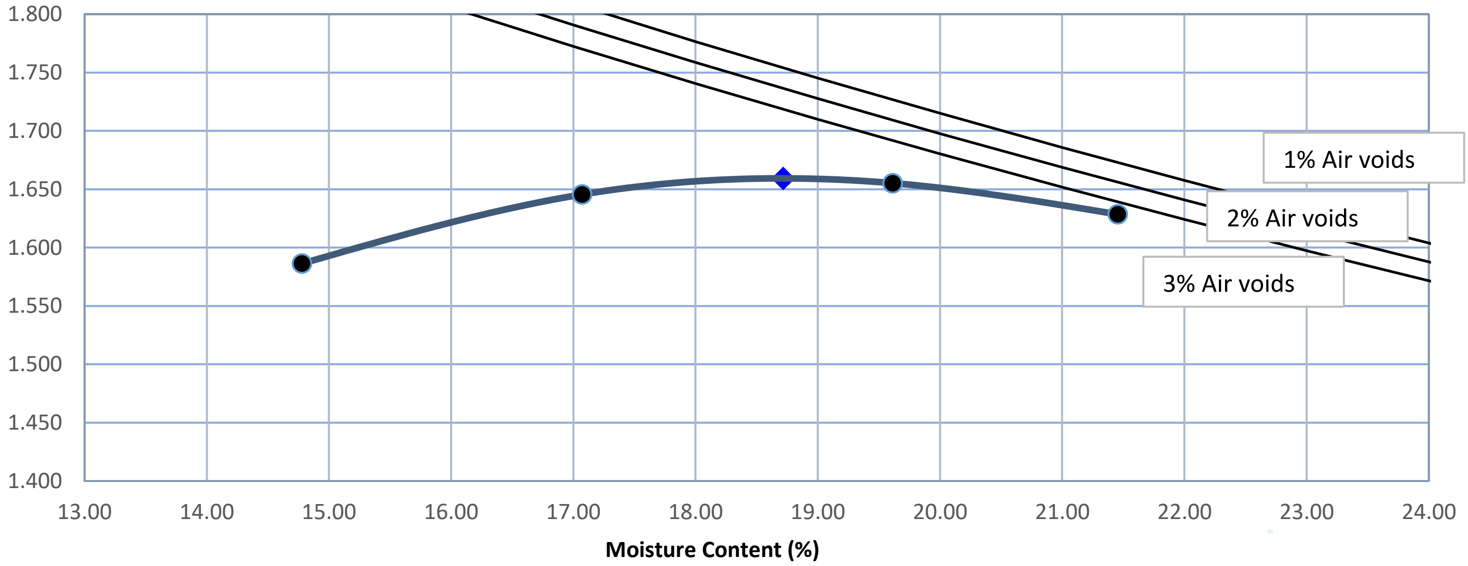
Sampling Method: **Sampled by Client, Tested as Received**

Sample Curing Time: **25 hrs**

Method used to Determine Liquid Limit: **Visual / Tactile Assessment by Competent Technician**

Material + 19.0mm (%): **0** **Material + 37.5mm (%)** **-**

Moisture Content (%)	**14.8**	**17.1**	**19.6**	**21.5**	
Dry Density (t/m^3)	**1.586**	**1.646**	**1.655**	**1.628**	



Standard Maximum Dry Density (t/m^3) **1.66**

Optimum Moisture Content (%) **18.5**

Comments: ***The above air void lines are derived from a calculated apparent particle density of 2.651 t/m³***

[redacted]

Date: 18-February-2022

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Perth
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WA 6155

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E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

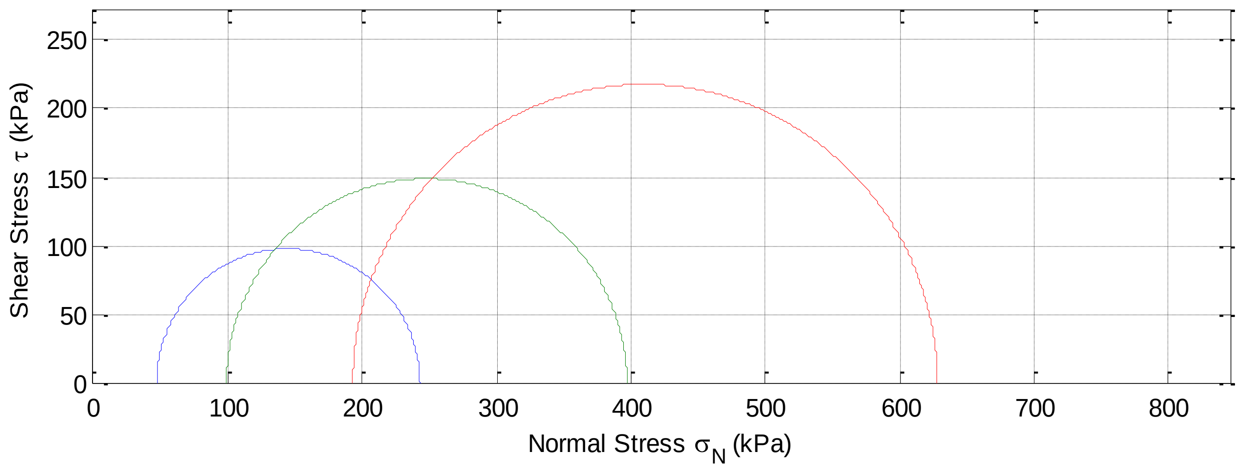
Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°c

Tested by:	Phil Li	Initial Moisture (%):	26.72	Strain Rate (mm/min):	0.006
Height (mm):	125.87	Final Moisture (%):	30.65	Skempton's (B):	0.98
Diameter (mm):	61.80	Bulk Density (t/m³):	1.91	Geology:	-
L/D Ratio:	2.04	Dry Density (t/m³):	1.50	Particle Density (t/m³):	-

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	30.16	36.66	49.03
Angle of Shear Resistance Φ' (Degrees) :	29.68	26.57	24.70

Accredited for compliance with ISO/IEC 17025-TESTING

NATA: 19078

Authorised Signatory (Geotechnical En [redacted]

NATA ACCREDITATION NO: 19078

Integrity Precision Innovation

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

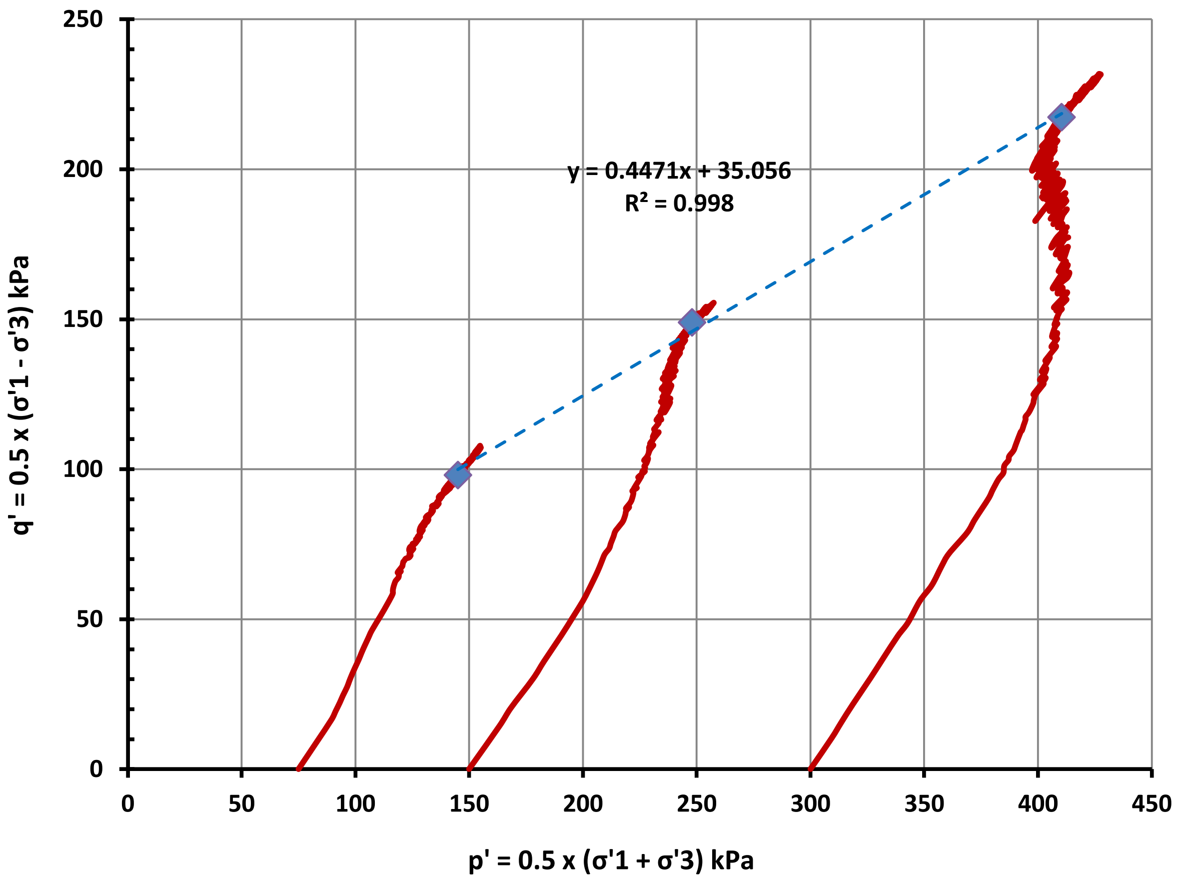
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**39.26**
Angle of Shear Resistance Φ' (Deg) :	**26.74**

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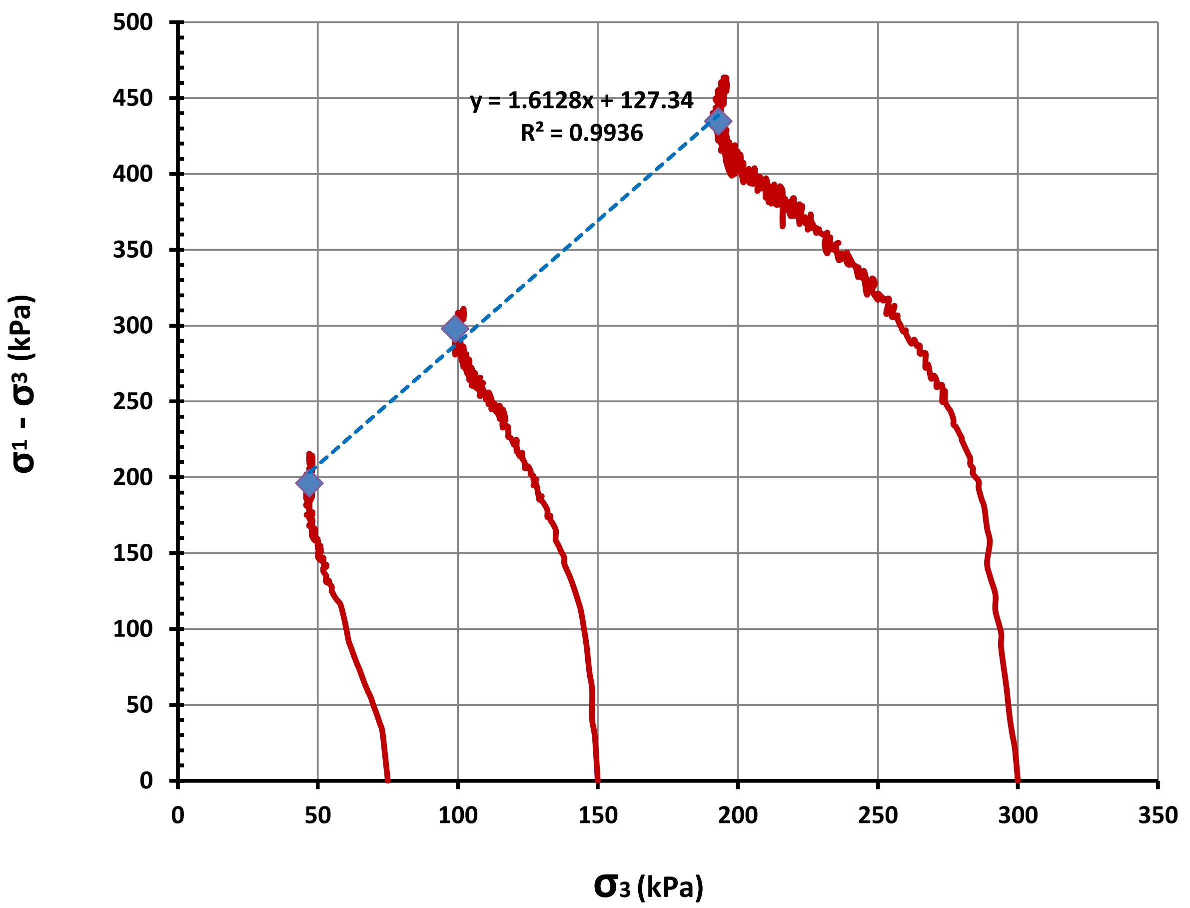
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**39.41**
Angle of Shear Resistance Φ' (Deg) :	**26.49**

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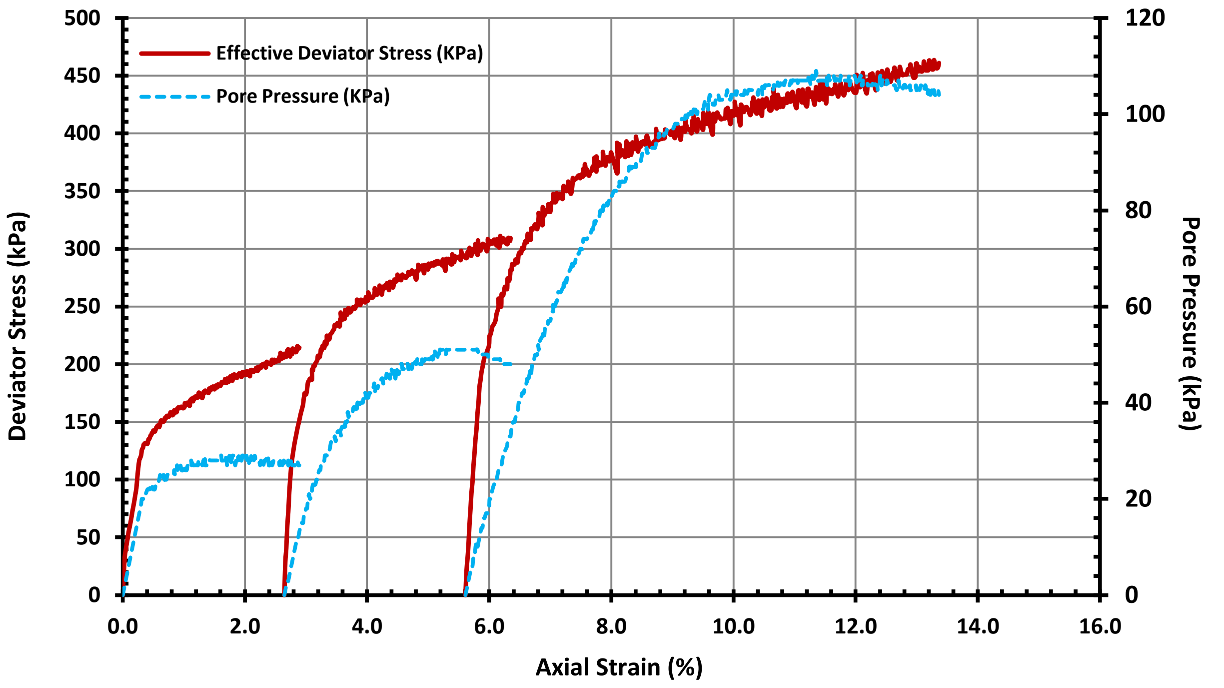
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U'_0	U'_f	Principal Effective Stresses			$\sigma'_1 - \sigma'_3$	Strain (%)
				σ'_1	σ'_3	σ'_1 / σ'_3		
1	75	0	28	243	47	5.17	196	2.23
2	150	0	51	397	99	4.01	298	5.76
3	300	0	107	628	193	3.25	435	12.18

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MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID:	TP02	**Depth (m):**	0.50 - 1.00
Lab ID:	WG22_2634_CU3	**Date Tested:**	28/02/2022

Failure Mode: Bulging Failure

Notes: **Sample remolded to 95% MDD @ OMC**

Stored and Tested the Sample as received

Samples supplied by the Client

NATA: 19078 **Authorised Signatory (Geotechnical Engineer):** [redacted]

NATA ACCREDITATION NO: 19078

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16 Gympie Way, Willetton
WA 6155

[redacted]

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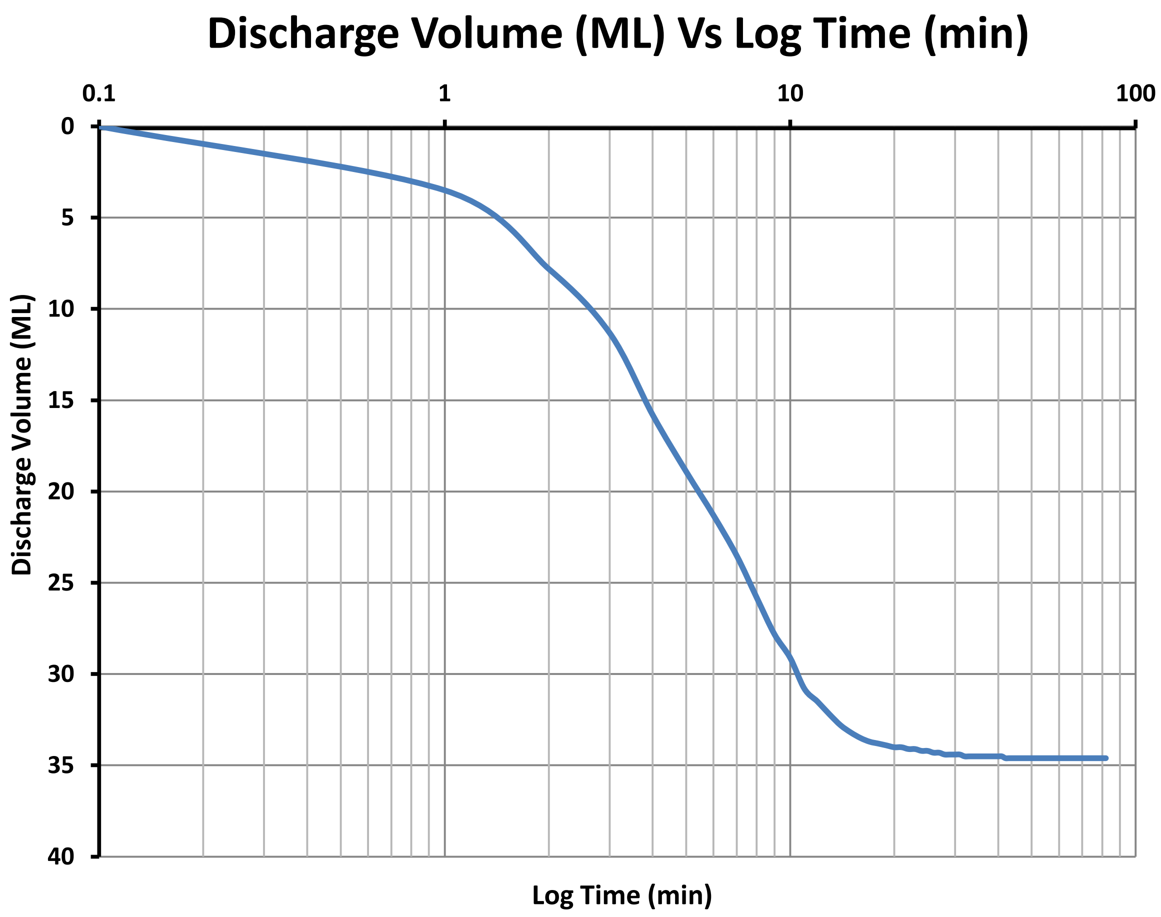
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Western Geotechnical Lab Services	Date Tested:	28/02/2022
Project:	Fingals TSG	EP Lab Job Number:	WGEO
Sample No:	TP02	Lab:	EPLab
Sample ID:	WG22_2634_CU3		
Depth (m):	0.50 - 1.00	Room Temperature at Test:	~ 18°C



Cv (cm^2/s): 0.062 based on $\mathbf{t_{90}}$

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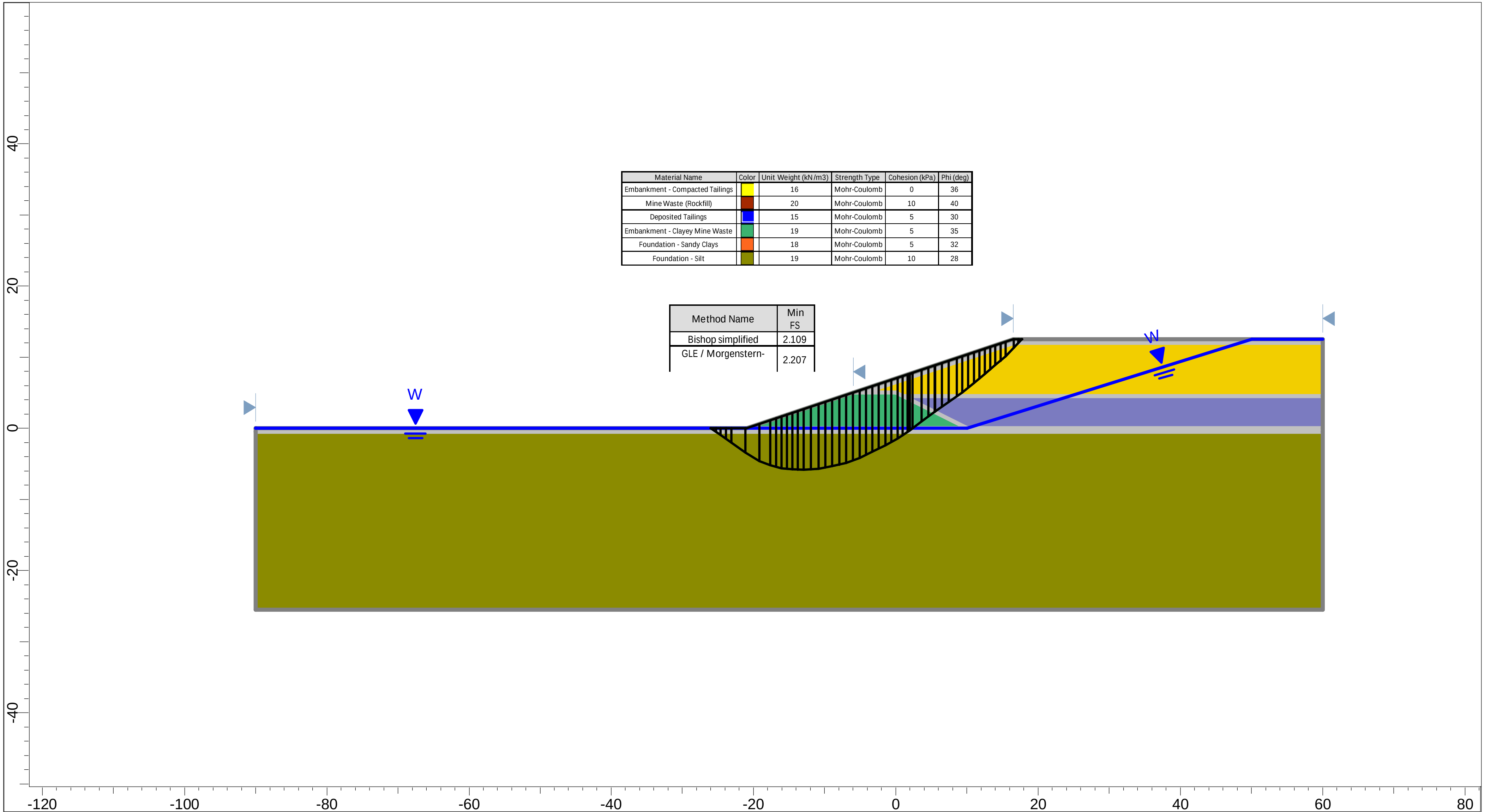
Appendix D
Slope Stability Analyses



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment - Compacted Tailings		16	Mohr-Coulomb	0	36
Mine Waste (Rockfill)		20	Mohr-Coulomb	10	40
Deposited Tailings		15	Mohr-Coulomb	5	30
Embankment - Clayey Mine Waste		19	Mohr-Coulomb	5	35
Foundation - Sandy Clays		18	Mohr-Coulomb	5	32
Foundation - Silt		19	Mohr-Coulomb	10	28

Method Name	Min FS
Bishop simplified	2.109
GLE / Morgenstern-	2.207

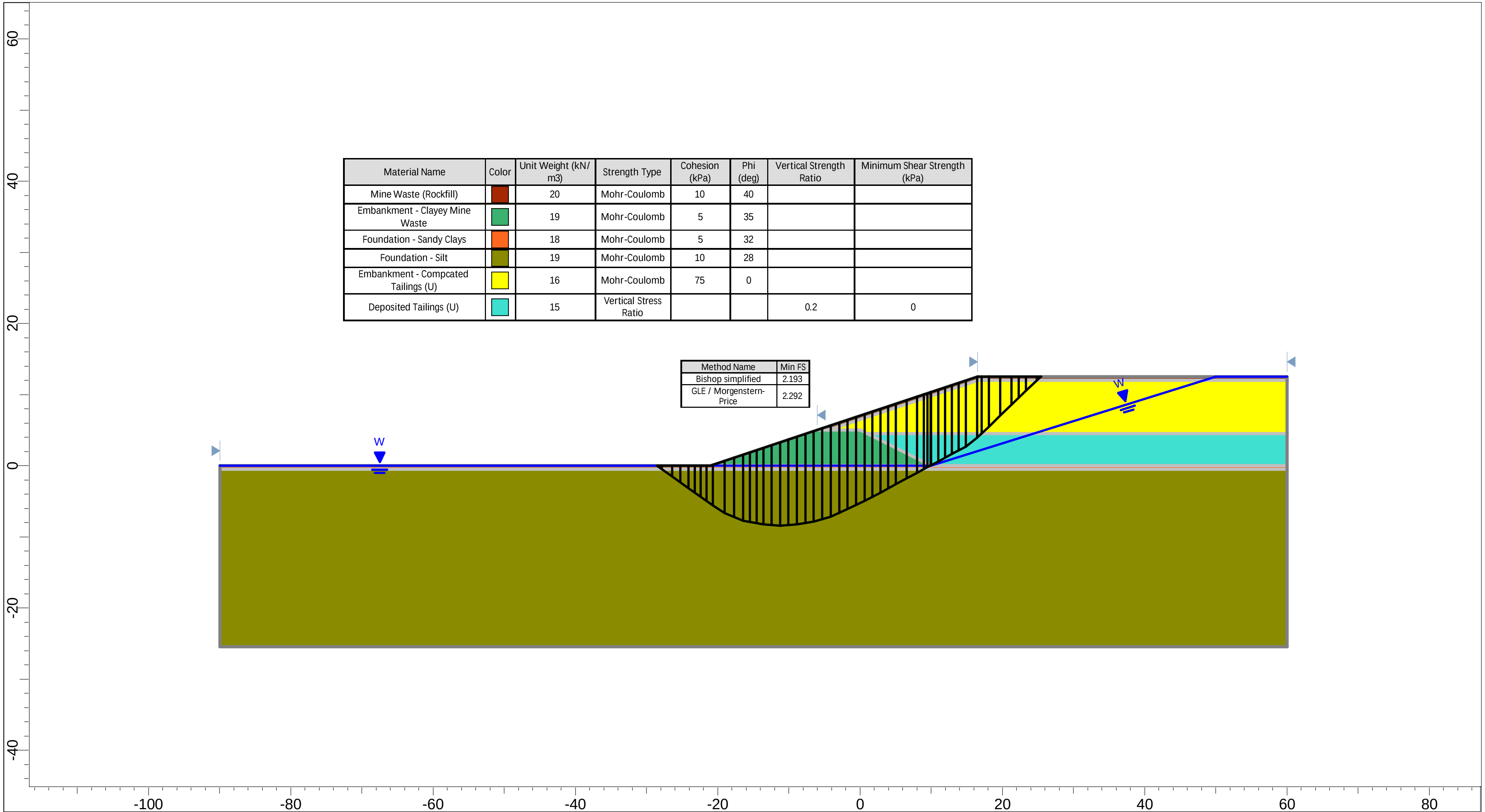
SLIDEINTERPRET 9.009

Project Fingals TSF

Scenario Case 1: Drained

Drawn By SW | *Company* CMW

Date 28/03/2022 | *File Name* Drained.slmd

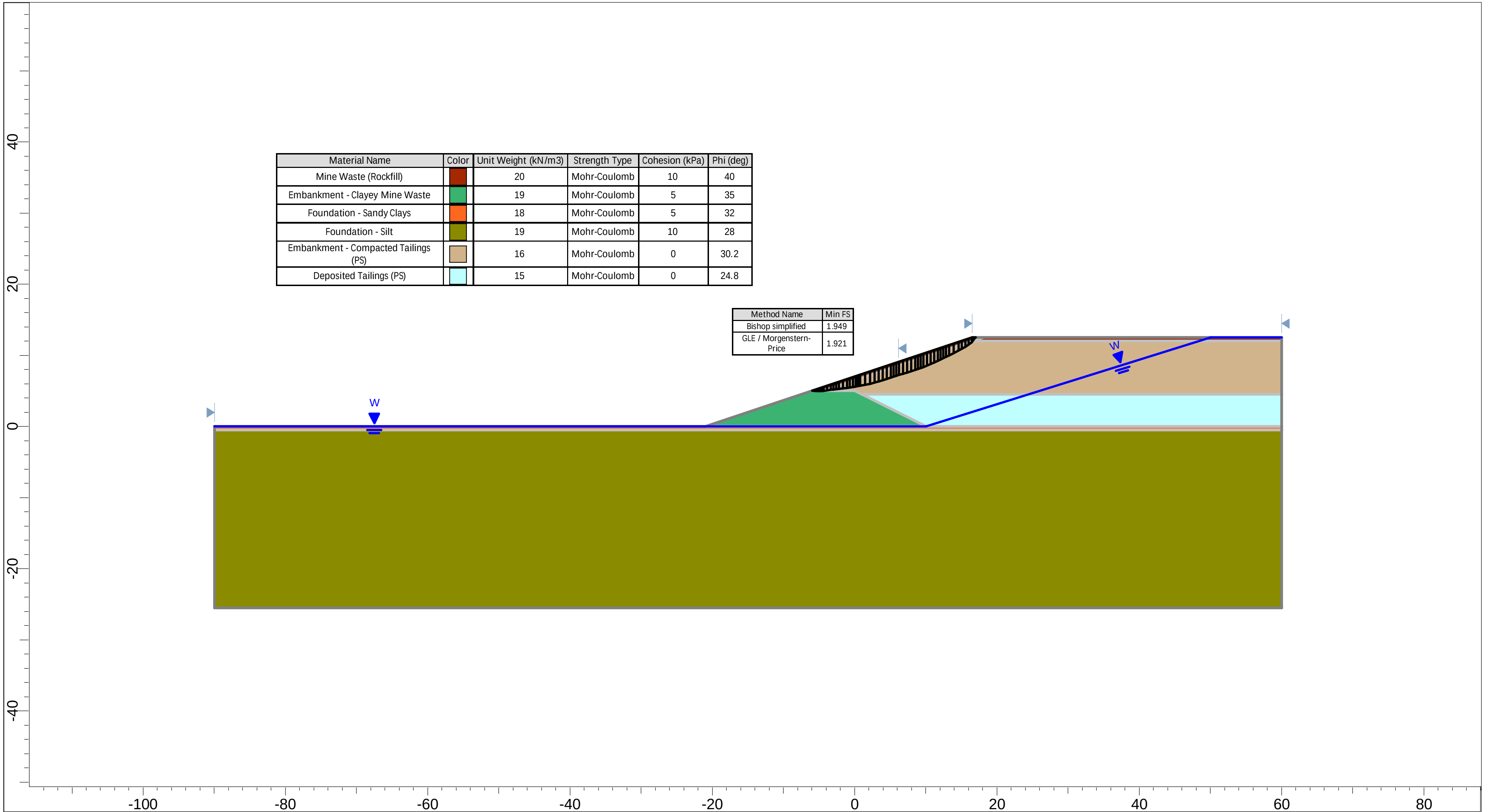


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (kPa)
Mine Waste (Rockfill)		20	Mohr-Coulomb	10	40		
Embankment - Clayey Mine Waste		19	Mohr-Coulomb	5	35		
Foundation - Sandy Clays		18	Mohr-Coulomb	5	32		
Foundation - Silt		19	Mohr-Coulomb	10	28		
Embankment - Compcated Tailings (U)		16	Mohr-Coulomb	75	0		
Deposited Tailings (U)		15	Vertical Stress Ratio			0.2	0

Method Name	Min FS
Bishop simplified	2.193
GLE / Morgenstern-Price	2.292

Project	Fingals TSF		
Scenario	Case 2: Undrained		
Drawn By	SW	*Company*	CMW
Date	28/03/2022	*File Name*	Undrained.slmd

SLIDEIN... 9.009



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Mine Waste (Rockfill)		20	Mohr-Coulomb	10	40
Embankment - Clayey Mine Waste		19	Mohr-Coulomb	5	35
Foundation - Sandy Clays		18	Mohr-Coulomb	5	32
Foundation - Silt		19	Mohr-Coulomb	10	28
Embankment - Compacted Tailings (PS)		16	Mohr-Coulomb	0	30.2
Deposited Tailings (PS)		15	Mohr-Coulomb	0	24.8

Method Name	Min FS
Bishop simplified	1.949
GLE / Morgenstern-Price	1.921

Project	Fingals TSF
Scenario	Case 3: Post-seismic
Drawn By SW	*Company* CMW
Date 28/03/2022	*File Name* Post-seismic.slmd

SLIDEIN[illegible] 9.009

Appendix B: Futi Bagus In-pit Tailings Storage Facility - Geotechnical Cutback Design Assessment

GEOAnalytica

Futi Bagus In-pit Tailings Storage Facility

Black Cat Syndicate Limited

Geotechnical Cutback Design Assessment

LMGAU0012-REP-001

21 September 2021

Disclaimer

[redacted]

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Tables List

1. INTRODUCTION

Black Cat Syndicate (herein referred to as BC8) is currently developing the Kal East Gold Project comprising four Mining Centres: Myhree, Fingals, Majestic, and Trojan.

At the Fingals Mining Centre lies the Futi Bagus Pit (FBP), which was developed in the 1990s and subsequently converted into an in-pit tailings storage facility (IPTSF). BC8 has subsequently discovered additional gold resources immediately southeast of the FBP and is proposing to develop a new open pit, which will intersect the existing tailings deposited within the FBP and requires a cutback into the deposited tailings forming the north-eastern face of the new pit shell and the adjacent natural ground. BC8 has indicated that the new open pit mine will have a short operating lifespan not exceeding 6 months.

BC8 has commissioned Land & Marine Geological Services Pty. Ltd. (L&MGSPL) and Geoanalytica Pty. Ltd. (Geoanalytica) to undertake geotechnical assessment of the proposed cutback into the in-situ tailings material within the FBP and the findings of this assessment is presented in this report.

1.1 Geotechnical Scope of Work

The geotechnical Scope of Work undertaken as part of the IPTSF cutback design assessment is as follows:

- Undertake geotechnical site investigation works (comprising both fieldwork and laboratory soil testing) of the deposited tailings within the FBP;
- Undertake geotechnical characterisation of the tailings to evaluate its composition, shear strength properties and moisture content;
- Identification of potential geohazards relating to the proposed cutback into tailings material;
- Undertake geotechnical slope stability assessment and provide recommendations for achieving a geotechnically-stable cut batter into the in-situ tailings material.

1.2 Provided Information

BC8 has provided Geoanalytica with (a) a plan layout drawing illustrating the proposed new pit footprint superimposed over a satellite image showing the existing FBP, and (b) a drawing illustrating the as-built cross-section of the FBP shell surface cut in the north-west to south-east direction. Both drawings are provided in Appendix A of this report.

2. GEOTECHNICAL SITE INVESTIGATION

The geotechnical site investigation works comprised fieldwork and laboratory soil testing as detailed below.

2.1 Fieldwork

Fieldwork comprised Piezocone Penetration Test (CPTu) probing at four (4) locations within the FBP footprint including (a) the undertaking of six (6) excess pore pressure dissipation (EPPD) tests along the probed depth, and (b) the extraction of eight (8) nos. undisturbed 63 mm diameter thin wall tube (U63) soil samples. The above works were undertaken utilising a 22 t truck-mounted rig operated by CPTWest Pty. Ltd.

The CPTu probes were aligned along a north-west to south-east axis of the proposed cutback through the tailings within the as-built pit cross-section of the pit, as per Figure 2 1 and the drawing in Appendix A.

Table 2-1 summarises GPS grid coordinates (GDA94 datum) and ground surface elevation (AHD) recorded at each CPTu location by the CPTu rig in-built GPS.FBP.

Table 2-1 CPTu location details

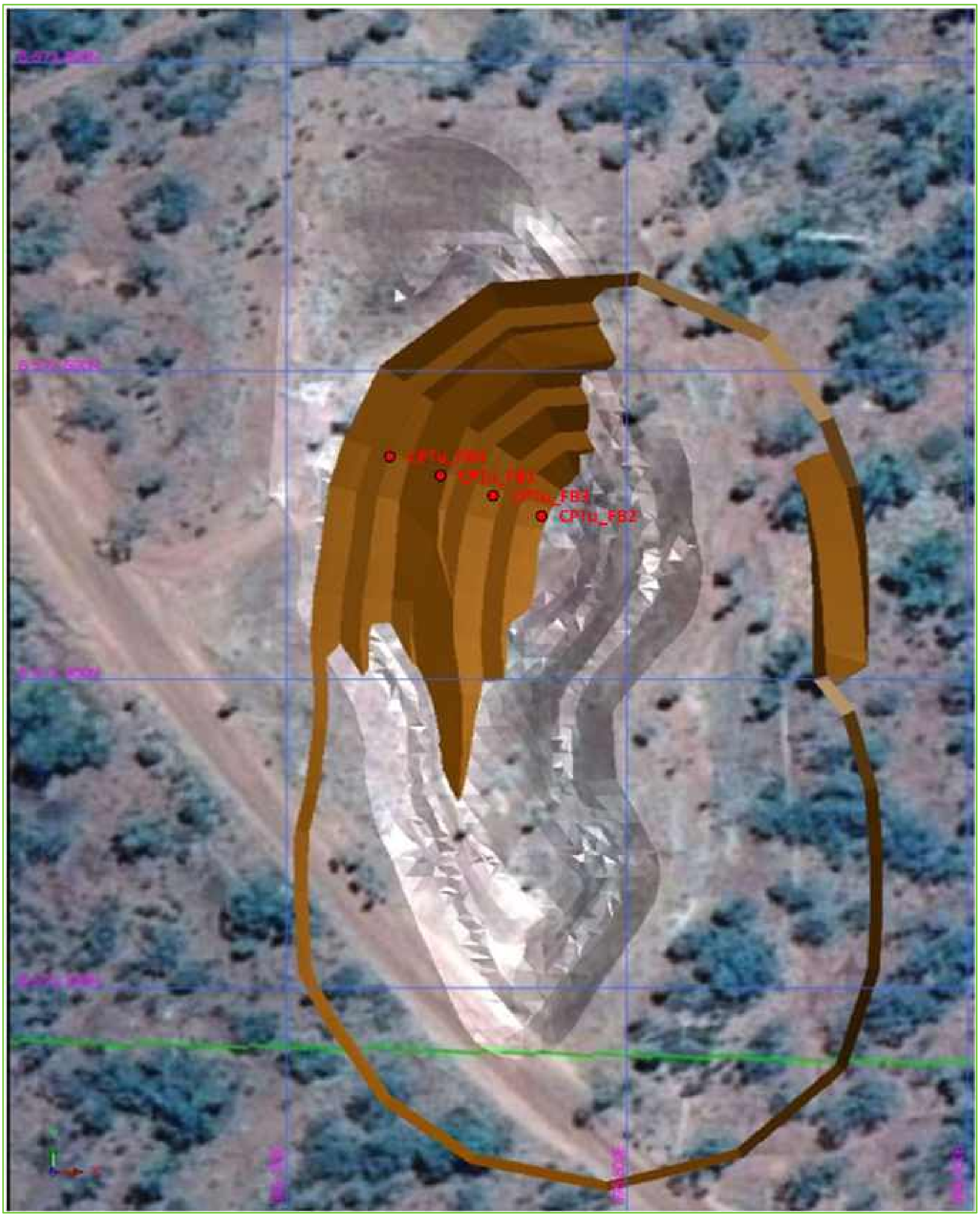
CPTu location	Location coordinates (m)		Probed surface elevation (RL m AHD)	CPTu probed depth (m)
	Easting	Northing		
CPTu_FB1	395745.20	6573466.26	391.02	35.95
CPTu_FB2	395774.84	6573453.11	391.53	43.65
CPTu_FB3	395760.66	6573459.69	391.21	44.08
CPTu_FB4	395730.29	6573472.71	391.05	31.49

Details of where the EPPD tests were undertaken, including time taken to achieve 50% and 90% pore pressure dissipation estimated based on a square root time approach, initial maximum pore pressure, and final pore pressure at end of test are summarised in Table 2-2 below. EPPD reading curves are provided in Appendix A.

Table 2-2 EPPD test details

CPTu location	Test depth (m)	Initial maximum pore pressure reading (kPa)	Final pore pressure reading at end of test (kPa)	Time to achieve 50% pore pressure dissipation (s)	Time to achieve 90% pore pressure dissipation (s)
CPTu_FB1	8.79	357.96	-21.83	46	286
CPTu_FB1	14.00	555.8	-1.59	53	345
CPTu_FB1	32.01	668.27	3.08	37	282
CPTu_FB2	14.01	266.87	20.26	54	525
CPTu_FB2	32.01	220.23	13.32	114	570
CPTu_FB2	43.01	320.77	6.87	4	58

Figure 2-1 CPTu probe location



Details of the CPTu location and probed depth from which the U63 tube soil samples were collected are summarised in Table 2-3.

Table 2-3 Undisturbed thin wall push tube soil sample collection details

CPTu location	Sampled depth (m)	CPTu location	Sampled depth (m)	CPTu location	Sampled depth (m)
CPTu_FB1	9	CPTu_FB1	13	CPTu_FB1	19
CPTu_FB3	14	CPTu_FB3	19	CPTu_FB2	9
CPTu_FB2	15.5	CPTu_FB2	21	-	-

2.2 Laboratory Testing

The U63 tube soil samples were sent to a NATA-accredited geotechnical soil testing laboratory for the following tests to be undertaken:

- One (1) nos. Particle Size Distribution (PSD) grading with hydrometer measurement;
- Two (2) nos. PSD grading only;
- Two (2) nos. particle density / specific gravity (S_g) measurement;
- Four (4) nos. phase diagram measurements comprising bulk density, moisture content, and void ratio measurement;
- Two (2) nos. Atterberg Limits measurements;
- Two (2) nos. minimum / maximum dry density measurements;
- Two (2) nos. consolidated undrained triaxial compression shear (CUTX) tests;
- Two (2) nos. consolidated drained triaxial compression shear (CDTX) tests; and
- Two (2) nos. direct shear box tests (DST).

Results from the above tests, including details of which U63 tube samples were used for each test, are summarised in Table 2-4 and Table 2-5.

Table 2-4 Geotechnical laboratory soil test results summary – Soil particle size distribution and density properties

CPTu location	Sampled depth (m)	Particle size distribution - % soil content smaller than the following particle size (mm):					Density and moisture properties						
		0.002	0.075	0.21	0.6	2.36	Particle specific gravity, S_g	In-situ moisture content (%)	In-situ bulk density (t/m³)	In-situ dry density (t/m³)	In-situ void ratio, e	Minimum dry density (t/m³)	Maximum dry density (t/m³)
CPTu_FB1	9	28.4	98.6	99.7	100	100	2.919	43.22	1.871	1.306	1.23	-	-
CPTu_FB1	13	-	-	-	-	-	-	-	-	-	-	-	-
CPTu_FB1	19	-	24.7	70	100	100	3.011	6.79	1.724	1.614	0.87	1.292	1.509
CPTu_FB3	14	-	-	-	-	-	-	-	-	-	-	-	-
CPTu_FB3	19	-	20.8	70	100	100	2.966	6.32	1.739	1.636	0.81	1.342	1.547
CPTu_FB2	9	-	-	-	-	-	-	-	-	-	-	-	-
CPTu_FB2	15.5	-	-	-	-	-	-	-	-	-	-	-	-
CPTu_FB2	21	-	-	-	-	-	3.041	8.09	1.878	1.737	0.75	-	-

Table 2-5 Geotechnical laboratory soil test results summary – Index properties and shear test data

CPTu location	Sampled depth (m)	Soil index properties			Triaxial shear test data - failure stress at different stage (1 - 3) (kPa)		Direct shear test data - failure stress at different stage (1 - 3) (kPa)	
		Plastic Limit (%)	Liquid Limit (%)	Plasticity index (%)	Effective lateral stress, σ_3'	Effective axial stress, σ_1'	Effective normal stress, σ_n'	Effective shear stress, τ'
CPTu_FB1	9	34.98	52.8	17.82	-	-	-	-
CPTu_FB1	13	-	-	-	5 (1), 11 (2), 26 (3)	87 (1), 111 (2), 154 (3)	-	-
CPTu_FB1	19	21.41	28.7	7.29	10 (1), 50 (2), 100 (3)	149 (1), 384 (2), 584 (3)	10 (1), 50 (2), 250 (3)	21 (1), 65 (2), 226 (3)
CPTu_FB3	14	-	-	-	-	-	-	-
CPTu_FB3	19	-	-	-	-	-	25 (1), 150 (2), 500 (3)	38 (1), 174 (2), 452 (3)
CPTu_FB2	9	-	-	-	-	-	-	-
CPTu_FB2	15.5	-	-	-	8 (1), 15 (2), 38 (3)	87 (1), 109 (2), 164 (3)	-	-
CPTu_FB2	21	-	-	-	25 (1), 75 (2), 400 (3)	190 (1), 470 (2), 1705 (3)	-	-

3. GEOTECHNICAL SITE CHARACTERISATION

3.1 Groundwater Condition

Based on both CPTu U2 pore pressure measurements and final pore pressure readings from the EPPD test, tending towards zero pressure reading, groundwater/phreatic surface is indicative that the tailings are not fully saturated, thus there is effectively no groundwater present throughout the entire in-situ tailings profile within the FBP.

3.2 In-situ Tailings Properties

3.2.1 Material Composition

In-situ tailings material intersected by the CPTu probing and undisturbed thin wall tube sampling can be delineated into two (2) categories: Coarse Tailings and Fine Tailings. The tailings type classification for all the collected undisturbed U63 tube samples is summarised in Table 3-1 below.

Table 3-1 Undisturbed thin wall push tube soil sample – tailings type classification

CPTu location	Sampled depth (m)	Tailings type
CPTu_FB1	9	Fine Tailings
CPTu_FB1	13	Fine Tailings
CPTu_FB1	19	Coarse Tailings
CPTu_FB3	14	Fine Tailings
CPTu_FB3	19	Coarse Tailings
CPTu_FB2	9	Fine Tailings
CPTu_FB2	15.5	Fine Tailings
CPTu_FB2	21	Coarse Tailings

Detail discussions of the material composition for both tailings types are provided below in general accordance with Australian Standard AS1726:2017 *Geotechnical Site Investigations*.

Coarse Tailings

The encountered Coarse Tailings material is composed predominantly of silty SAND material, with the silt being of low plasticity, whereas the sands are fine-grained and its particle angularity is sub-rounded to sub-angular.

The Coarse Tailings material can generally be distinguished from the CPTu data where (a) the cone tip resistance $q_t \geq 5$ MPa, and (b) the q_t trace profile with depth is jagged and zigzags.

Fine Tailings

The encountered Fine Tailings material is composed predominantly of SILT material of high plasticity.

The Fine Tailings material can generally be distinguished from the CPTu data where (a) the cone tip resistance $q_t \leq 5$ MPa, and (b) the q_t trace profile with depth is generally smooth and linearly increasing with depth.

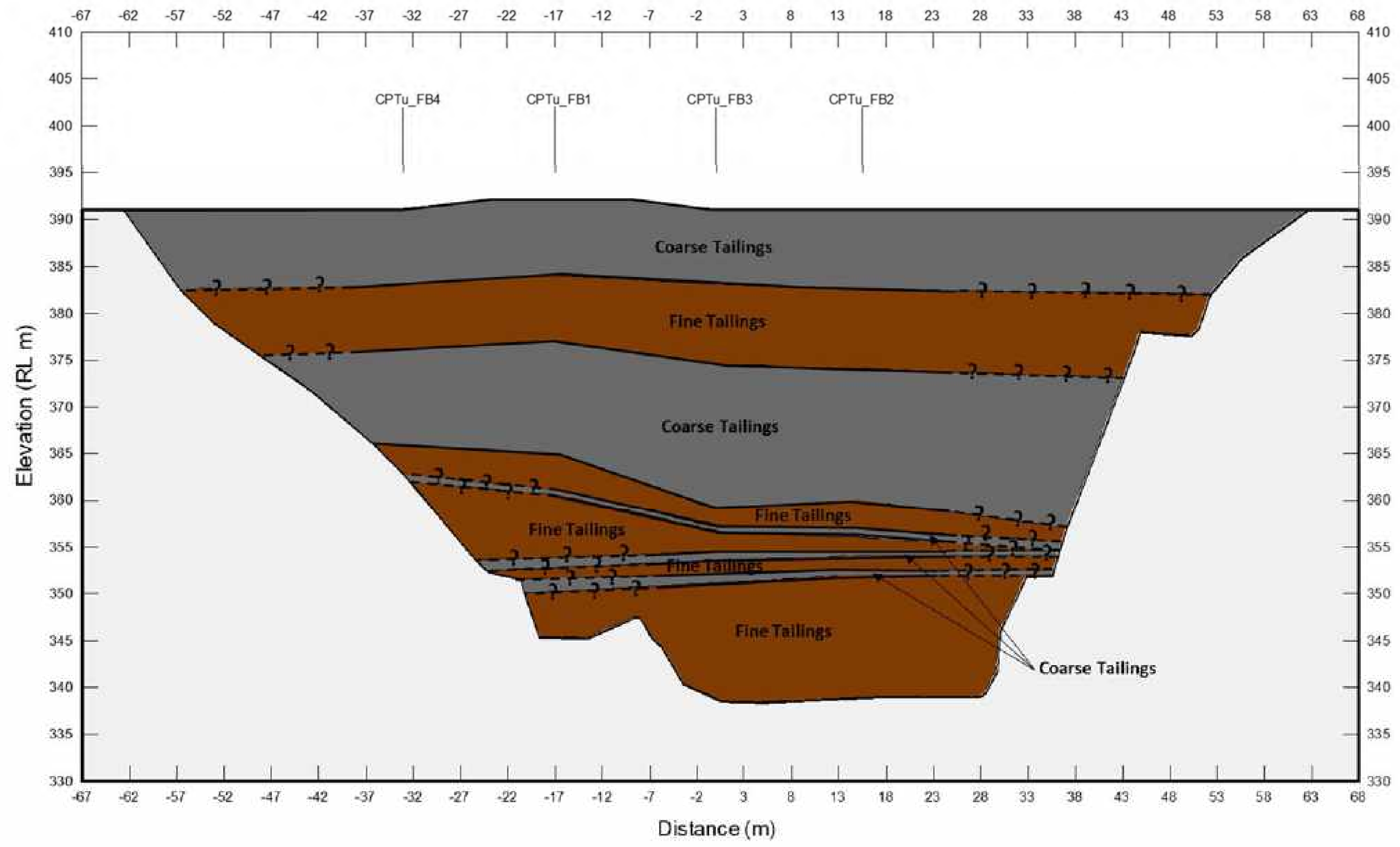
3.2.2 Distribution of in-situ Coarse and Fine Tailings

The lateral and vertical distribution of both Coarse and Fine Tailings within FBP has been interpreted from the CPTu q_t data, as per above discussions, and is illustrated on the provided as-built FBP shell cross-section as per Figure 3-1.

The interpretation of the layering within the FBP, indicates the following:

- The tailings materials and layering may reflect the timing of deposition and the treatment of difference ore types as indicated be the alternate sand and clay layers. As far as we are aware there are no reports of the process and deposition covering the period of operation;
- Segregation of the tailings during deposition near the pit rim as the sand fraction falls out of suspension, with the finer fraction (silt and clay) carried further out into the deposition area; and
- Tailings deposition points may have been moved around the pit rim resulting in alternating sand and clay layers, although typically, in-pit tailings deposition is typically focused on maintaining the supernatant pond and water recovery pump at the haul ramp, which means limited movement of deposition locations.

Figure 3-1 In-situ Coarse and Fine Tailings distribution within FBP



3.2.3 Density and moisture condition

Coarse Tailings

The Coarse Tailings material possesses in-situ bulk density ranging between 1.7 t/m^3 and 1.9 t/m^3, with the in-situ moisture content ranging between 6% and 8%, and the corresponding in-situ dry density ranging between 1.6 and 1.7 t/m^3.

The measured soil particle density (specific gravity) for the Coarse Tailings particles range between 2.9 and 3.0 t/m^3, which is somewhat higher than typical gold tailings where the values are closer to 2.70 t/m^3.

Fine Tailings

The Fine Tailings material is anticipated to possess similar bulk density as per the above range, and is skewed to the higher end, however it possesses an in-situ moisture content of ~40%. The measured in-situ dry density is approximately 1.3 t/m^3.

The measured soil particle density (specific gravity) for the Fine Tailings particles is similar to that of the Coarse Tailings particles.

3.2.4 Shear Strength

Coarse Tailings

This material observed to possess some degree of cementation, for which the successful extraction of undisturbed samples via the thin wall push tube sampling method is most likely attributed to (see Figure 3-2 for illustration), and is possibly associated with the conditioning effect of lime introduced into the milled ore, prior to leaching, to maintain a sufficiently high pH as part of the gold cyanidation process.

Due to its dry condition, above observed cemented nature, and free-drained nature associated with its coarse-grained soil composition, the Coarse Tailings material is anticipated to shear in a drained effective manner under all soil stress conditions (static and transient), and its geotechnical shear strength can be defined under the Mohr-Coulomb failure criterion. The governing shear strength parameters defined under this failure criterion is the effective friction angle φ' and apparent cohesion c'. Both these parameters have been interpreted from laboratory CDTX and DST effective failure stress measurements as presented on a graph in Figure 3-3. The adopted design Mohr-Coulomb failure plane is defined as a red line in Figure 3-3 and is represented by φ' = 40° and c' = 20 kPa.

Fine Tailings

As groundwater/phreatic surface has not been encountered within the FBP, the in-situ Fine Tailings material is anticipated to geotechnically shear in a drained effective manner under static soil stress conditions, and its effective geotechnical shear strength has been interpreted based on the Mohr-Coulomb failure criterion as per above discussion. The design effective geotechnical shear strength parameters has been interpreted from laboratory CUTX effective failure stress measurements, as per graph in Figure 3-4, and is estimated to be represented by φ' = 26° and c' = 22.5 kPa.

It is however to be noted that due to its high in-situ moisture content relative to its liquid limit, and the observed excess pore pressure development during CPTu probe penetration through the in-situ Fine Tailings layers, the in-situ Fine Tailings material can also potentially shear in an undrained manner under static transient soil stress conditions typically arising from mine blasting activities.

The geotechnical shear strength under such shear behaviour can be defined under the Tresca failure criterion, with the governing parameter being the undrained shear strength parameter S_u.

S_u has been interpreted from the CPTu q_t data as per empirical relationship by Robertson (2015) and is based on a typical cone factor N_{kt} of 14. The interpreted S_u profile with depth is presented as a graph in Figure 3-5. Based on this graph, S_u is indicated to be approximately 50 kPa for Fine Tailings present above RL 375 m, and at least 70 kPa or more at depths lower than RL 365 m.

3.2.5 Design geotechnical parameters

Design geotechnical parameters adopted for assessments covered by this report is summarised in Table 3-2 below.

Table 3-2 Design geotechnical parameters for in-situ tailings material within FBP

Soil material	Bulk unit weight (kN/m³)	Drained effective geotechnical shear strength		Undrained geotechnical shear strength, S_u (kPa)
		Effective friction angle, φ’ (°)	Apparent cohesion, c’ (kPa)	
Coarse Tailings	18.5	40	20	N/A
Fine Tailings	18.5	26	22.5	50 above RL 375 m 70 below RL 365 m

Figure 3-2 Push tube sampler end with extracted undisturbed in-situ Coarse Tailings material

Figure 3-3 Geotechnical effective failure shear stress response of Coarse Tailings

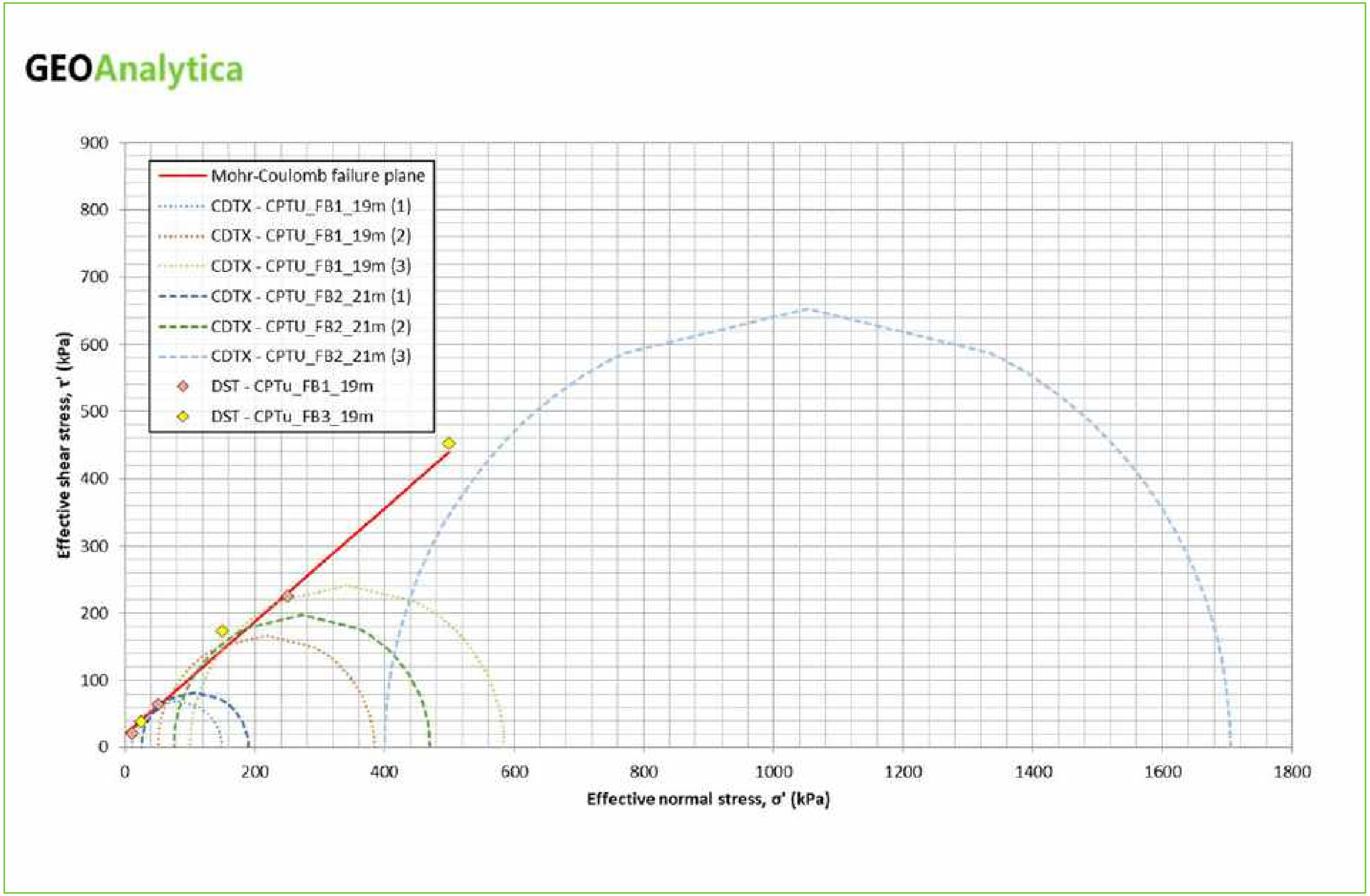


Figure 3-4 Geotechnical effective failure shear stress response of Fine Tailings

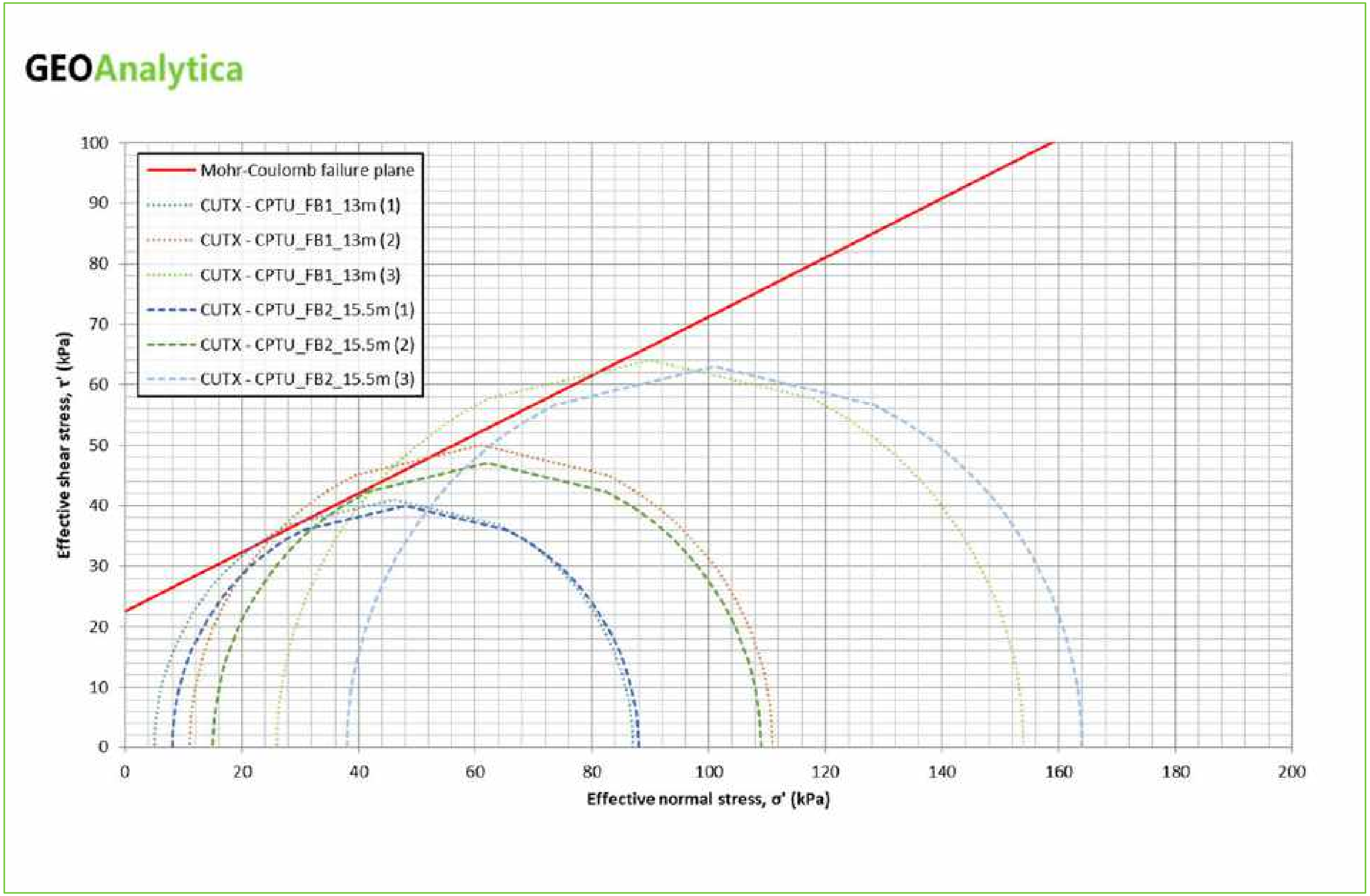
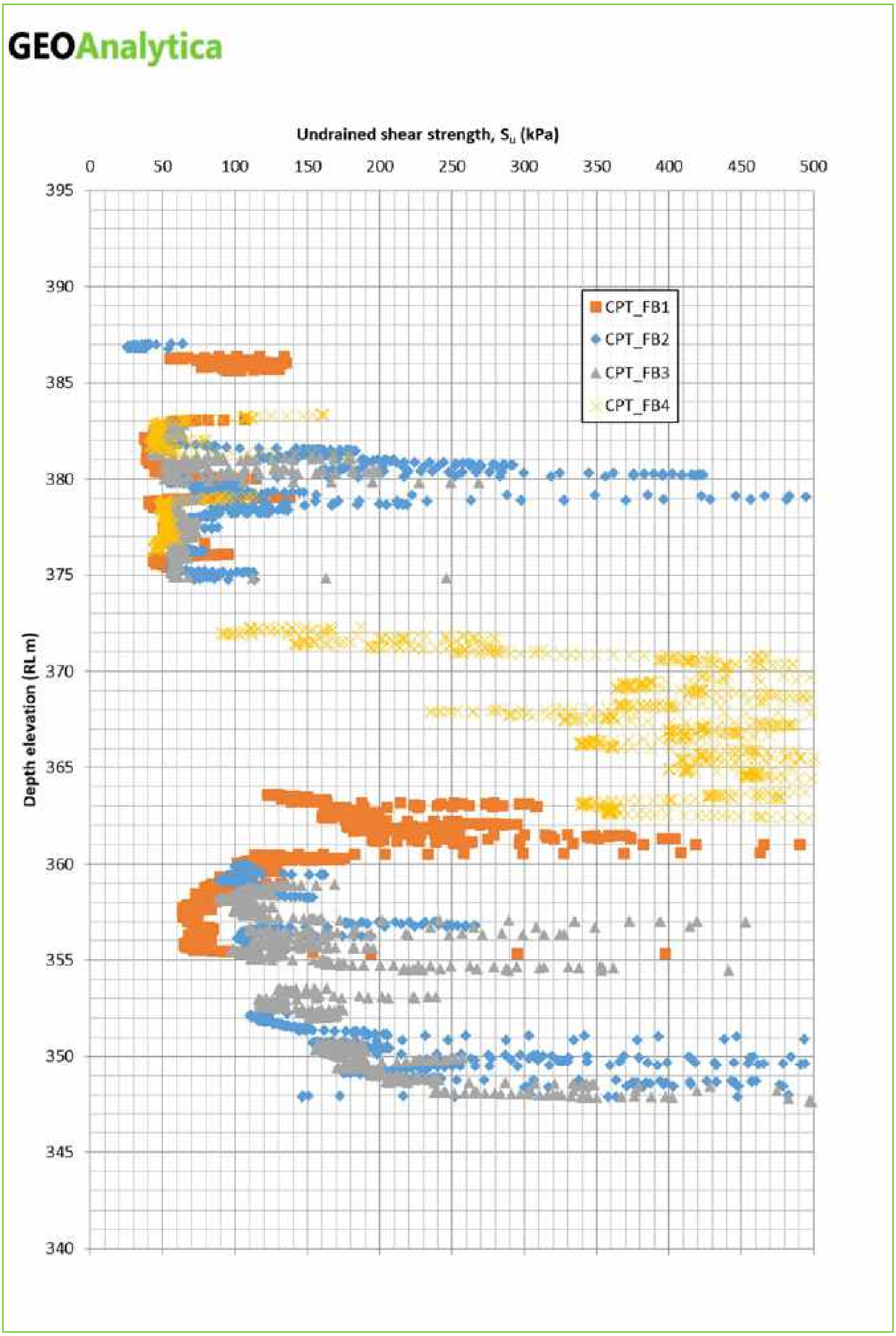


Figure 3-5 Geotechnical undrained shear strength of Fine Tailings



4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Potential Geohazards

Based on the interpreted geotechnical characteristics of the in-situ tailings material within FBP, BC8 should be aware of the potential geohazards associated with the proposed cutback into the tailings material as part of the open pit mine development:

1) Slumping failure of the tailings cutback embankment as the tailings geotechnical shear strength transition from drained to undrained state due to mine blasting activities; and/or
2) Trafficking difficulty and bogging risk for tracked earthworks machinery traversing across the tailings surface during the cutback exercise. The in-situ tailings is anticipated to be too soft to support the traversing of haul trucks.

4.2 Assessment Objectives

In relation to the potential geohazards identified in Section 4.1, The following assessments have been undertaken:

1) Slope stability assessment to evaluate what is the maximum allowable slope gradient that can be formed when cutting into the in-situ tailings while ensuring the cut slope has sufficient geotechnical stability;
2) Ground bearing pressure assessment to evaluate the maximum allowable track ground bearing pressure of earthwork machineries that can be safely supported by the in-situ Coarse and Fine Tailings material; and
3) Detail discussion on the cutback earthworks sequence considering only tracked earthwork machineries, and not haul trucks, are likely able to traverse across the in-situ tailings.

4.3 Slope Stability Assessment

4.3.1 General methodology

The assessment involves the estimation of geotechnical slope stability Factors of Safety (FoS_{slope}) based on a two-dimensional Limit Equilibrium (2D LE) analysis approach. The commercial analysis software Geostudio SLOPE/W 2012, employing the Morgenstern-Price method of slices, has been utilised for this assessment.

As detailed above, the assessment has been carried out to estimate the maximum allowable slope gradient at which the tailings can be cut to and considers the following soil stress conditions:

- Static conditions whereby all in-situ tailings material geotechnically shear in a drained manner;
- Transient condition to simulate mine blasting activities, whereby the in-situ Fine Tailings material is treated to geotechnically shear in an undrained manner, whereas the in-situ Coarse Tailings still geotechnically shear in a drained manner; and
- Drained and undrained design geotechnical shear strength parameters in Table 3-2 have been adopted.

Geotechnical slope stability assessment considering seismic soil stress conditions has not been undertaken as it is not deemed to be necessary due to the short operating lifespan of the proposed new open pit mine (≤ 6 months).

4.3.2 FoS criteria

Considering the dry condition of the in-situ tailings and FBP, the proposed cutback into such tailings is anticipated to be no different to cutback into naturally-occurring soils, as such the recommended FoS_{slope} criteria provided in the CSIRO (2009) *Guidelines for Open Pit Slope Design* is deemed to be applicable for this assessment. The adopted FoS_{slope} criteria is as per Table 4-1 below.

Table 4-1 Geotechnical slope stability FoS_{slope} criteria

Soil stress condition	Minimum FoS_{slope} requirement
Static	≥ 1.3
Transient	≥ 1.1

4.3.3 Analysis results and recommendation

Based on a few SLOPE/W analysis permutations, a global, overall, cutback slope gradient from crest to toe must not be steeper than 1V:1.7H (≤ 30.45° taken from the horizontal plane) is required to ensure the slope possesses sufficient FoS_{slope} ≥ 1.3; SLOPE/W output illustrating the predicted critical geotechnical failure mechanism and corresponding FoS_{slope} is provided in Figure 4-1.

Under transient conditions, the proposed cutback slope is anticipated to be geotechnically unstable with a high potential for large slumping failure onto the pit base regardless of how mild the cutback slope gradient where blasting works are required for the new open mine pit development. If blasting is anticipated all in-situ tailings material will have to be removed from the FBP prior to any blasting works.

4.4 Track Ground Bearing Pressure Assessment

An assessment to estimate the maximum allowable track ground bearing pressure (q_{all}) has been undertaken based on recommendations by Lyamin et al (2007), utilising the design geotechnical parameters provided in Table 3-2, and considers the following assumptions:

- The earthwork machineries comprise dozers and / or excavators than run on tracks; and
- The track width is at least 600 mm or more;
- Fine Tailings material geotechnically behave in an undrained manner due to vibrations induced by the earthworks machinery; and
- A minimum geotechnical bearing capacity FoS of 3.0 has been applied.

The estimated q_{all} for the different in-situ tailings material, including recommendations of suitable earthwork machineries, are summarised in Table 4-2 below.

Table 4-2 Maximum allowable ground-bearing pressure and earthwork machinery recommendation

In-situ tailings material	Maximum allowable ground-bearing pressure, q_{all} (kPa)	Earthwork machinery recommendation
Coarse Tailings	150	Cat D11T dozer or equivalent

In-situ tailings material	Maximum allowable ground-bearing pressure, q_{all} (kPa)	Earthwork machinery recommendation
Fine Tailings present above RL 375 m	100	Cat D8T dozer or equivalent
Fine Tailings present below RL 365 m	140	Cat D11T dozer or equivalent

4.5 Cutback earthworks sequence considerations

It is anticipated that the tailings cutback earthworks will have to be undertaken in conjunction with the advancement of the new open mine pit, and the following earthworks sequence should be considered:

1) Excavation into natural ground within the new open mine pit footprint is advanced down by increments of not more than 3 m depth (referred to below as newly-excavated basin);
2) Dozers (as per recommendation in Table 4-2) are used to push the in-situ tailings onto the newly-excavated floor where truck and excavators are located on natural ground to facilitate load and haul operations for the mine waste, tailings and ore, as appropriate;
3) The newly-excavated basin is advanced another 3 m depth, and the above earthwork sequence is repeated.

Figure 4-1 Geotechnical slope stability analysis output – Static soil stress condition

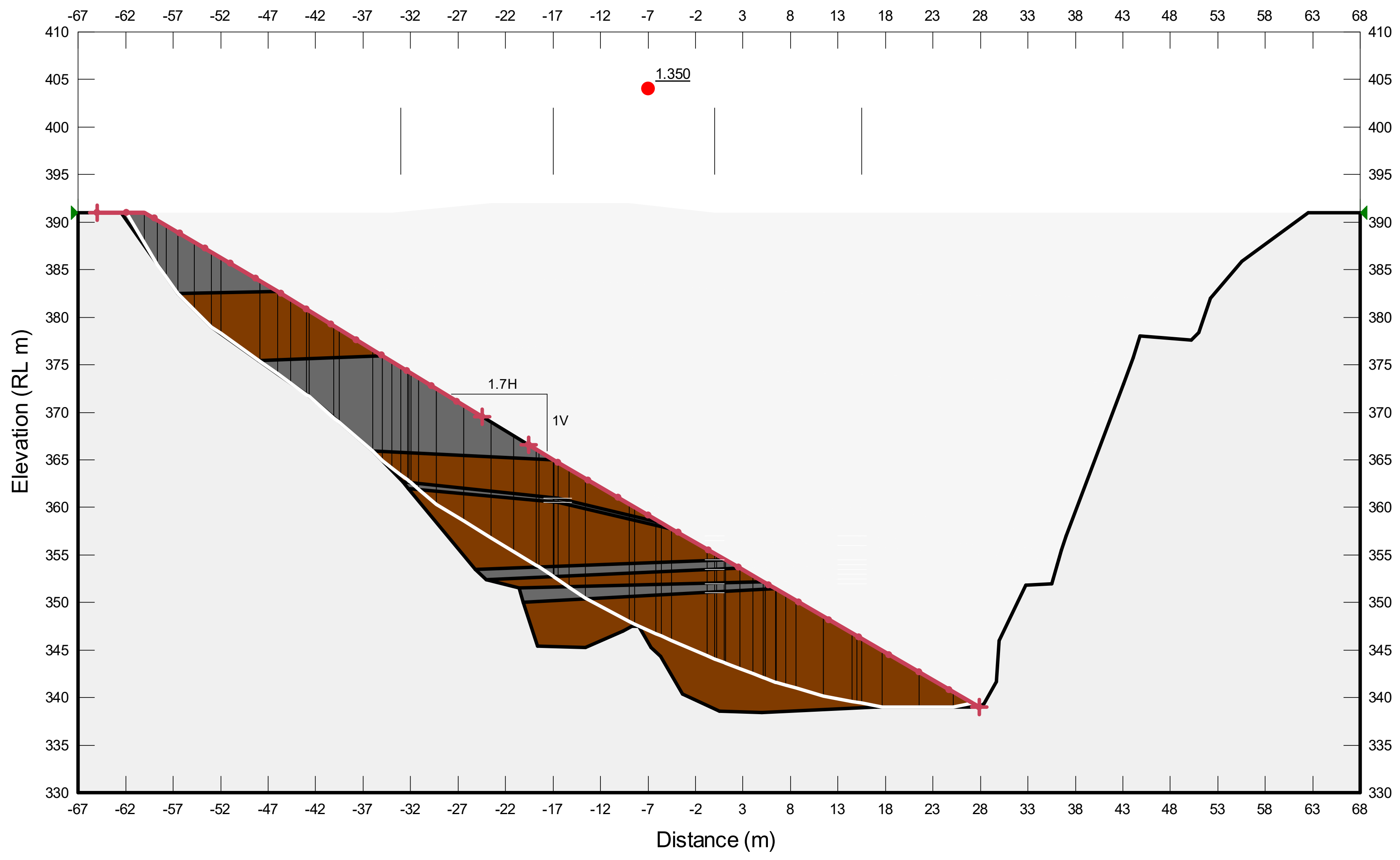
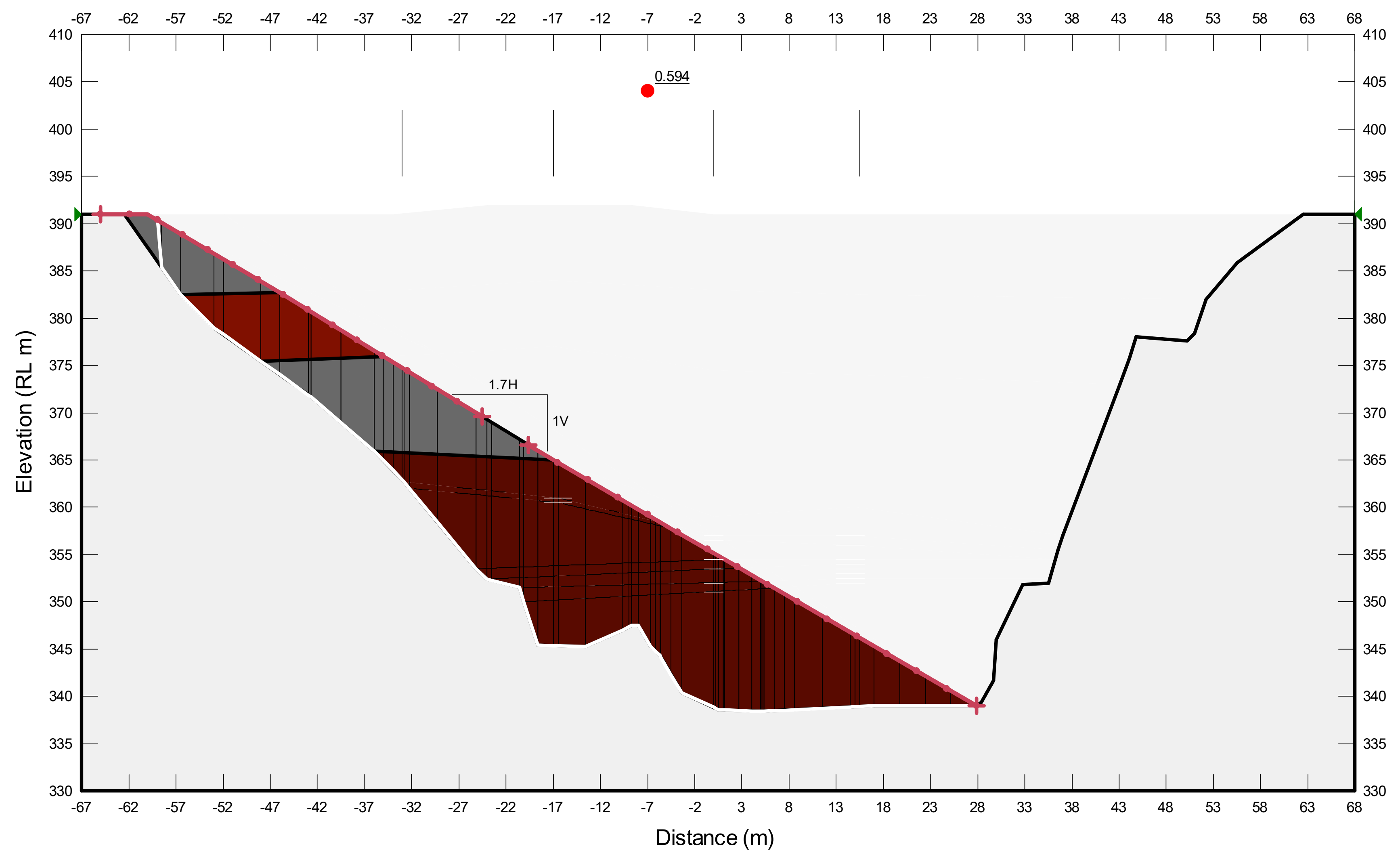


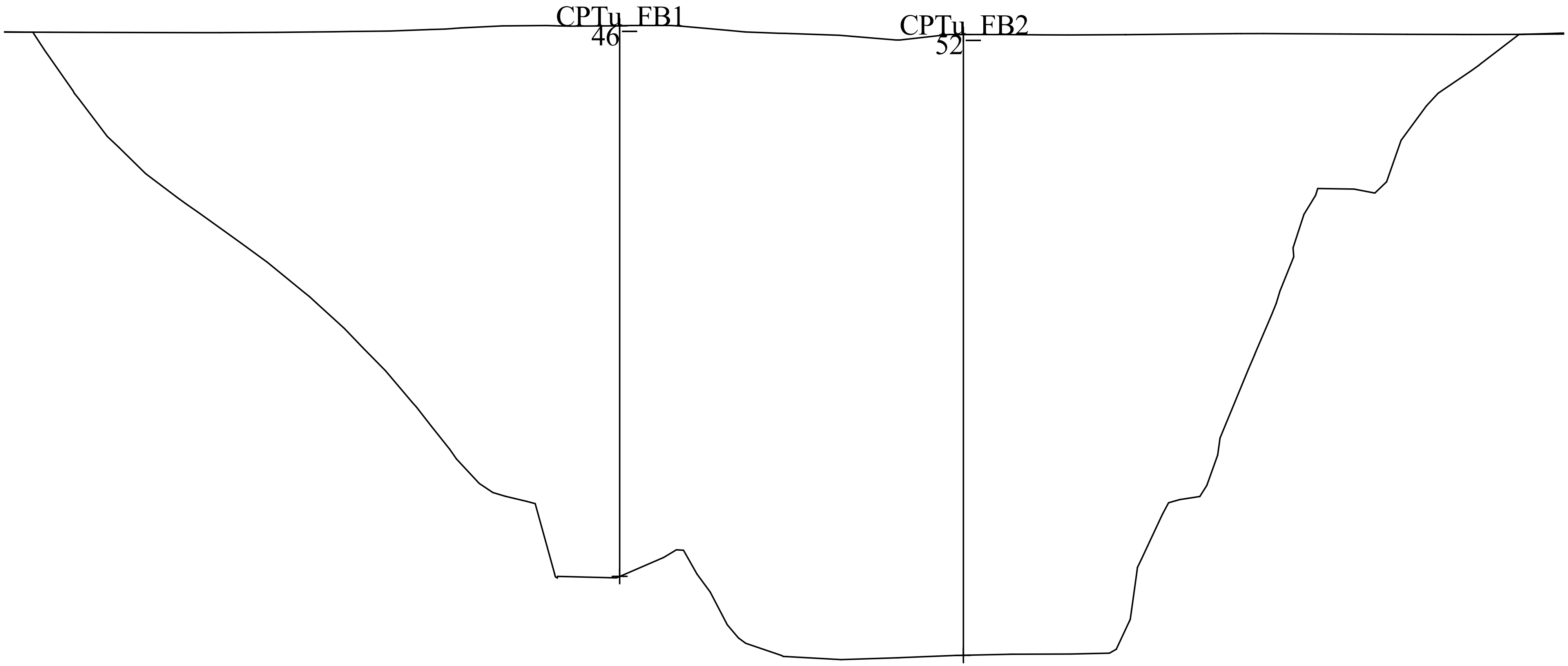
Figure 4-2 Geotechnical slope stability analysis output – Transient soil stress condition



5. REFERENCE

1. Lyamin, A.V., Salgado, R., Sloan, S.W., and Prezzi, M. (2007) “Two- and three-dimensional bearing capacity of footings in sand”, *Geotechnique*, Vol. 57, no. 8, pp. 647 - 662
2. Robertson, P.K. (2015), *Guide to Cone Penetration Testing*, 6th Edition

Appendix A Client-supplied information



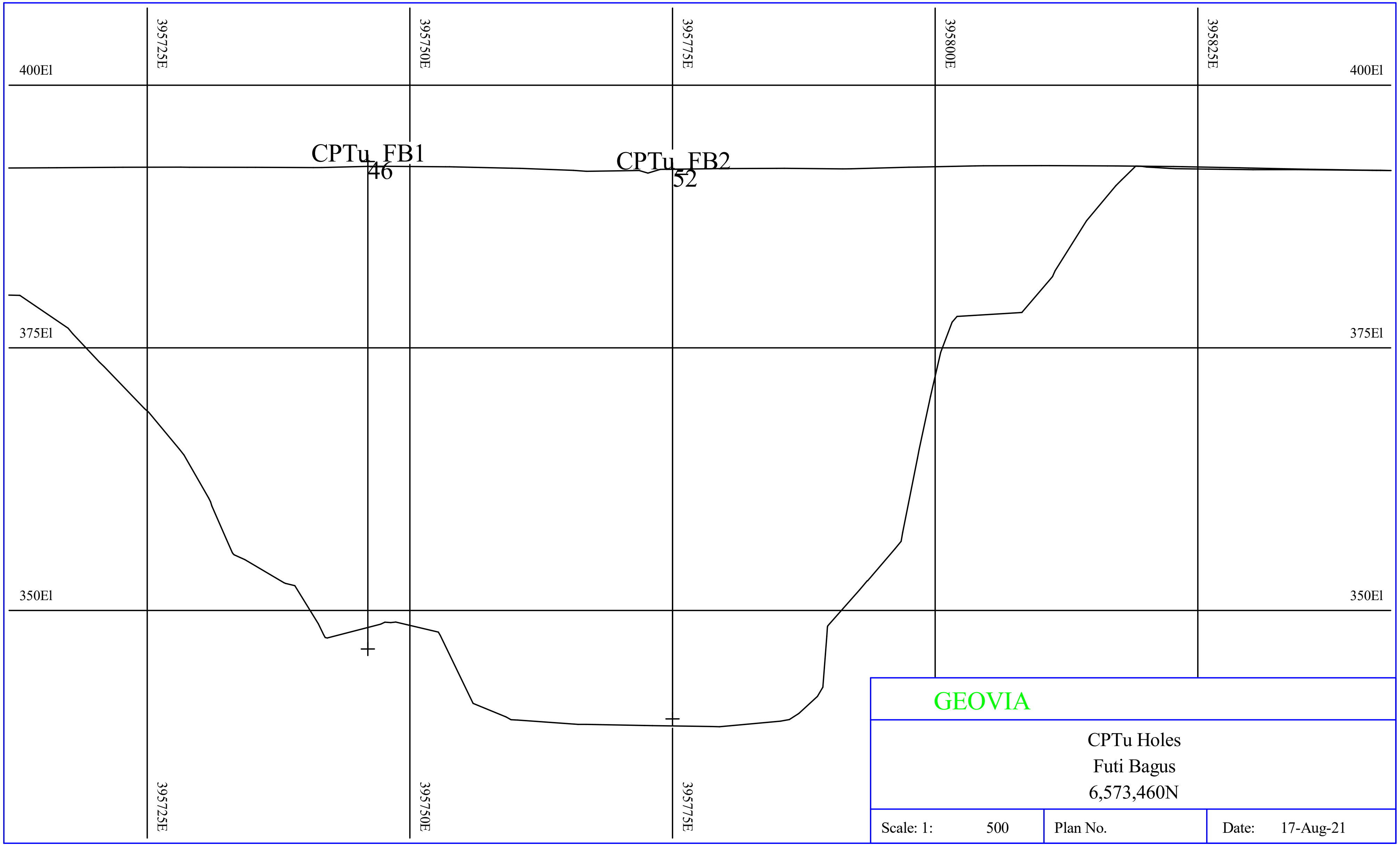
GEOVIA

CPTu Holes
Futi Bagus

Scale: 1: 500	Plan No.	Date: 17-Aug-21

cptu_holes_str

SURPAC - GEOVIA



cptu_holes_str_01

SURPAC - GEOVIA

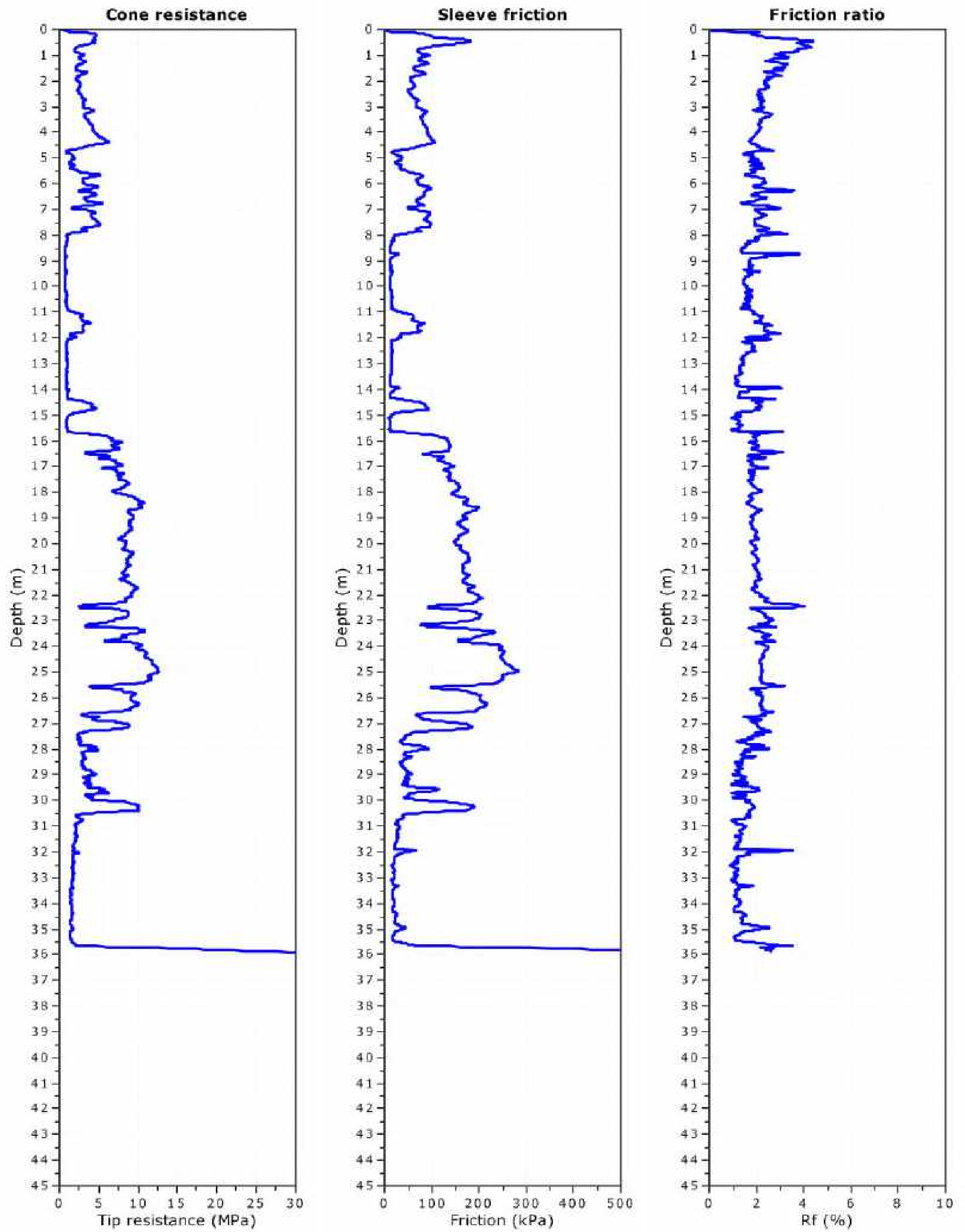
Appendix B Geotechnical site investigation data – CPTu plots

info@cptwest.com.au
www.cptwest.com.au
[redacted]

CPTu_FB1

Total depth: 35.95 m, Date: 24/08/2021
Surface Elevation: 391.02 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395745.20, Y:6573466.26
Cone Operator: Andrew

Futi Bagus	**Futi Bagus Tailings**
Kalgoorli	**Kalgoorlie**

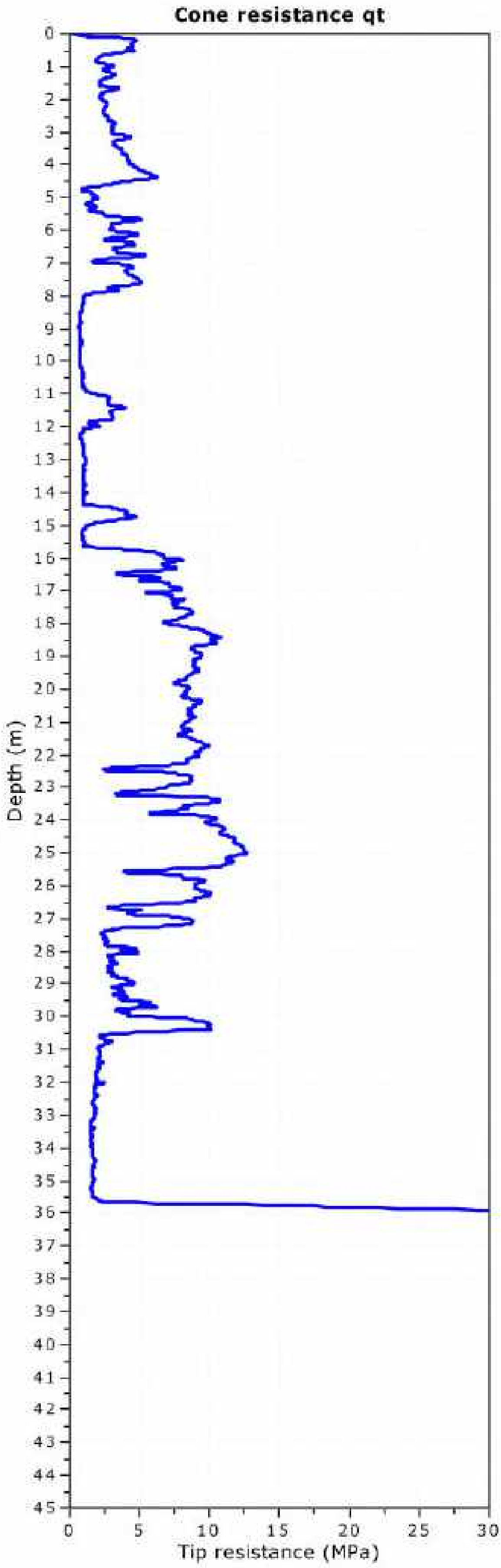


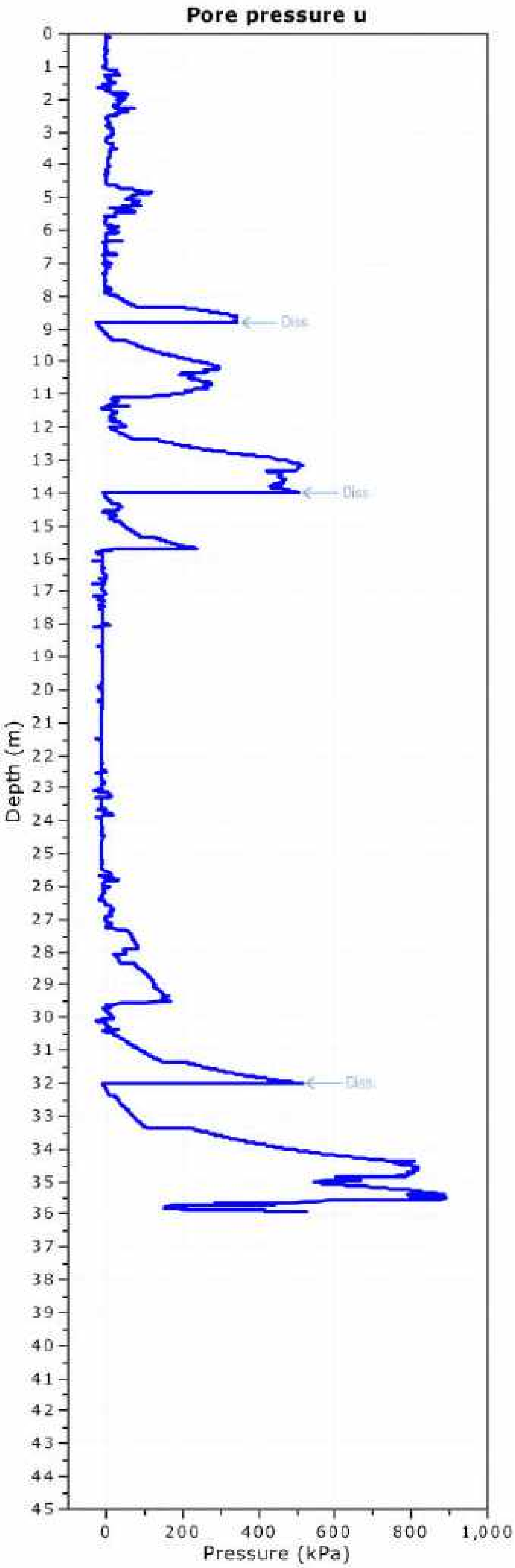
info@cptwest.com.au
www.cptwest.com.au
[redacted]

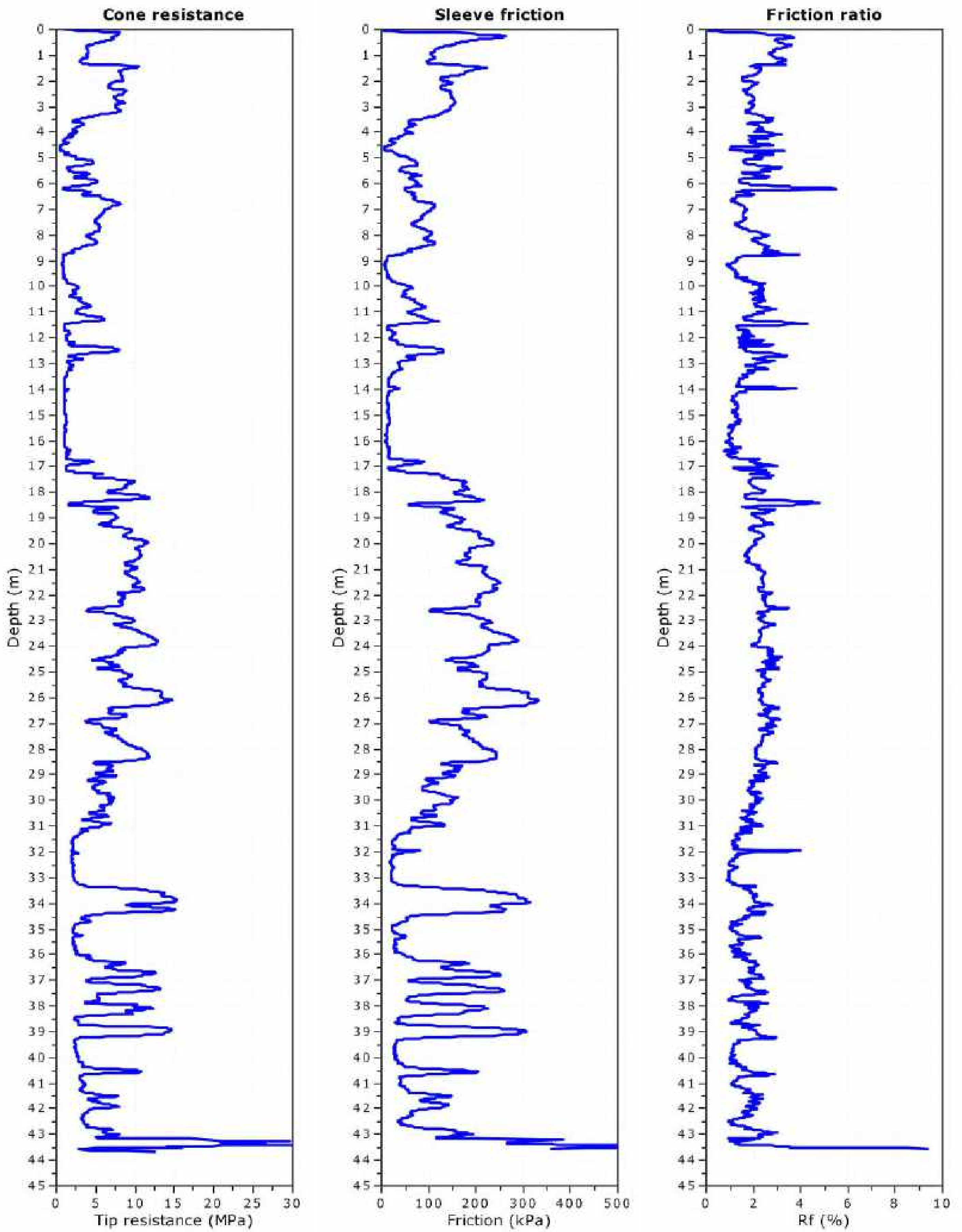
CPTu_FB1

Total depth: 35.95 m, Date: 24/08/2021
Surface Elevation: 391.02 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395745.20, Y:6573466.26
Cone Operator: Andrew

Futi Bagus **Futi Bagus Tailings**
Kalgoorli **Kalgoorlie**





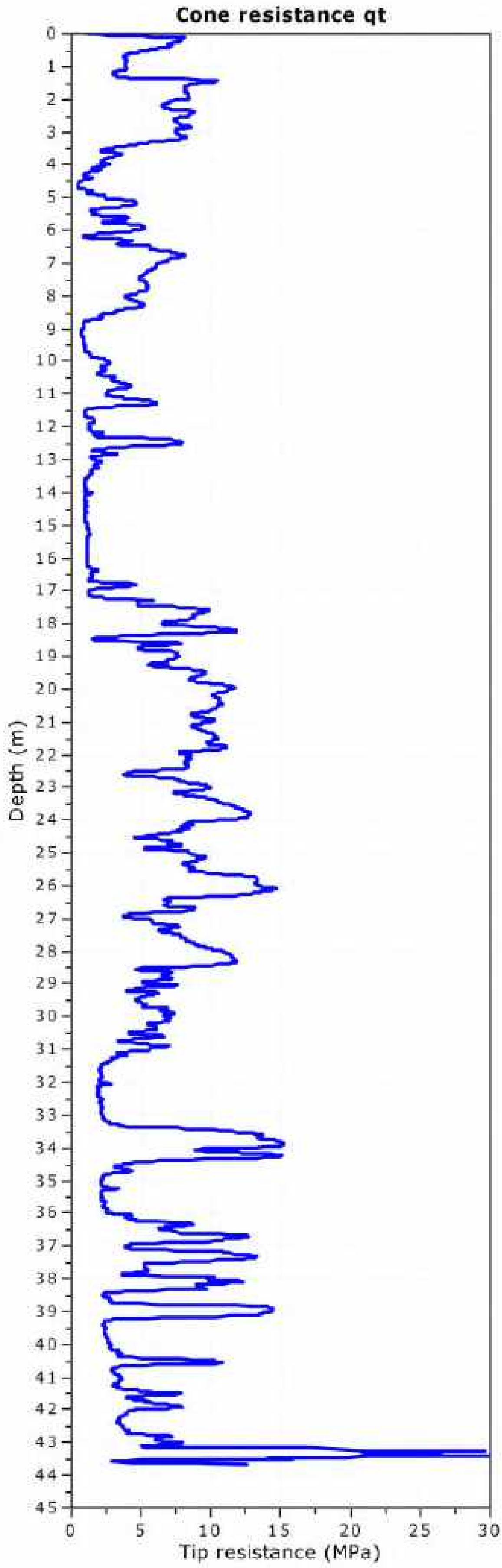

Cone resistance
Depth (m)
Tip resistance (MPa)
Sleeve friction
Depth (m)
Friction (kPa)
Friction ratio
Depth (m)
Rf (%)

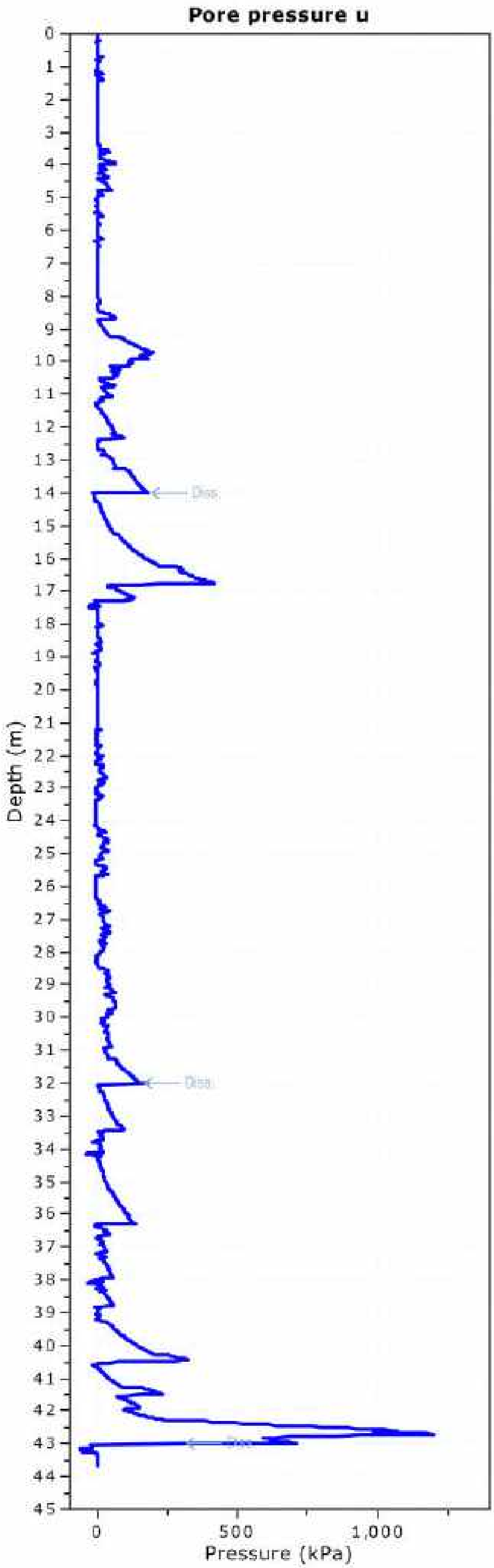
info@cptwest.com.au
www.cptwest.com.au
[redacted]

CPTu_FB2

Total depth: 43.65 m, Date: 24/08/2021
Surface Elevation: 391.53 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395774.84, Y:6573453.11
Cone Operator: Andrew

Futi Bagus Kalgoorli **Futi Bagus Tailings**
Kalgoorlie



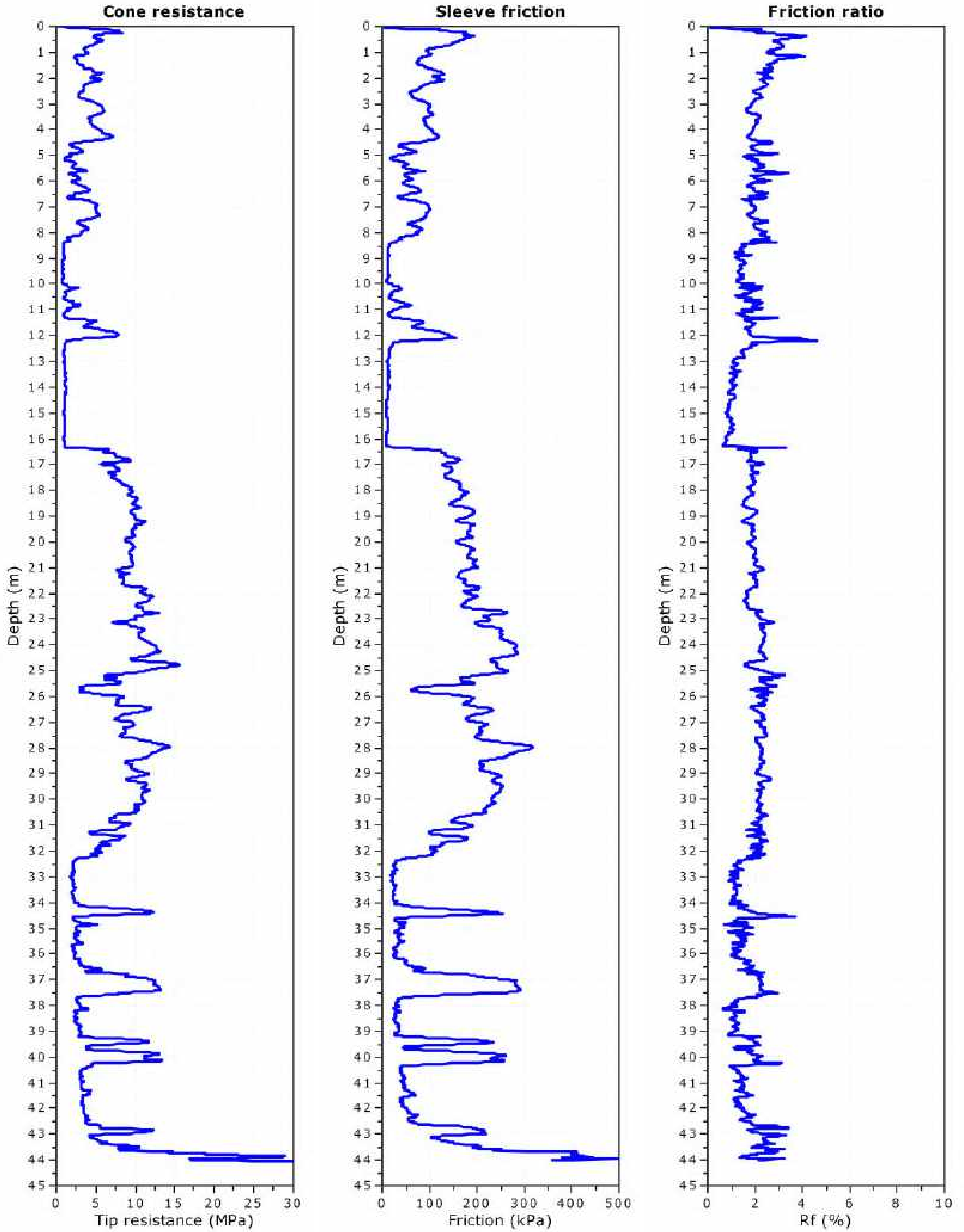


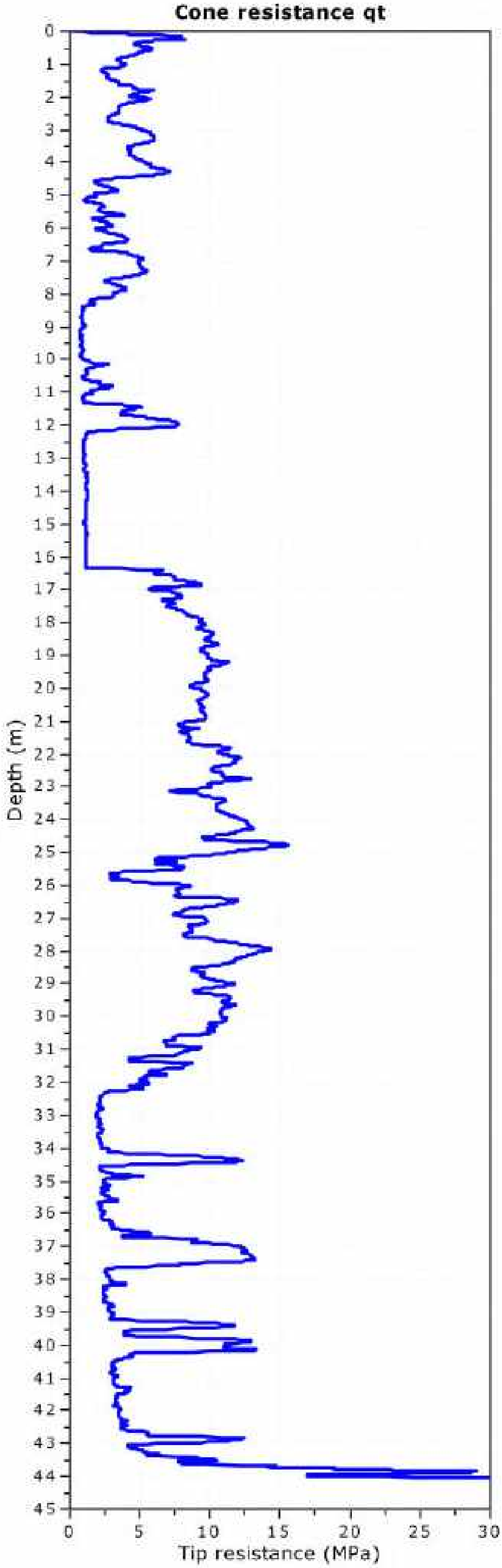
info@cptwest.com.au
www.cptwest.com.au
[redacted]

CPTu_FB3

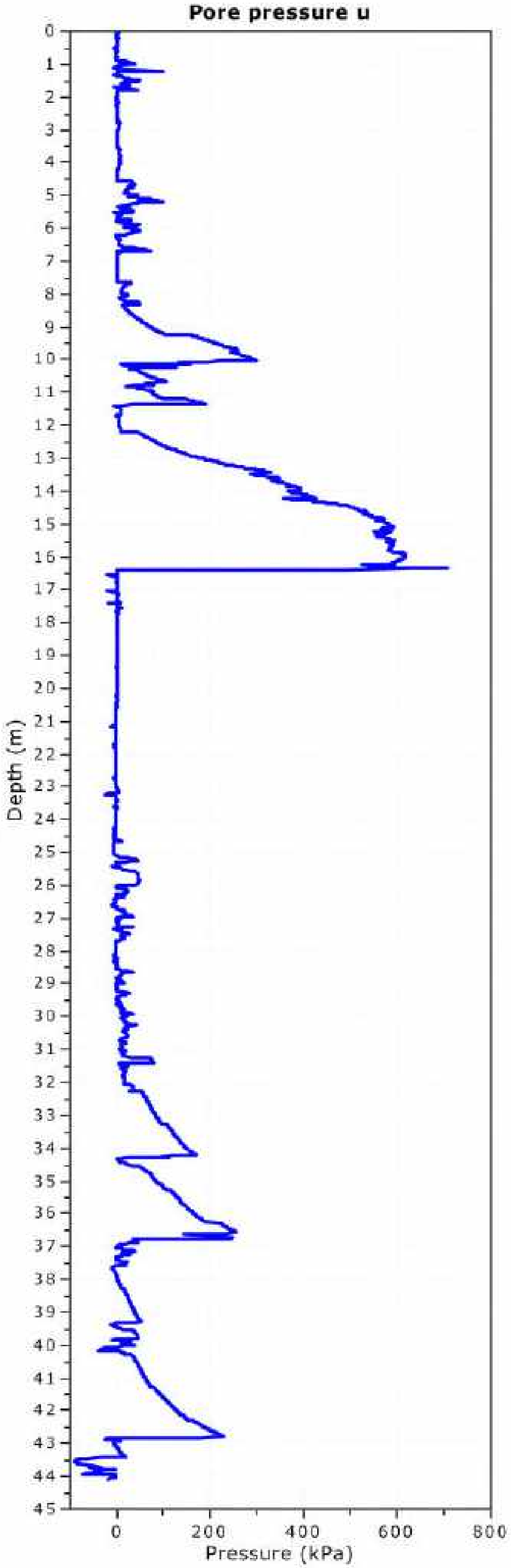
Total depth: 44.08 m, Date: 24/08/2021
Surface Elevation: 391.21 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395760.66, Y:6573459.69
Cone Operator: Andrew

Futi Bagus---- **Futi Bagus Tailings**
Kalgoorli **Kalgoorlie**





Cone resistance qt
Depth (m)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
0 5 10 15 20 25 30
Tip resistance (MPa)



Pore pressure u
Depth (m)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
0 200 400 600 800
Pressure (kPa)

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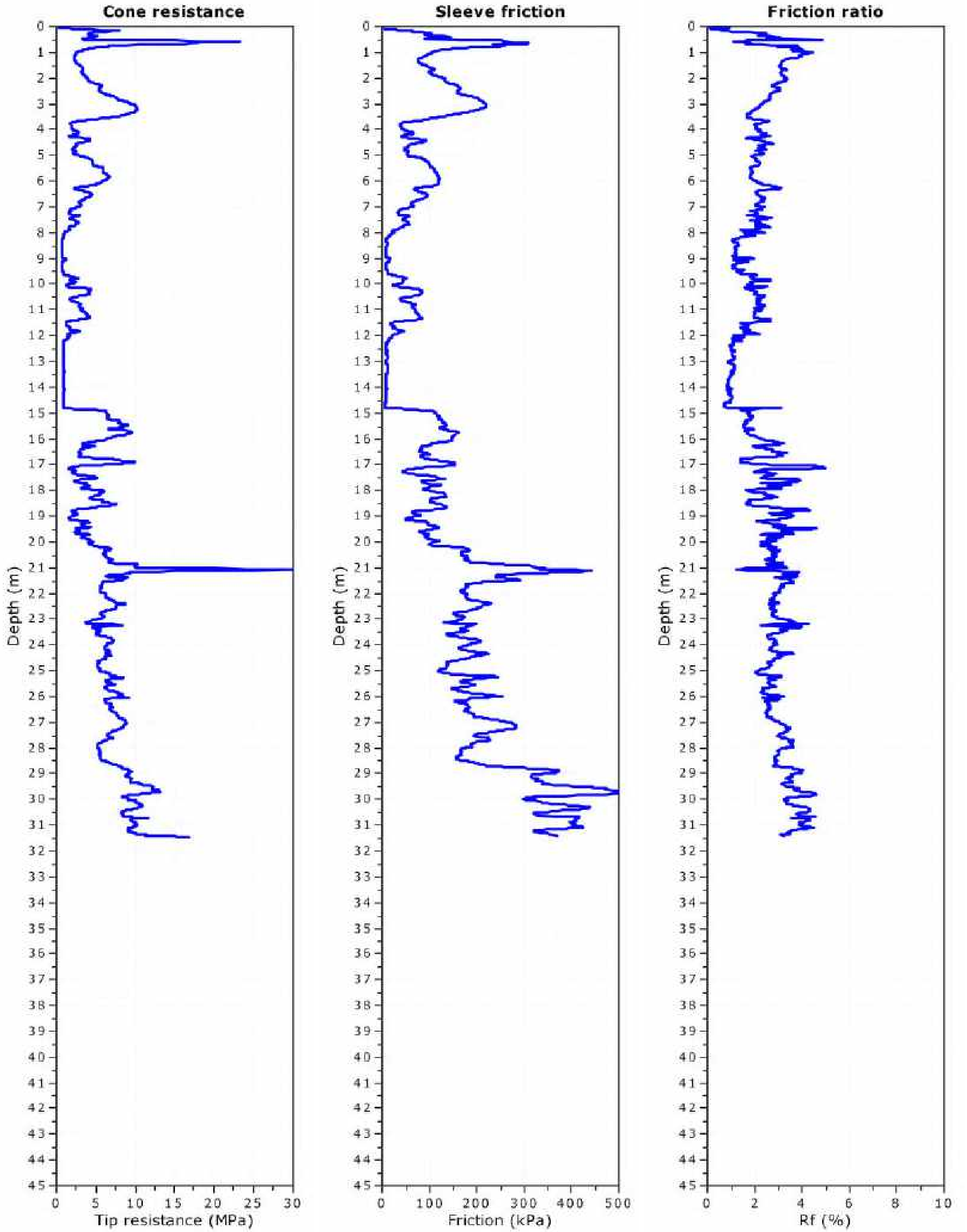
[redacted]5

CPTu_FB4

Total depth: 31.49 m, Date: 24/08/2021
Surface Elevation: 391.05 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395730.29, Y:6573472.71
Cone Operator: Andrew

Futi Bagus **Futi Bagus Tailings**
Kalgoorli **Kalgoorlie**

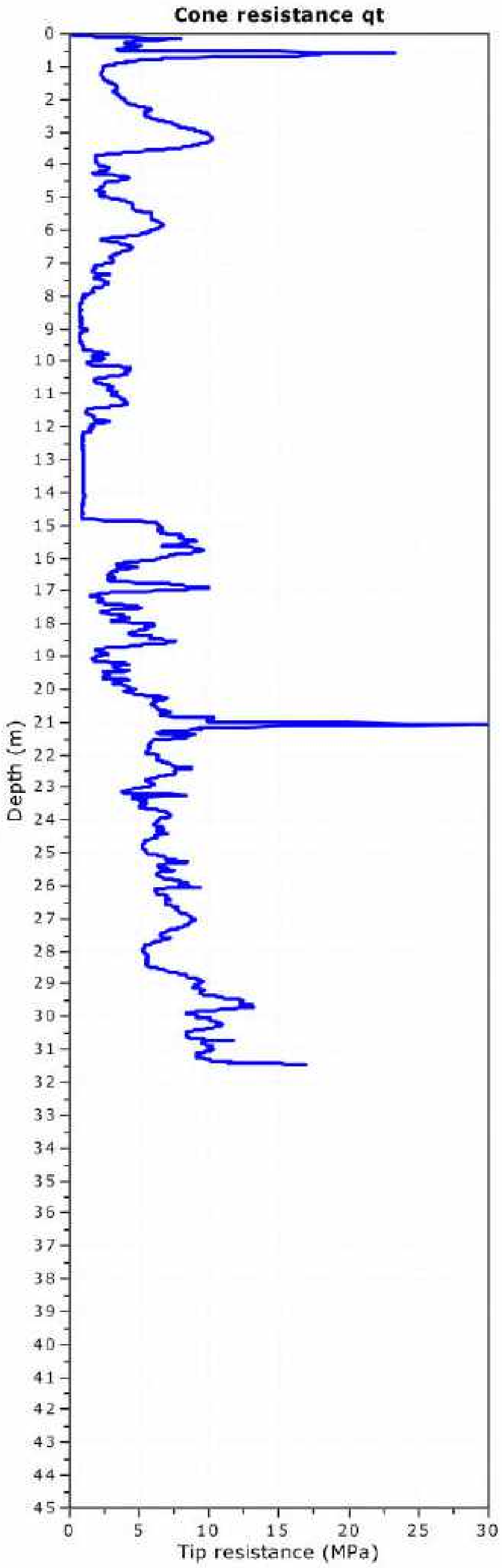


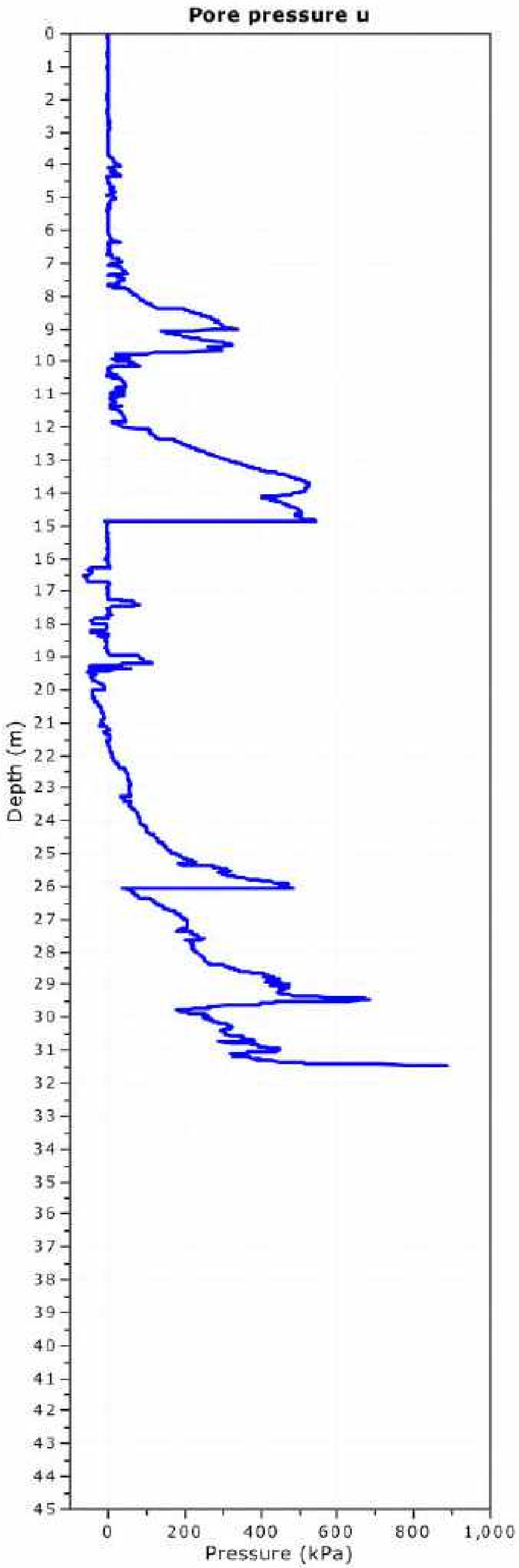
info@cptwest.com.au
www.cptwest.com.au
[redacted]

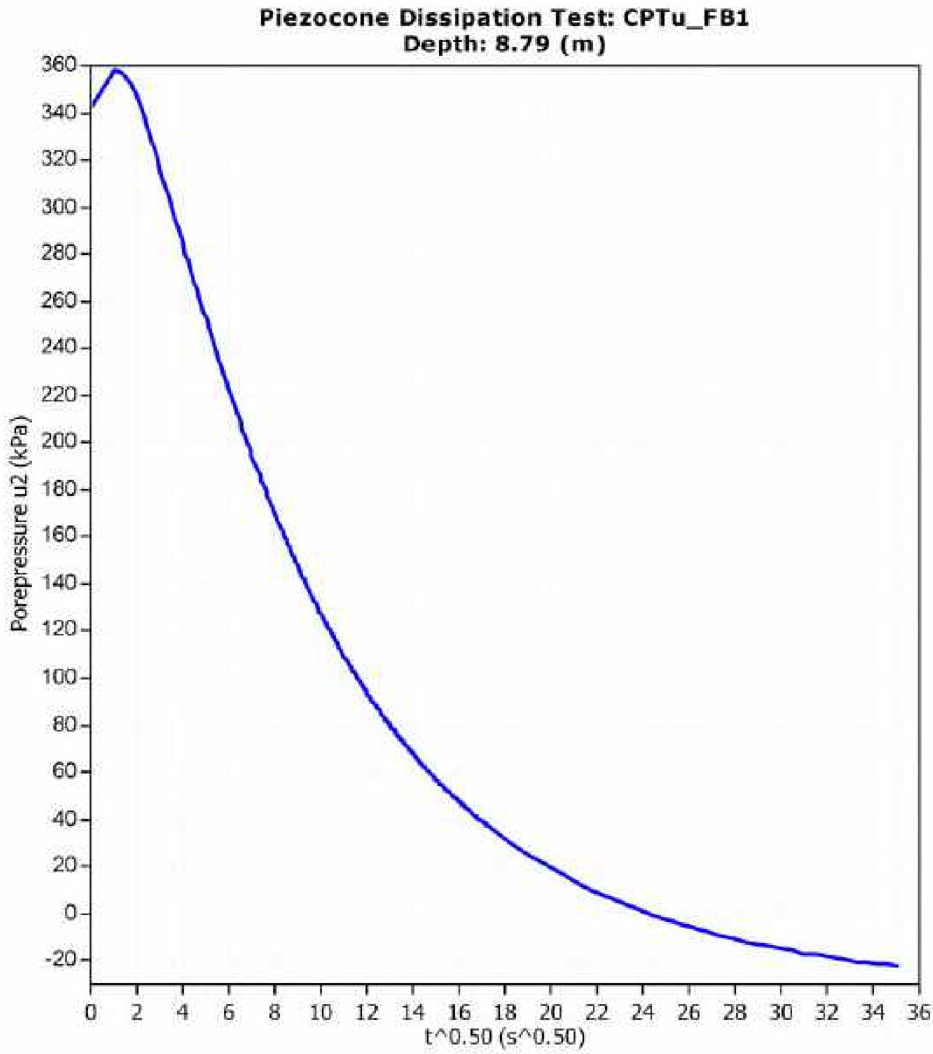
CPTu_FB4

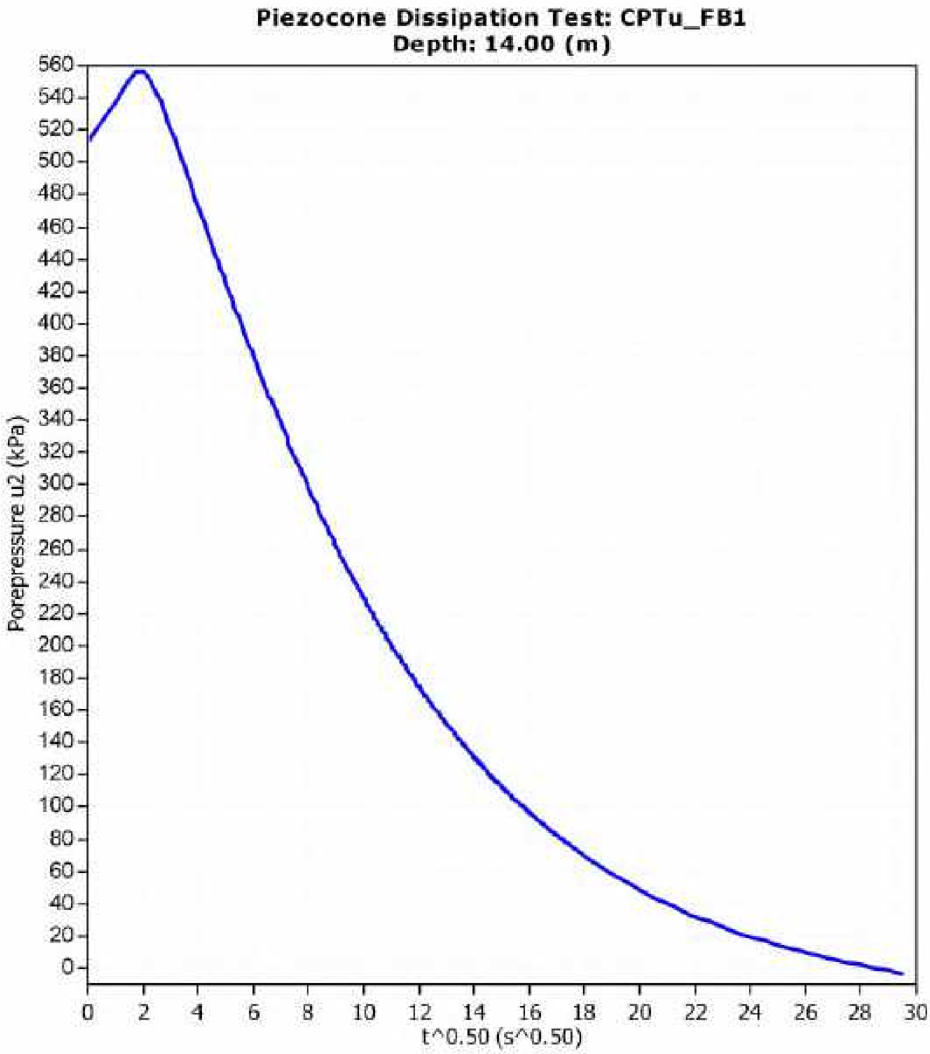
Total depth: 31.49 m, Date: 24/08/2021
Surface Elevation: 391.05 [(IIF(<unit_system>=0,'m','ft'))]
Coords: X:395730.29, Y:6573472.71
Cone Operator: Andrew

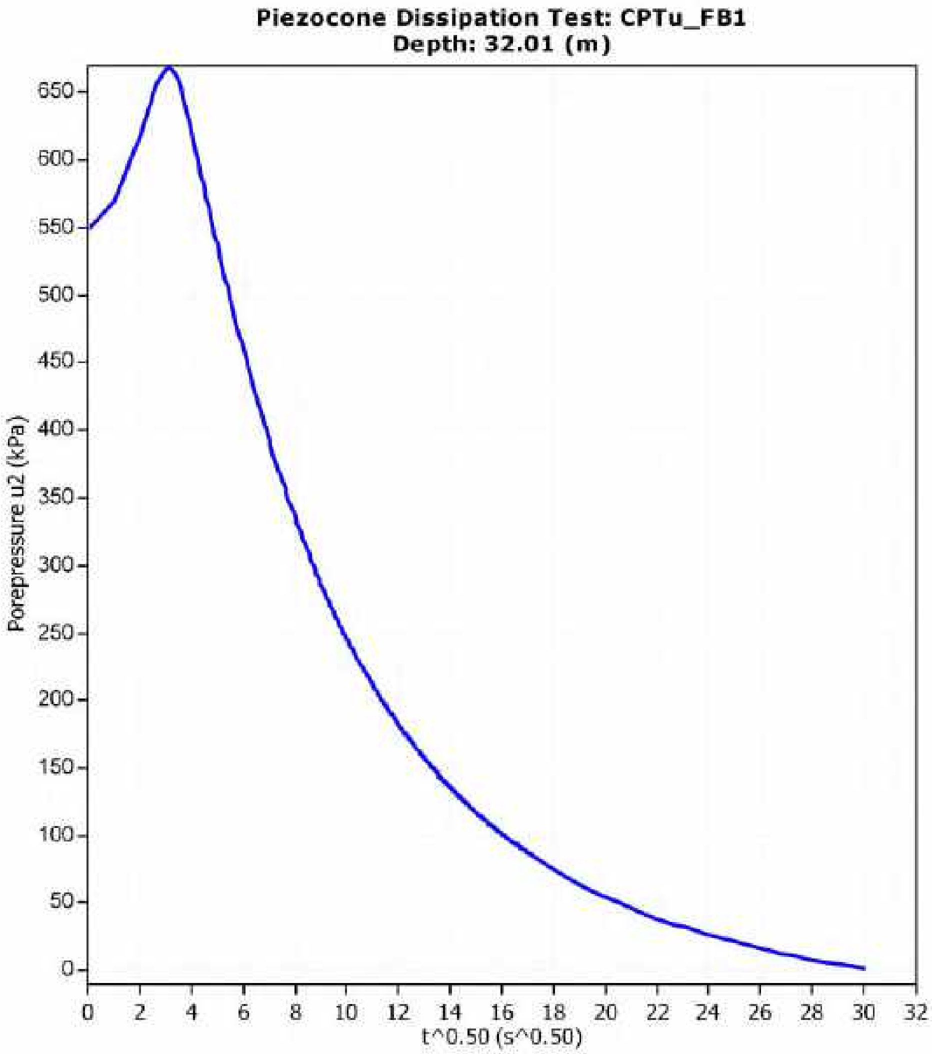
Futi Bagus Kalgoorli **Futi Bagus Tailings**
Kalgoorlie

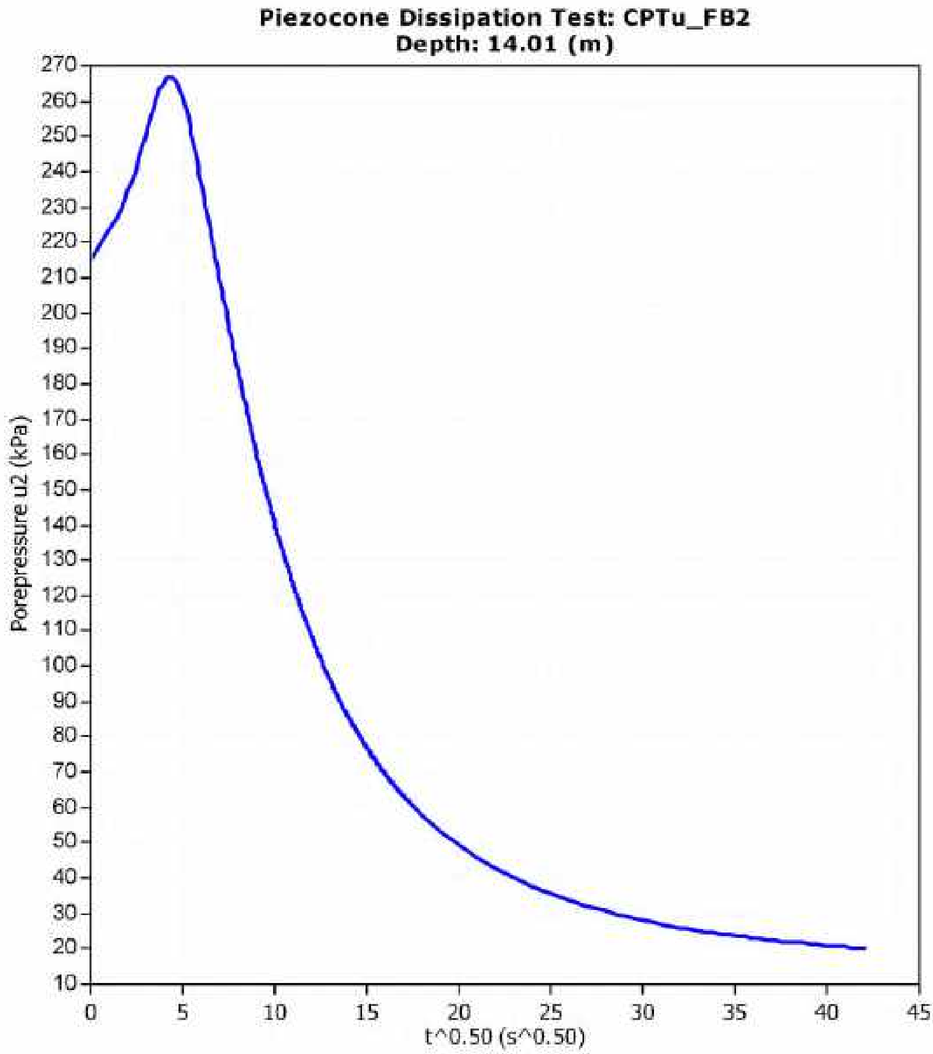


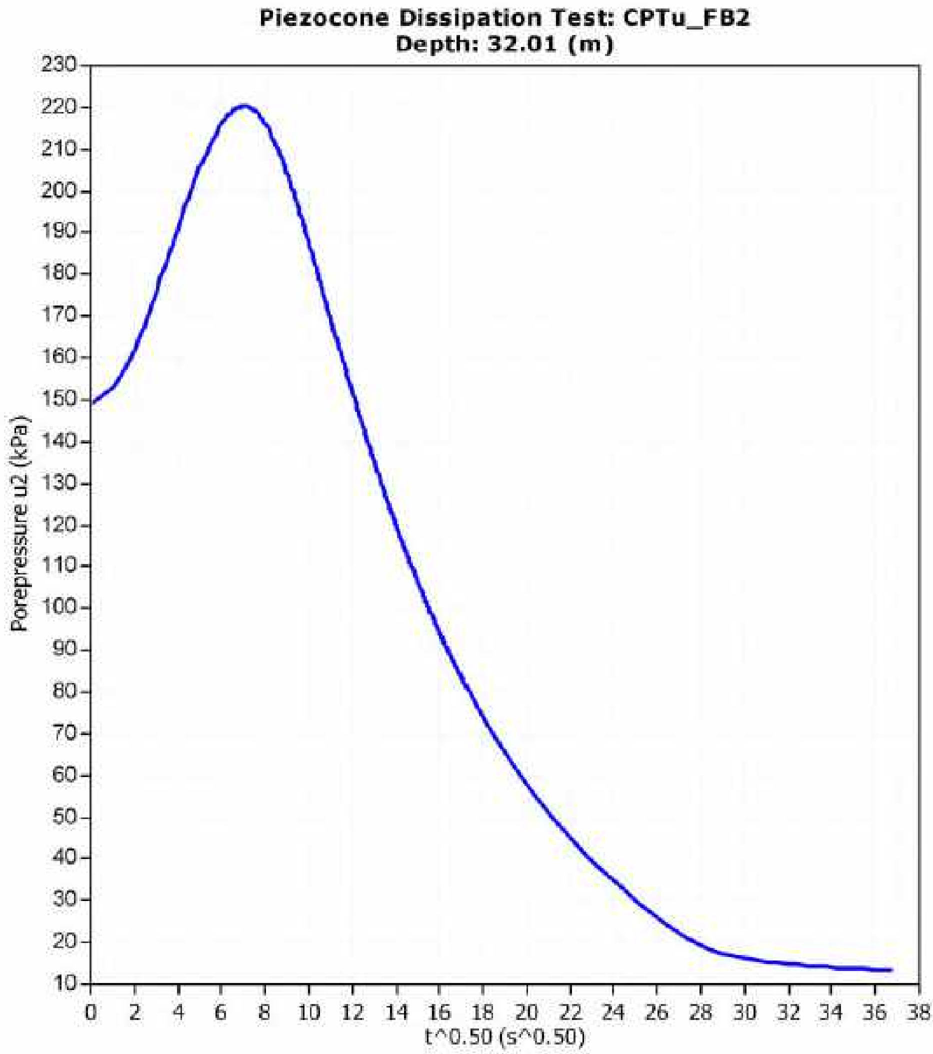


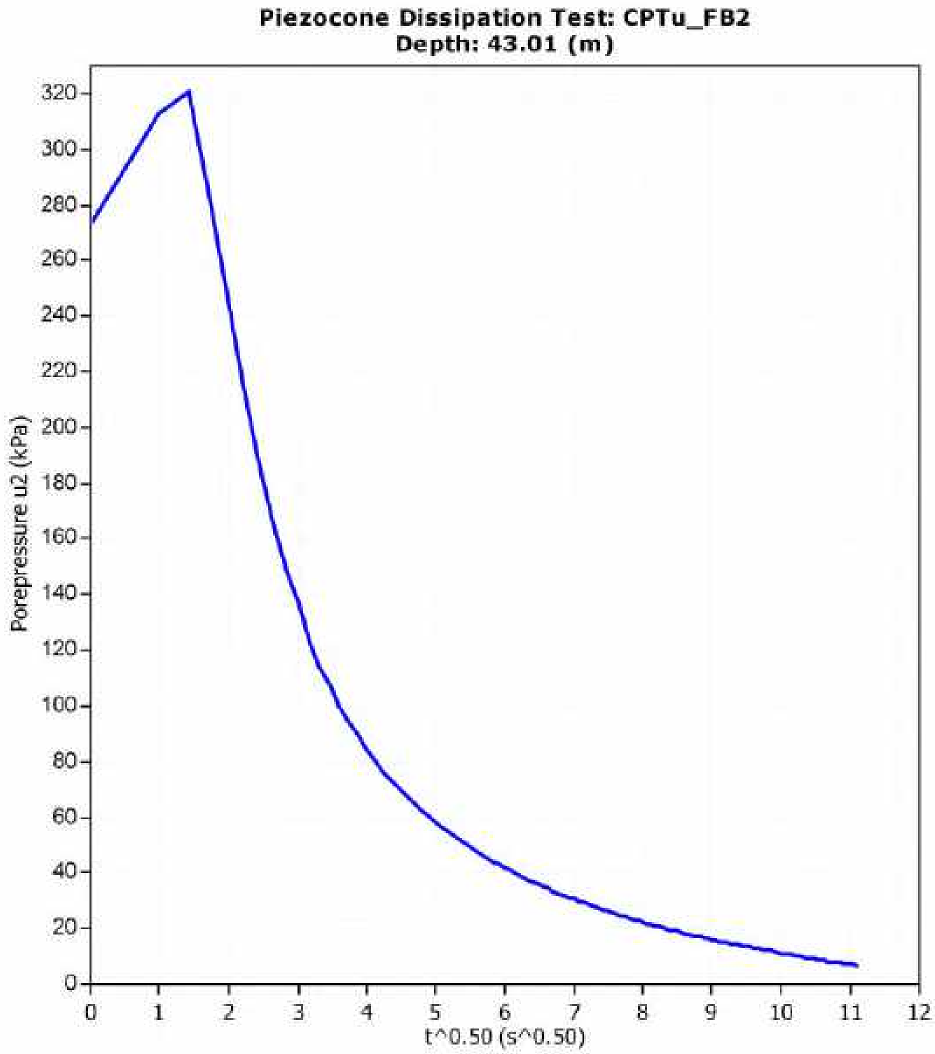

Piezocone Dissipation Test: CPTu_FB1
Depth: 8.79 (m)
Porepressure u2 (kPa)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
t^0.50 (s^0.50)


Piezocone Dissipation Test: CPTu_FB1
Depth: 14.00 (m)
Porepressure u2 (kPa)
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
t^0.50 (s^0.50)


Piezocone Dissipation Test: CPTu_FB1
Depth: 32.01 (m)
Porepressure u2 (kPa)
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
t^0.50 (s^0.50)


Piezocone Dissipation Test: CPTu_FB2
Depth: 14.01 (m)
Porepressure u2 (kPa)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
30
35
40
45
t^0.50 (s^0.50)


Piezocone Dissipation Test: CPTu_FB2
Depth: 32.01 (m)
Porepressure u2 (kPa)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
t^0.50 (s^0.50)


Piezocone Dissipation Test: CPTu_FB2
Depth: 43.01 (m)
Porepressure u2 (kPa)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
0
1
2
3
4
5
6
7
8
9
10
11
12
t^0.50 (s^0.50)

Appendix C Geotechnical site investigation data – laboratory test certificates

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

E-PRECISION LABORATORY

RELATIVE DENSITY TEST REPORT

Test Method: AS1289 5.5.1

Client:	Geo Analytica	Date Tested:	08/09/2021
Project:	BC8 Futi Bagus Testing 2021	Date Reported:	14/09/2021
		EP Lab Job Number:	GEO
Lab:	EPLAB		
Tested by:	Phil		

Lab ID:	CPTU_FB1_MM	CPTU_FB3_MM			
Test Type:	MAX / MIN DENSITY	MAX / MIN DENSITY			
Depth (m):	19	19			
Lithology/Description:	-	-			
Moisture Content (%):	-	-			
Max Dry Density (t/m^3)	**1.509**	**1.547**			
Min Dry Density (t/m^3)	**1.292**	**1.342**			

Notes:
Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signatory (Geotechnical Engineer): [redacted]

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

E-Precision Laboratory

DENSITY REPORT

Test Method: In House

Client:	Geo Analytica	Date Tested:	2/09/2021
Project:	BC8 Futi Bagus Testing 2021	Lab:	EPLAB

Test Results

Sample ID	Depth (m)	Particle Density (t/m^3)	Bulk Density (t/m^3)	Moisture Content (%)	Void Ratio (ei)
CPTU FB1	9	2.919	1.871	43.22	1.23
CPTU FB1	19	3.011	1.724	6.79	0.87
CPTU FB3	19	2.966	1.739	6.32	0.81
CPTU FB2	21	3.041	1.878	8.09	0.75

Notes: tested using distilled water @ 19deg

[redacted]

Samples tested as supplied by client
Samples supplied by the Client

Authorised Signature:

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

E-Precision Laboratory

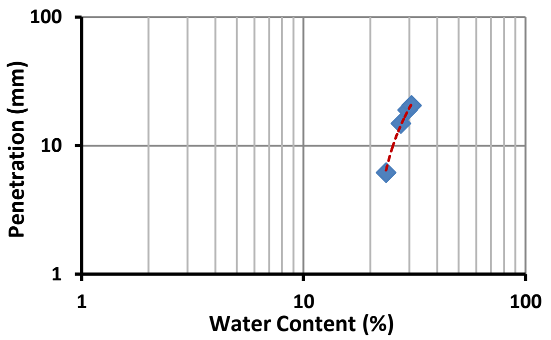
ATTERBERG LIMITS TEST REPORT

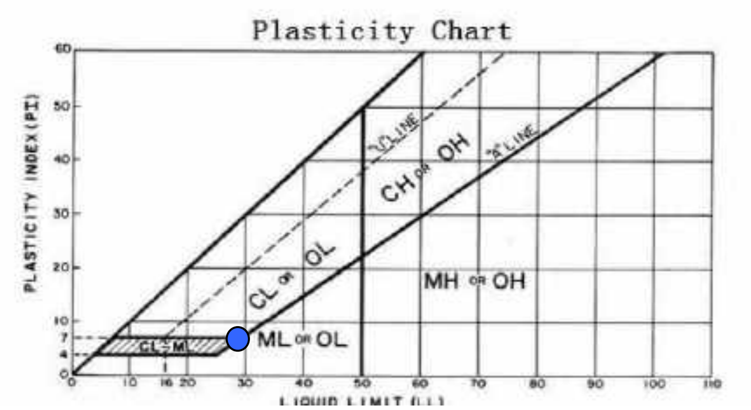
Test Method: BS1377 AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	Geo Analytica	Date Tested:	12/09/2021
Project:	BC8 Futi Bagus Testing 2021	Lab:	EPLAB
Sample No:	CPTU_FB1	Job Number:	GEO
Lab ID:	CPTU_FB1_19.00_ATT		
Depth(m):	19	Room Temperature at Test:	20°C
Tested by:	Raymond	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m³):	-
		Dry Density (t/m³):	-

Liquid Limit (%):	28.70
Plastic Limit (%):	21.41
Plasticity Index (%):	7.29
Liquidity Index (%):	-
Shrinkage Limit (%):	18.92
Linear Shrinkage(%):	2.19

Results Chart





Notes: The sample/s were tested oven dried, dry sieved and in a 125-250m[redacted]mould.

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature: [redacted]

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87

Integrity Precision Innovation

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

E-Precision Laboratory

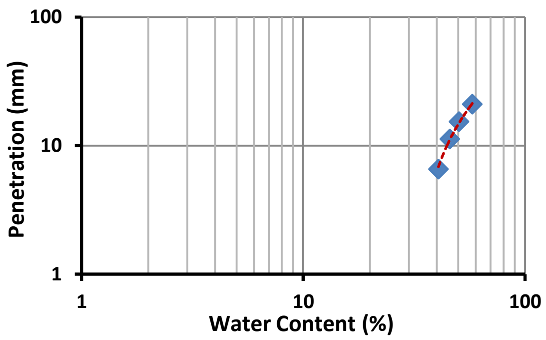
ATTERBERG LIMITS TEST REPORT

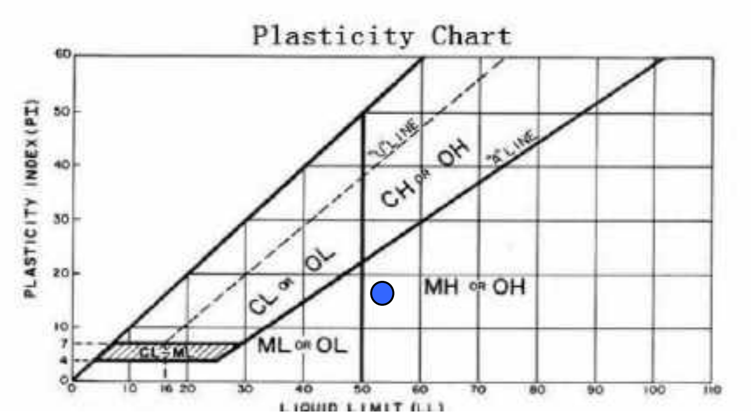
Test Method: BS1377 AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	Geo Analytica	Date Tested:	12/09/2021
Project:	BC8 Futi Bagus Testing 2021	Lab:	EPLAB
Sample No:	CPTU_FB1	Job Number:	GEO
Lab ID:	CPTU_FB1_9.00_ATT		
Depth(m):	9	Room Temperature at Test:	20°C
Tested by:	Raymond	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m³):	-
		Dry Density (t/m³):	-

Liquid Limit (%):	52.80
Plastic Limit (%):	34.98
Plasticity Index (%):	17.82
Liquidity Index (%):	-
Shrinkage Limit (%):	26.12
Linear Shrinkage(%):	6.64

Results Chart





Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature: [redacted]

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[redacted]

E-PRECISION LABORATORY

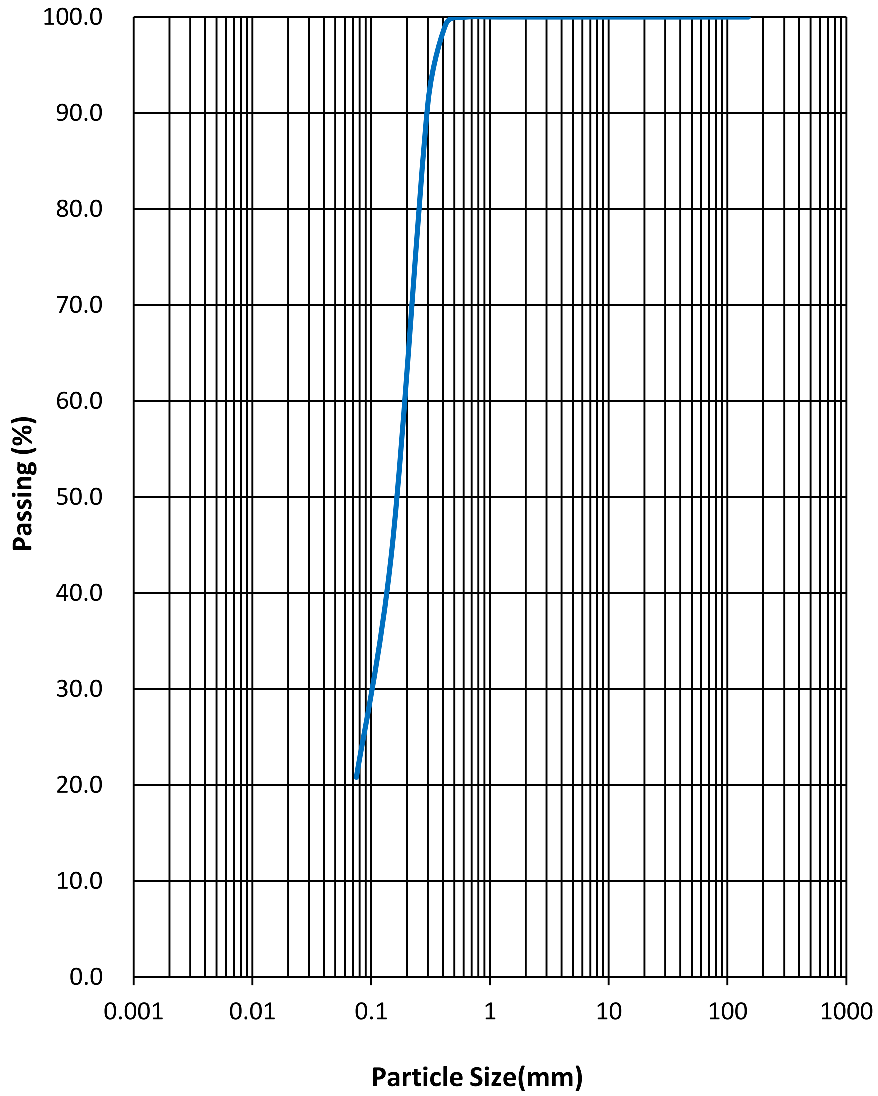
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1

Client:	Geo Analytica	Date Tested:	10/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Depth(m):	19
Lab ID:	CPTU_FB1_19.00_PSD	Room Temperature at Test:	19°C
Tested by:	Kohei	2.36mm Particle Density (t/m³):	-
Checked by:	Phil		

Sieve Size (mm)	Passing %
150	100.0
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
9.5	100.0
4.75	100.0
2.36	100.0
1.18	100.0
0.6	100.0
0.425	99.3
0.3	91.0
0.15	44.8
0.075	20.8

PSD Graph



Notes:
Stored and Tested the Sample as received
Samples supplied by the Client

Authorized Signature [redacted]

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E-Precision Laboratory

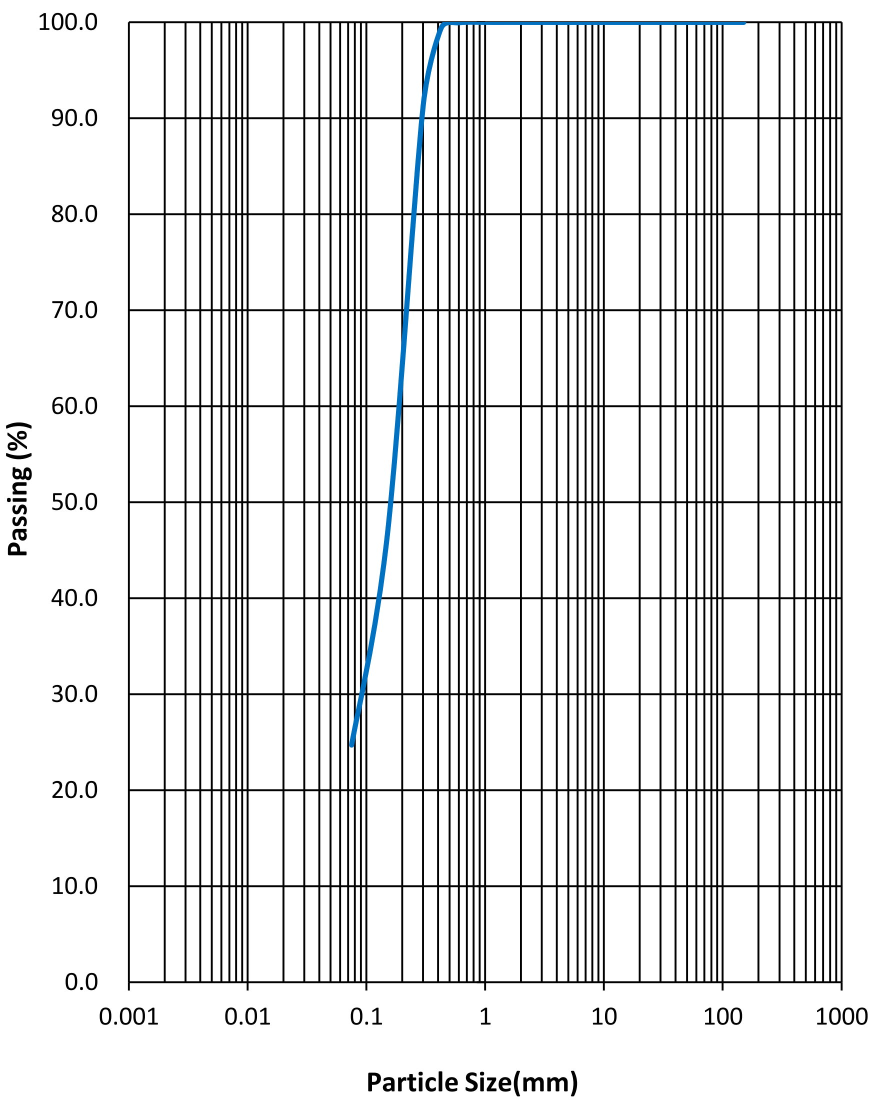
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1

Client:	Geo Analytica	Date Tested:	10/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Depth(m):	19
Lab ID:	CPTU_FB1_19.00_PSD	Room Temperature at Test:	19°C
Tested by:	Kohei	2.36mm Particle Density (t/m³):	-
Checked by:	Phil		

Sieve Size (mm)	Passing %
150	100.0
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
9.5	100.0
4.75	100.0
2.36	100.0
1.18	100.0
0.6	100.0
0.425	99.4
0.3	91.3
0.15	46.6
0.075	24.7

PSD Graph



Notes:
Stored and Tested the Sample as received
Samples supplied by the Client

Authorized Signature: [redacted]

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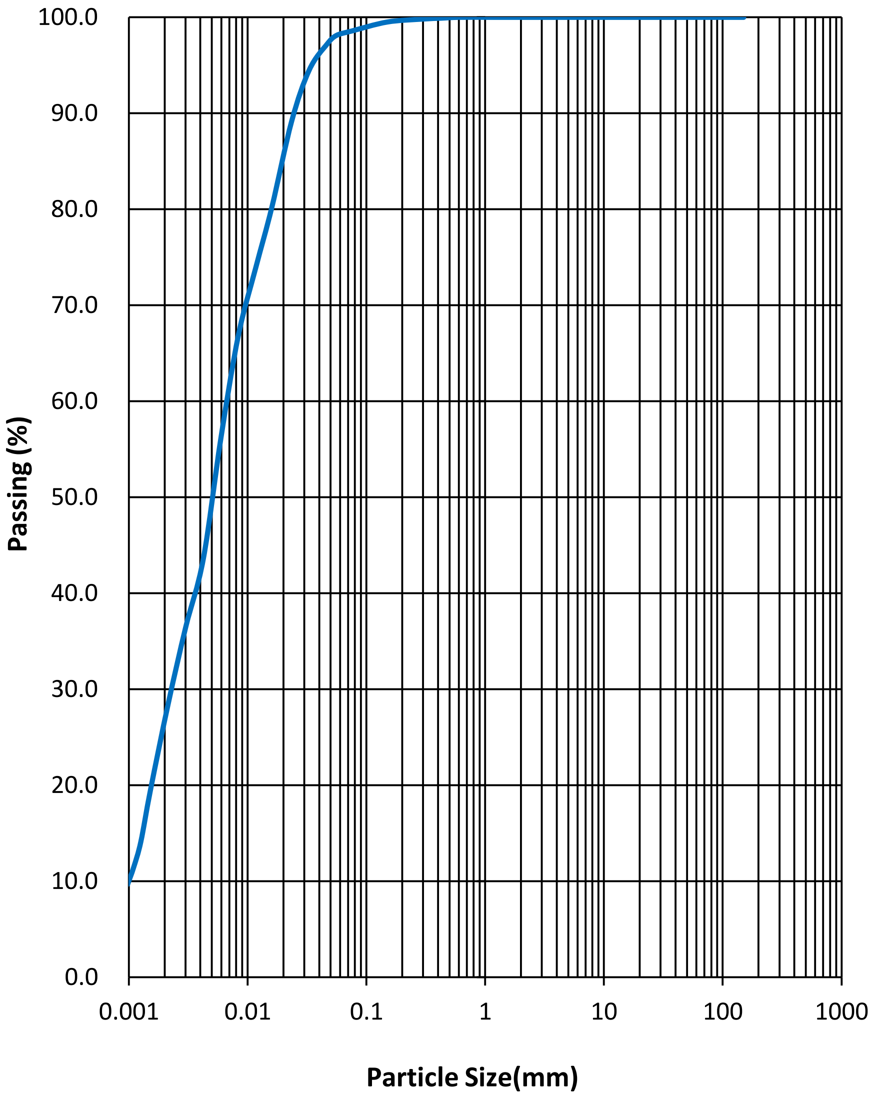
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3 3.5.1

Client:	Geo Analytica	Date Tested:	10/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Depth(m):	19
Lab ID:	CPTU_FB1_9.00_PSDH	Room Temperature at Test:	19°C
Tested by:	Kohei	2.36mm Particle Density (t/m^3):	2.919
Checked by:	Phil		

Sieve Size (mm)	Passing %
150	100.0
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
9.5	100.0
4.75	100.0
2.36	100.0
1.18	100.0
0.6	100.0
0.425	99.9
0.3	99.8
0.15	99.5
0.075	98.6
0.05579	98.1
0.04668	97.2
0.03306	94.5
0.02347	89.2
0.01601	80.2
0.01174	74.0
0.00835	66.8
0.00595	56.1
0.00424	43.6
0.00301	36.5
0.00214	28.4
0.00152	19.5
0.00126	14.1
0.00110	11.4
0.00098	9.7

PSD Graph



Notes:
Stored and Tested the Sample as received
Samples supplied by the Client

Authorized Signatu[redacted]

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E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

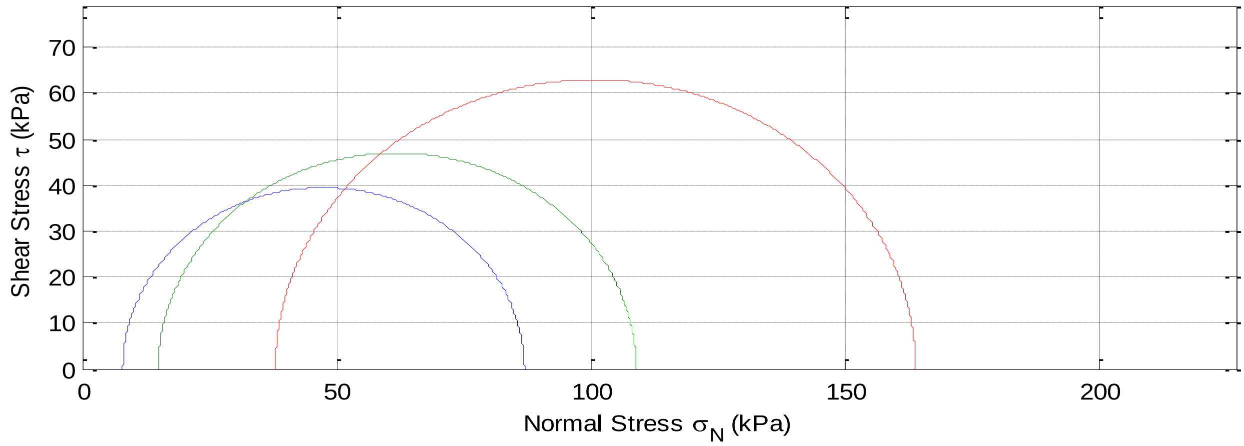
Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°c

Tested by:	Phil Li	Initial Moisture (%):	38.78	Strain Rate (mm/min):	0.006
Height (mm):	141.95	Final Moisture (%):	29.69	Skempton's (B):	1
Diameter (mm):	59.13	Bulk Density (t/m³):	2.15	Geology:	-
L/D Ratio:	2.40	Dry Density (t/m³):	1.55		

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	17.45	20.53	23.22
Angle of Shear Resistance Φ' (Degrees) :	30.96	26.57	24.70

Accredited for compliance with ISO/IEC 17025-TESTING
NATA: 19078
Authorised Signatory (Geotechnical Engineer): [redacted]

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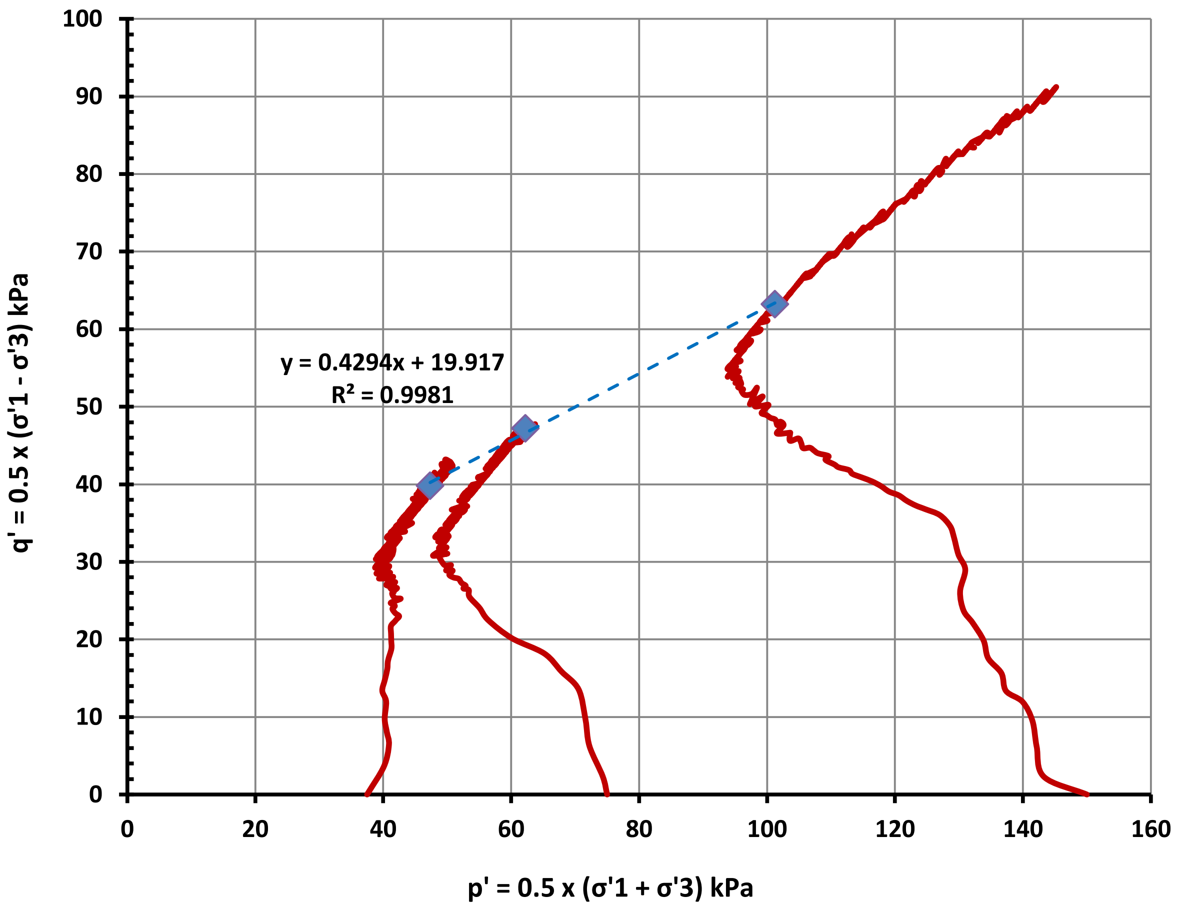
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**22.06**
Angle of Shear Resistance Φ' (Deg) :	**25.47**

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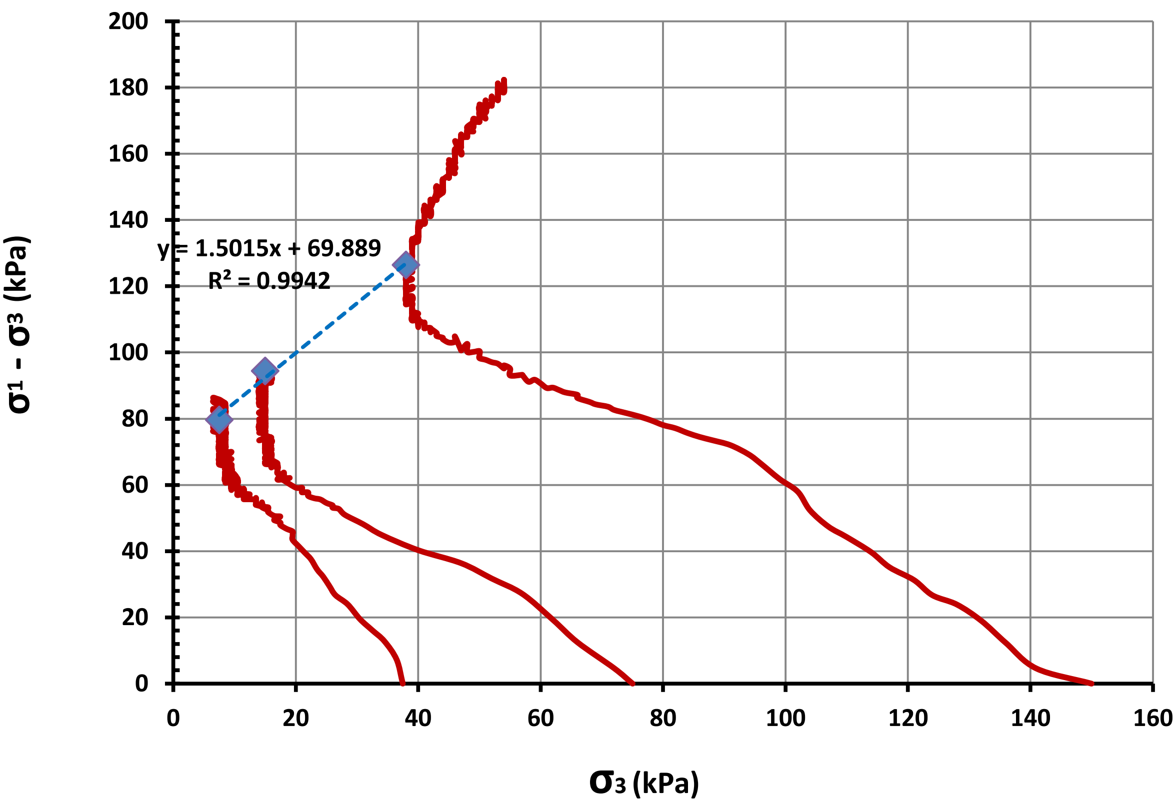
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**22.10**
Angle of Shear Resistance Φ' (Deg) :	**25.38**

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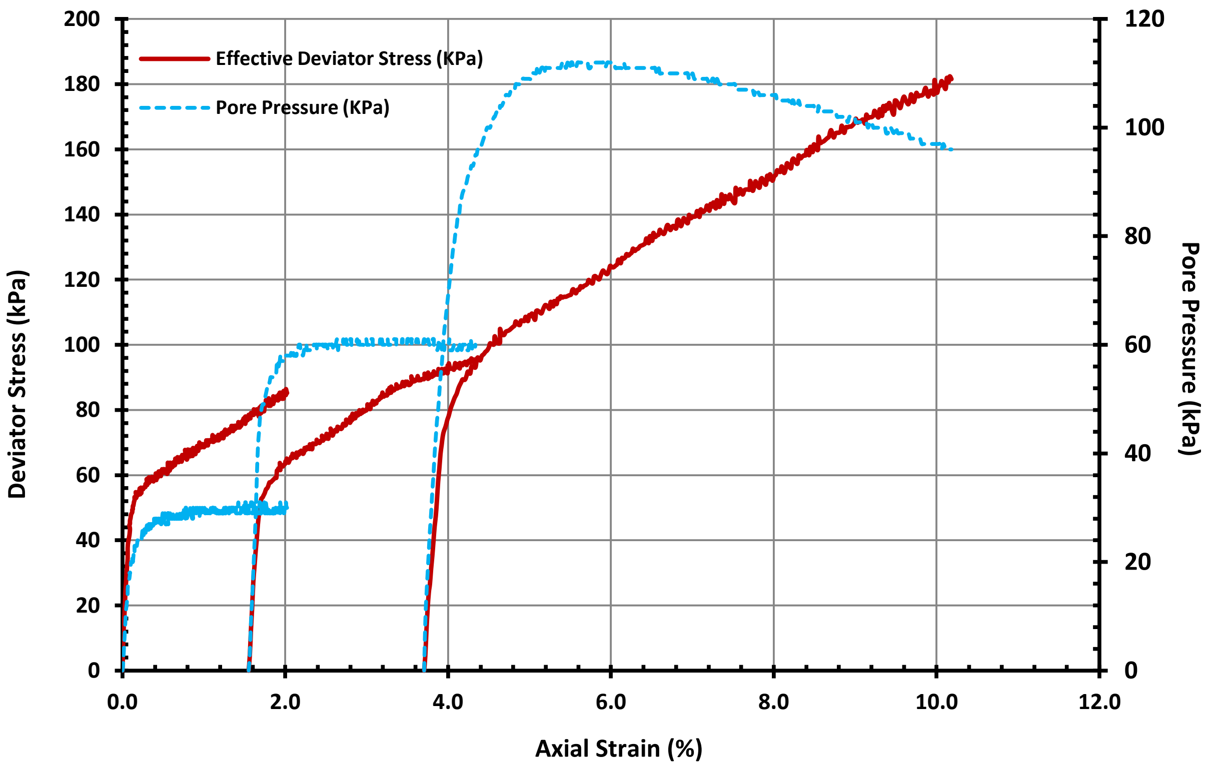
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U'0	U'f	Principal Effective Stresses			σ'1 - σ'3	Strain (%)
				σ'1	σ'3	σ'1 / σ'3		
1	37.5	0	30	87	8	11.62	80	1.65
2	75	0	60	109	15	7.30	94	4.19
3	150	0	112	164	38	4.33	126	6.16

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MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID:	CPTU_FB2	**Depth (m):**	15/01/1900
Lab ID:	CPTU_FB2_15.50_CU3	**Date Tested:**	01/09/2021

Failure Mode: Bulging Failure

Notes: **Sample extruded from tubes**
Stored and Tested the Sample as received
Samples supplied by the Client

[redacted]

NATA: 19078 **Authorised Signatory (Geotechnical Engineer):**

NATA ACCREDITATION NO: 19078

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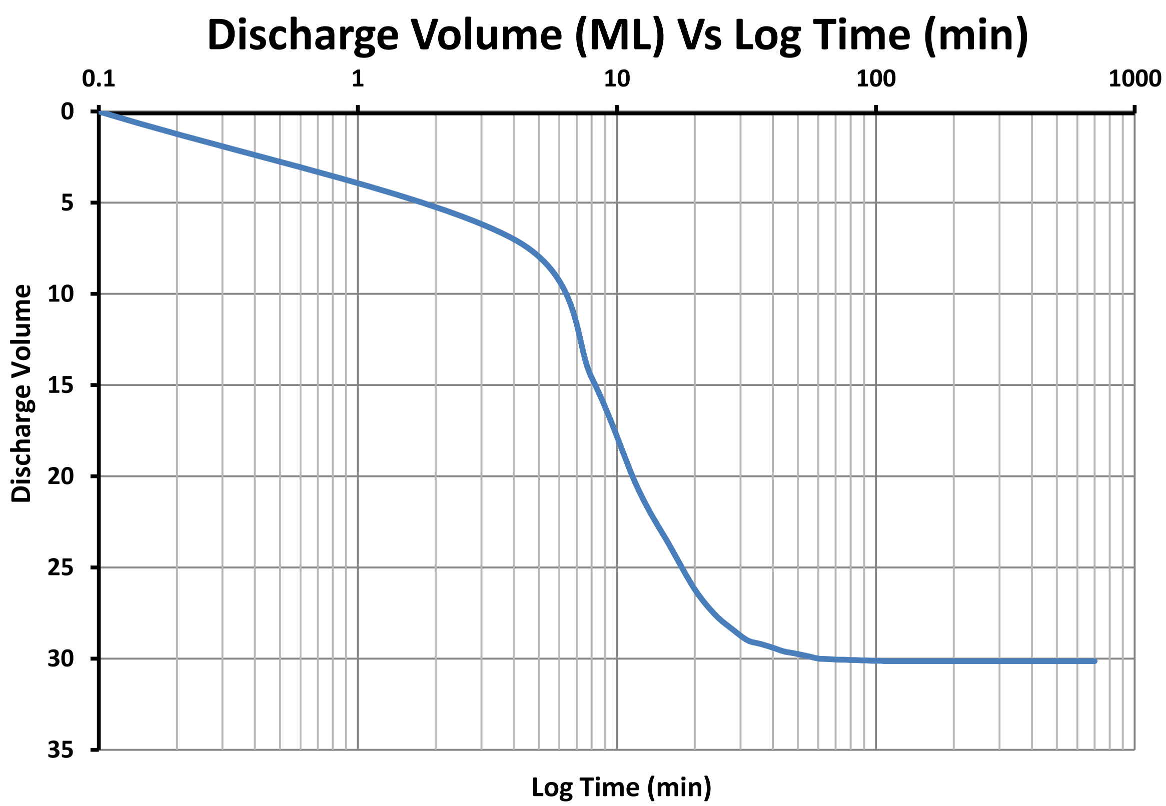
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_15.50_CU3		
Depth (m):	15.5	Room Temperature at Test:	~ 18°C



Cv (cm²/s): 0.050 based on $\mathbf{t_{90}}$

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MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

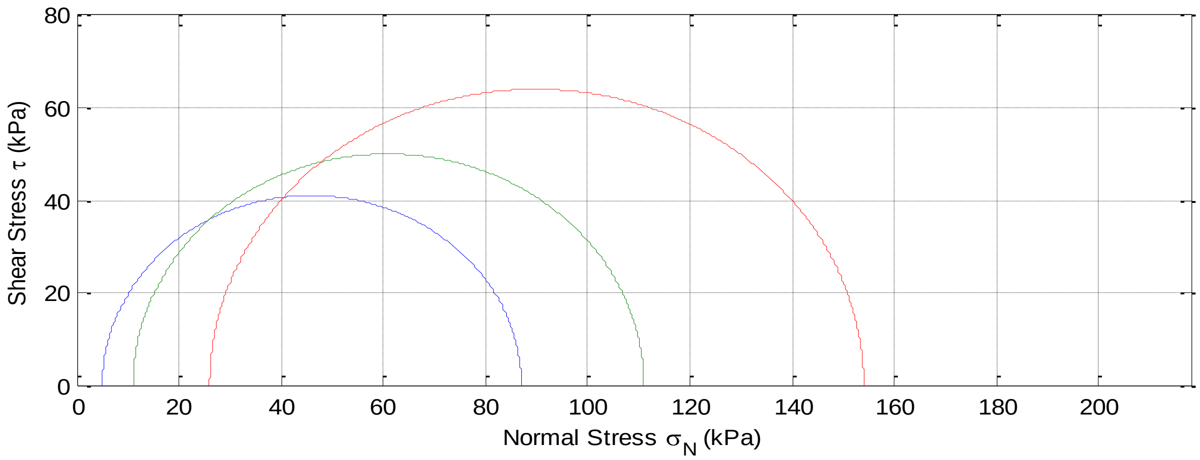
Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°c

Tested by:	Phil Li	Initial Moisture (%):	36.38	Strain Rate (mm/min):	0.006
Height (mm):	135.71	Final Moisture (%):	29.66	Skempton's (B):	0.98
Diameter (mm):	59.08	Bulk Density (t/m^3):	2.14	Geology:	-
L/D Ratio:	2.30	Dry Density (t/m^3):	1.57		

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	16.75	19.89	23.47
Angle of Shear Resistance Φ' (Degrees) :	36.87	31.38	28.81

Accredited for compliance with ISO/IEC 17025-TESTING

NATA: 19078

Authorised Signatory (Geotechnical Eng [redacted]

NATA
ACCREDITATION NO: 19078

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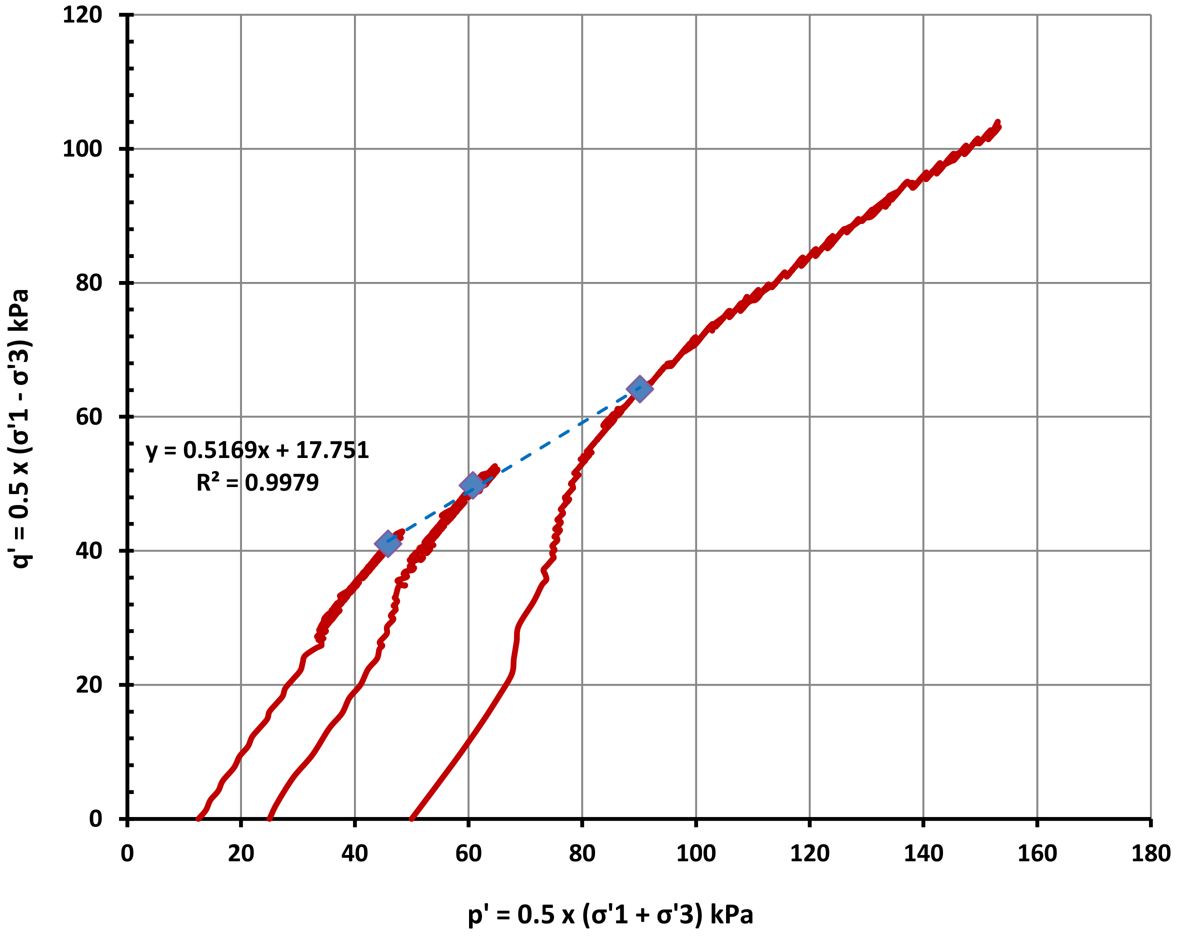
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :		**20.78**
Angle of Shear Resistance Φ' (Deg) :		**31.33**

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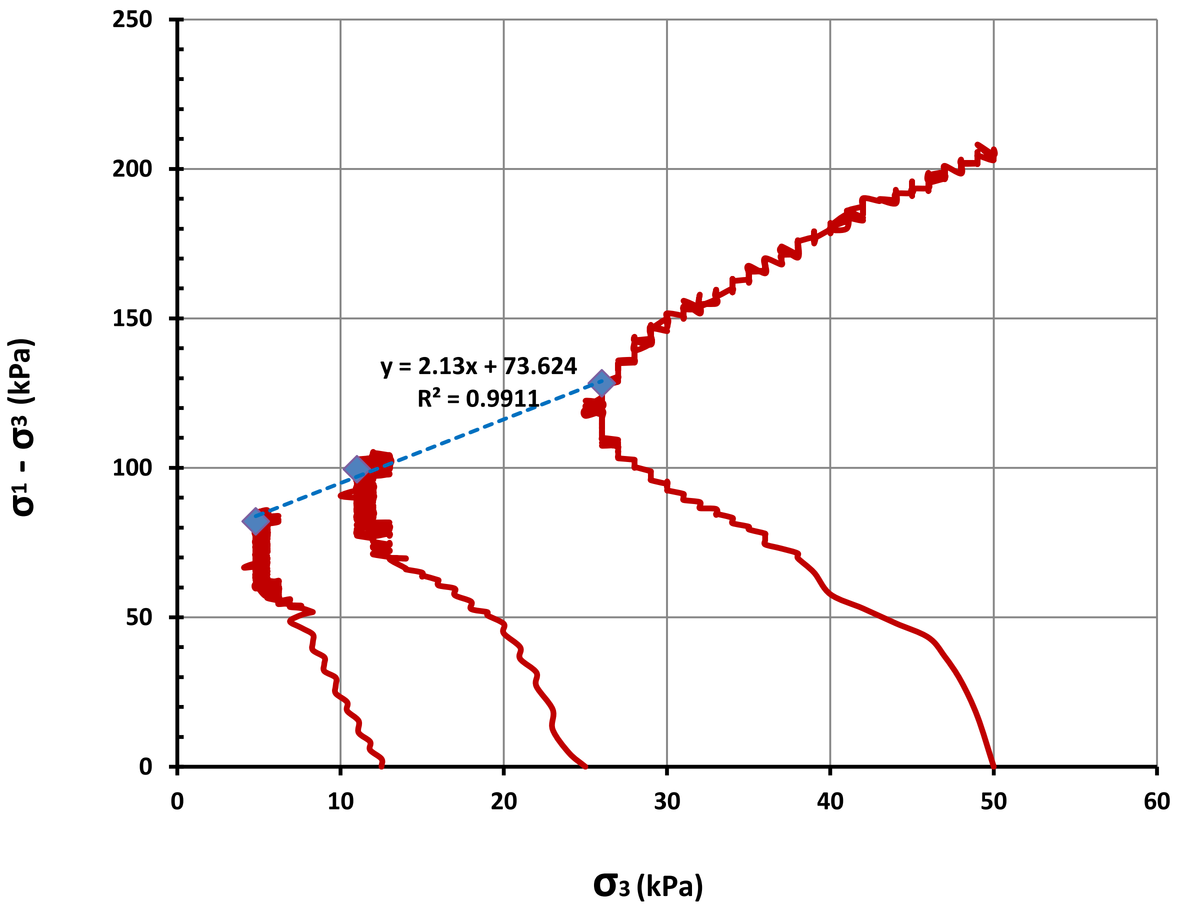
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 20.81
Angle of Shear Resistance Φ' (Deg) : 31.05

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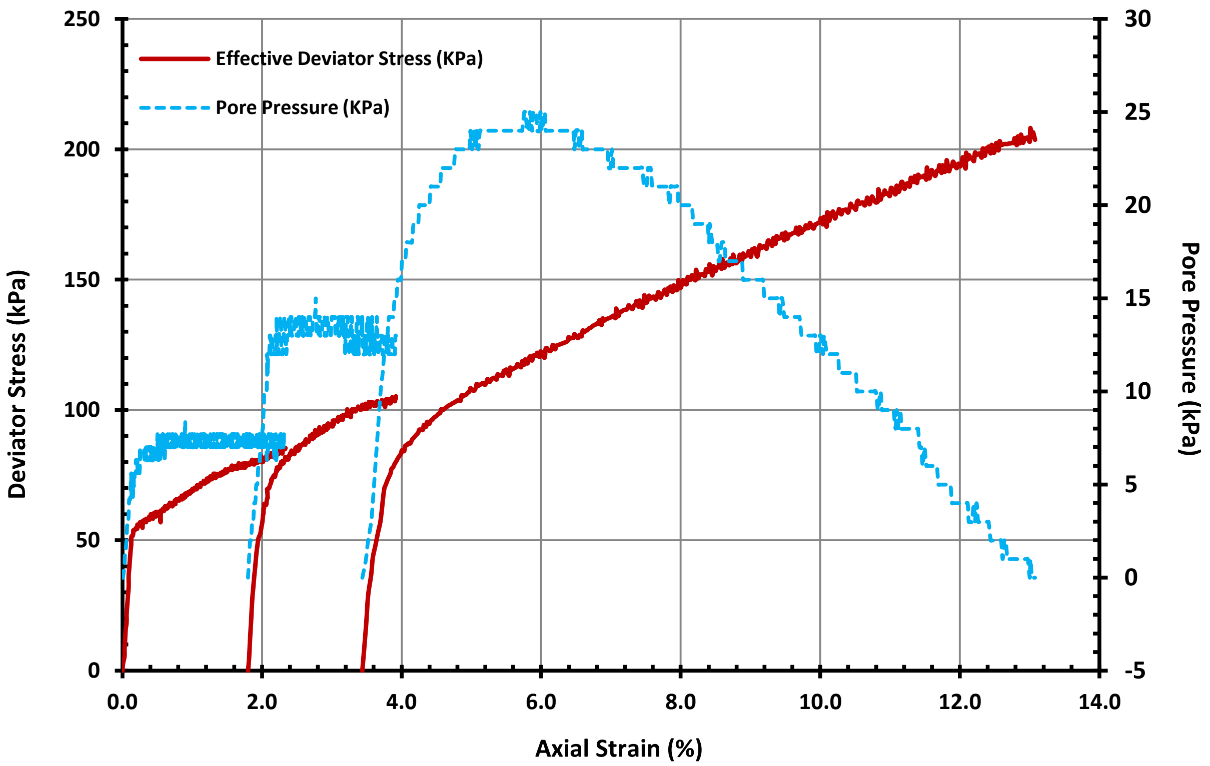
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U'_0	U'_f	Principal Effective Stresses			$\sigma'_1 - \sigma'_3$	Strain (%)
				$\sigma'1$	$\sigma'3$	$\sigma'1 / \sigma'3$		
1	12.5	0	8	87	5	18.10	82	2.06
2	25	0	14	111	11	10.05	100	3.29
3	50	0	24	154	26	5.93	128	6.58

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MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID:	CPTU_FB1	**Depth (m):**	13/01/1900
Lab ID:	CPTU_FB1_13.00_CU3	**Date Tested:**	01/09/2021

Failure Mode: Bulging Failure

Notes: **Sample extruded from tubes**
Stored and Tested the Sample as received
Samples supplied by the Client
NATA: 19078 **Authorised Signatory (Geotechnical E** [redacted]

NATA ACCREDITATION NO: 19078

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87

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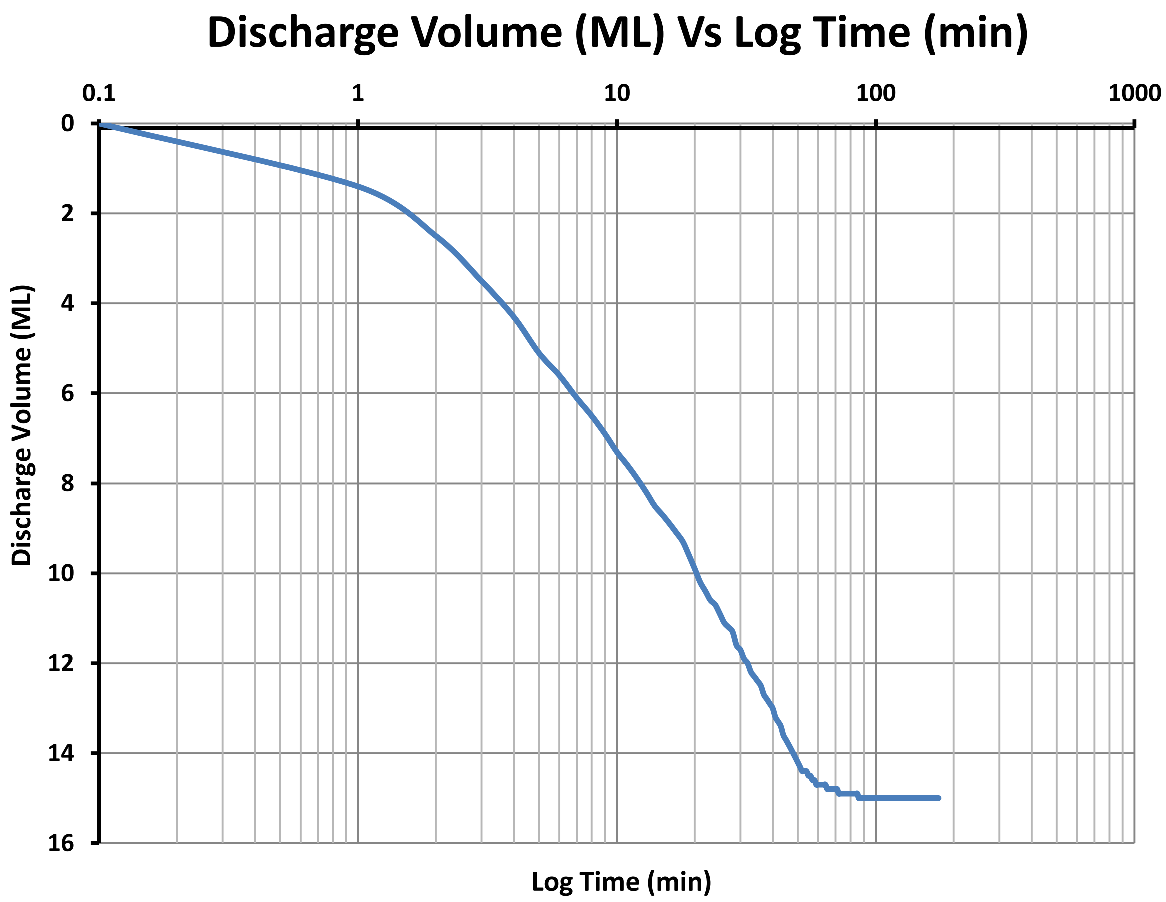
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	Geo Analytica	Date Tested:	01/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_13.00_CU3		
Depth (m):	13	Room Temperature at Test:	~ 18°C



Cv (cm²/s): 0.080 based on t_{90}

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E-Precision Laboratory

MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

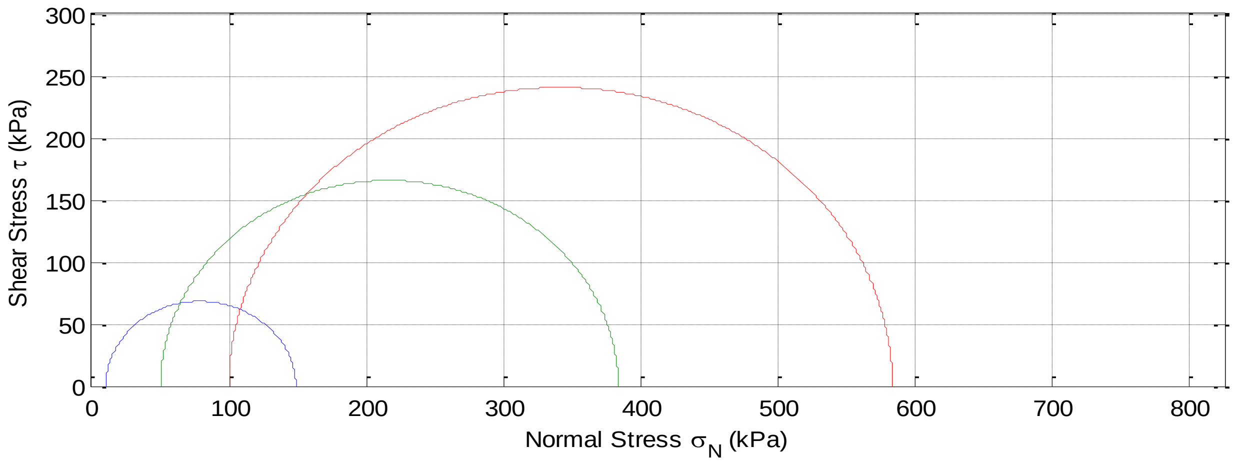
Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

Tested by:	Phil Li	Initial Moisture (%):	9.53	Strain Rate (mm/min):	0.01
Height (mm):	125.43	Final Moisture (%):	18.95	Skempton's (B):	1
Diameter (mm):	63.72	Bulk Density (t/m³):	1.85	Geology:	-
L/D Ratio:	1.97	Dry Density (t/m³):	1.69		

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	18.62	22.89	46.00
Angle of Shear Resistance Φ' (Degrees) :	45.29	41.02	36.87

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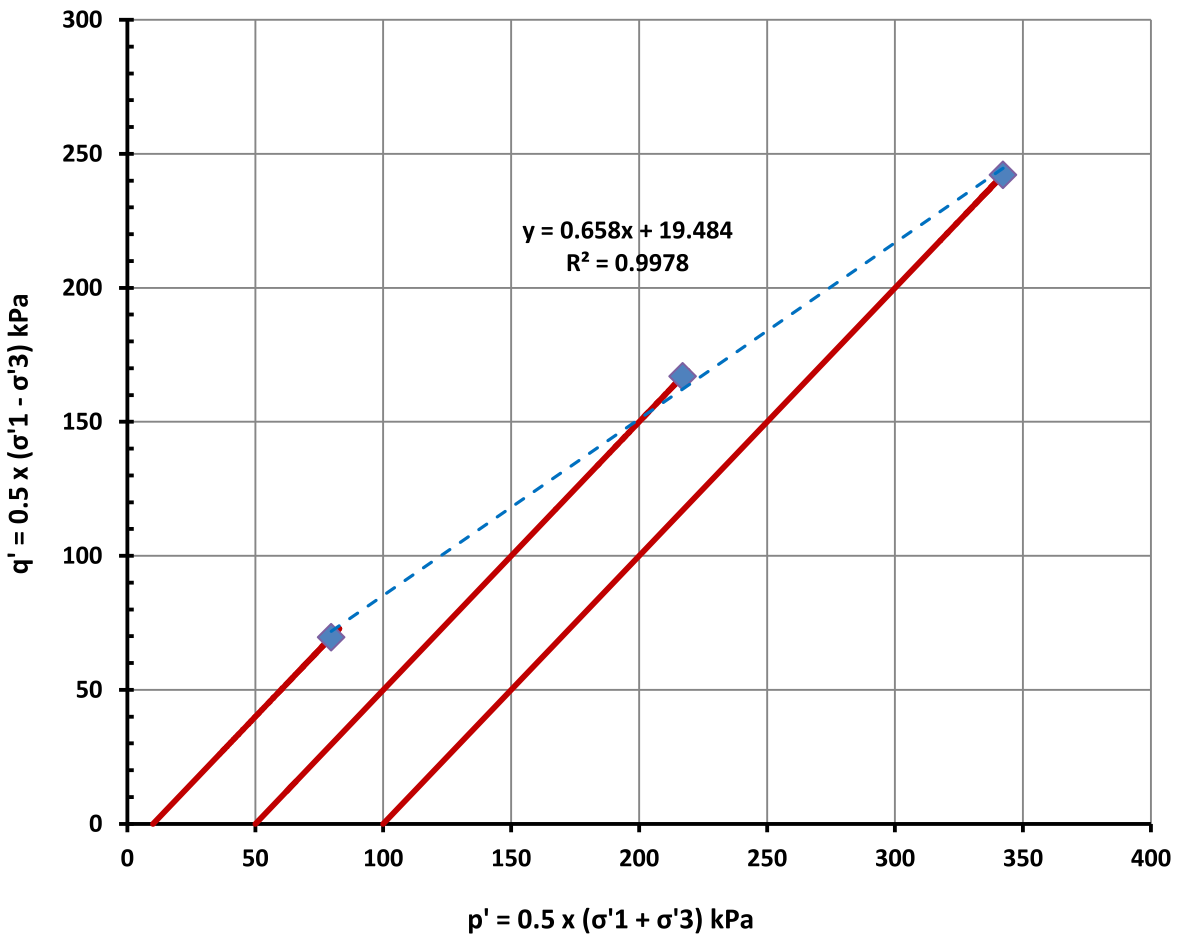
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**25.94**
Angle of Shear Resistance Φ' (Deg) :	**41.30**

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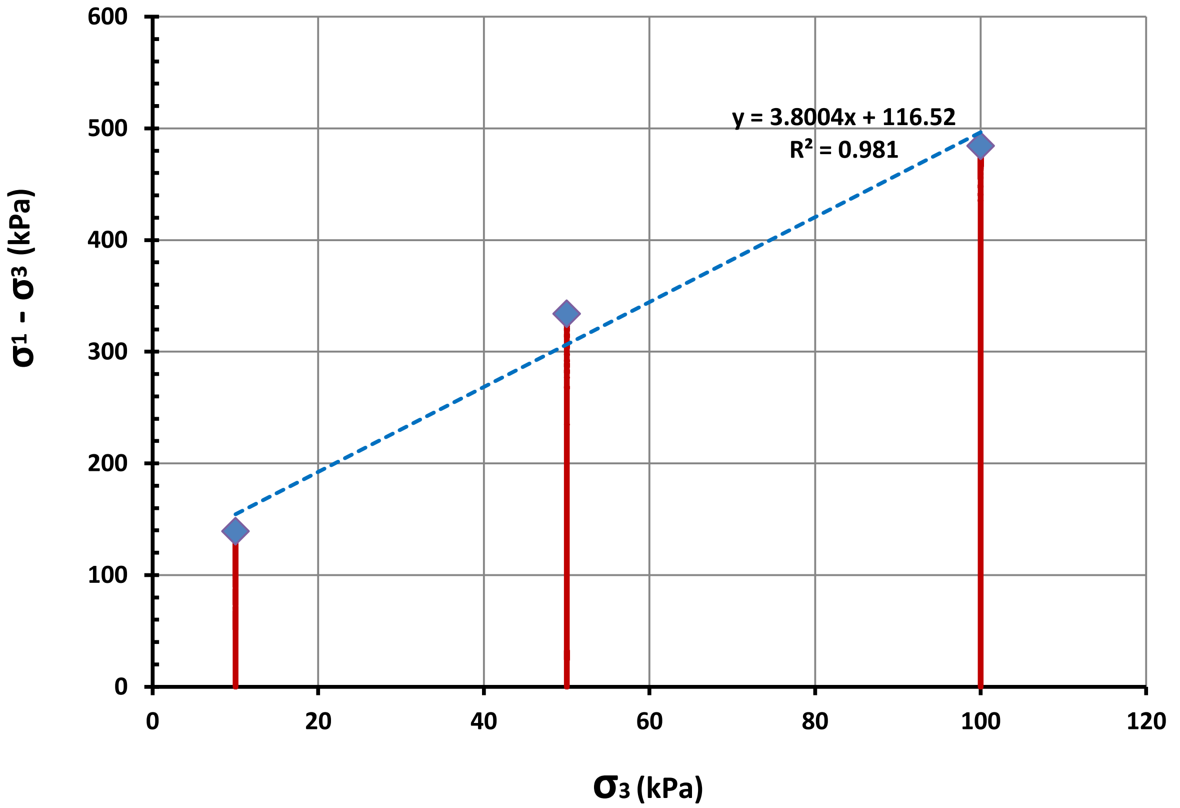
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**26.59**
Angle of Shear Resistance Φ' (Deg) :	**40.93**

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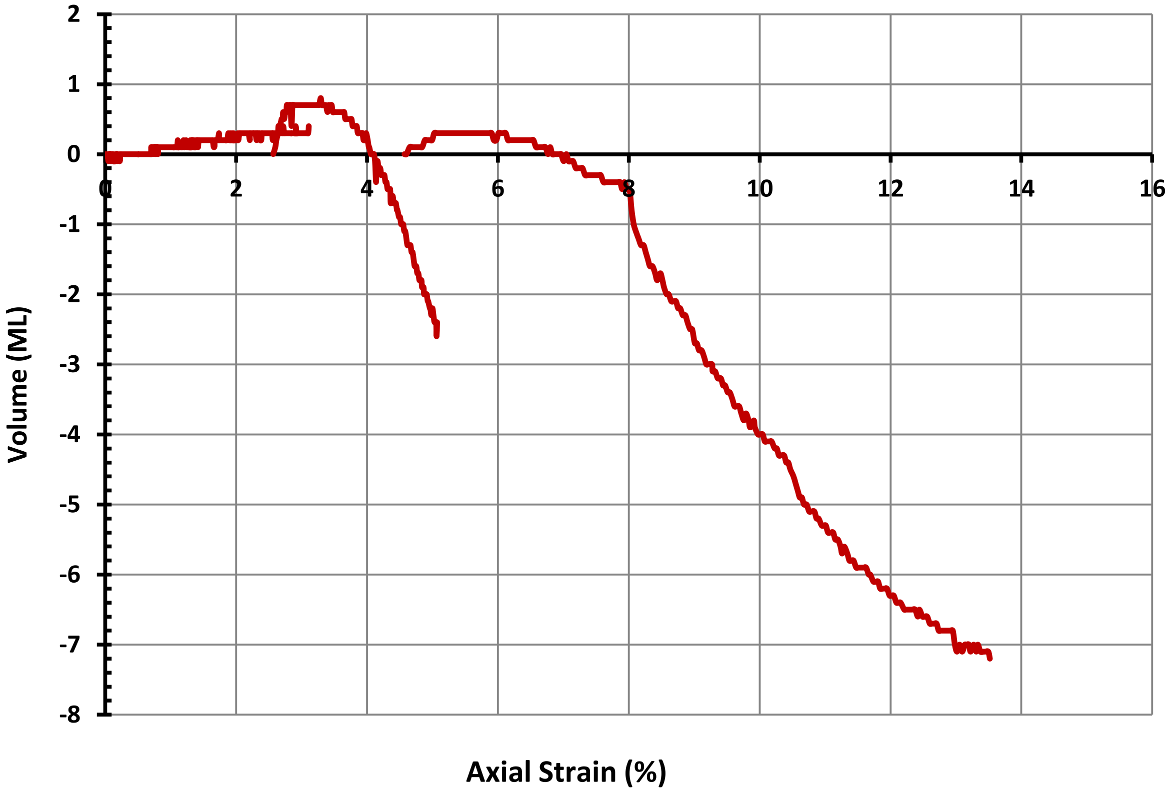
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

Volume (ML) Vs Axial Strain (%)



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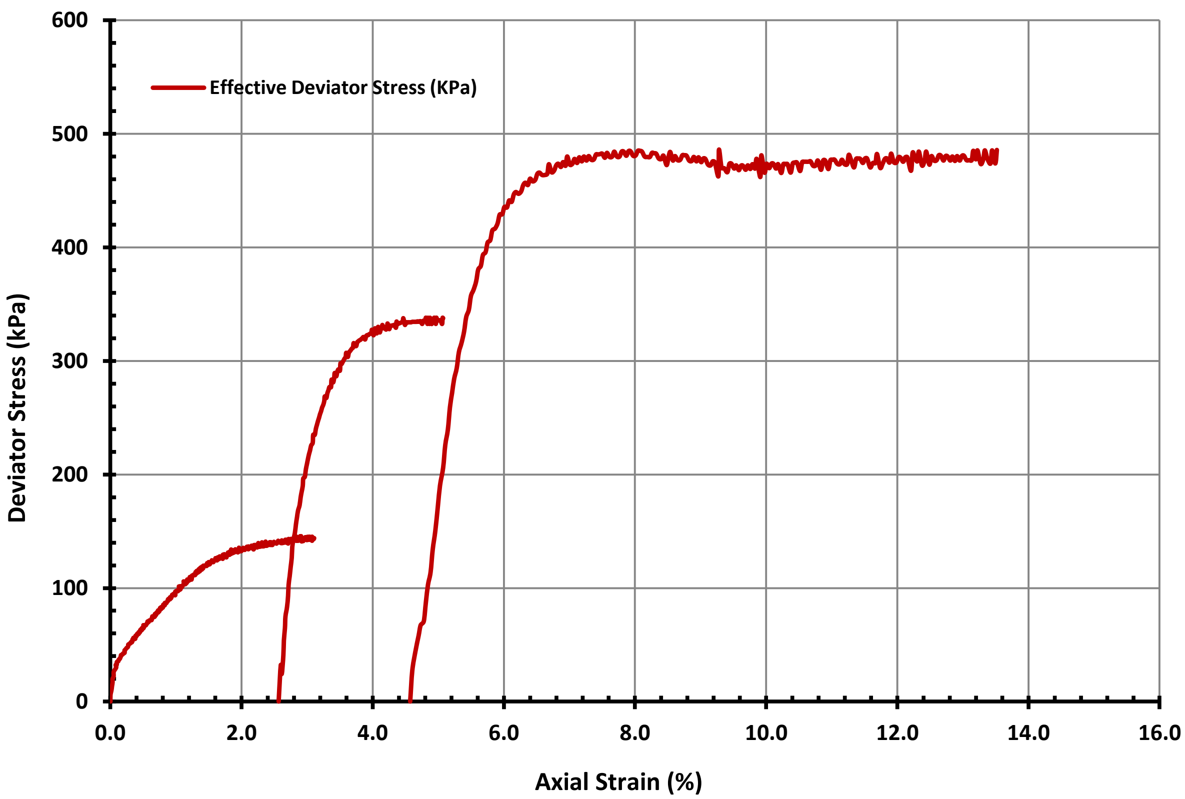
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

Deviator Stress (kPa) Vs Strain Diagram (%)



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U'_0	U'_f	Principal Effective Stresses			$\sigma'_1 - \sigma'_3$	Strain (%)
				σ'_1	σ'_3	σ'_1 / σ'_3		
1	10	0	0	149	10	14.93	139	2.71
1	50	0	0	384	50	7.68	334	4.51
1	100	0	0	584	100	5.84	484	7.80

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MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C

Photo After Test

Failure Mode: Bulging Failure

Notes:

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signatory (Geotechnical Engineer): [redacted]

Perth
16 Gympie Way, Willetton
WA 6155

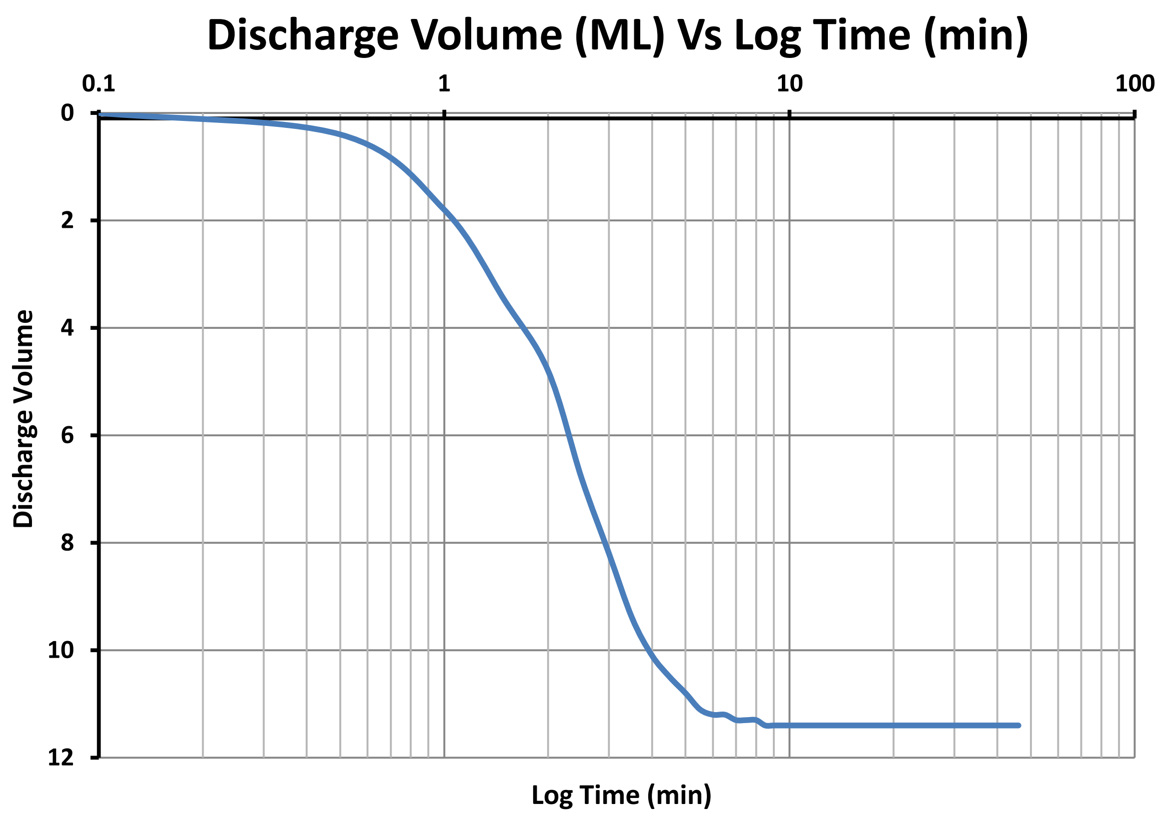
[redacted]

E-Precision Laboratory

MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_CD3		
Depth (m):	19	Room Temperature at Test:	~ 18°C



Cv (cm²/s): 0.765 based on $\mathbf{t_{90}}$

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[redacted]

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MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

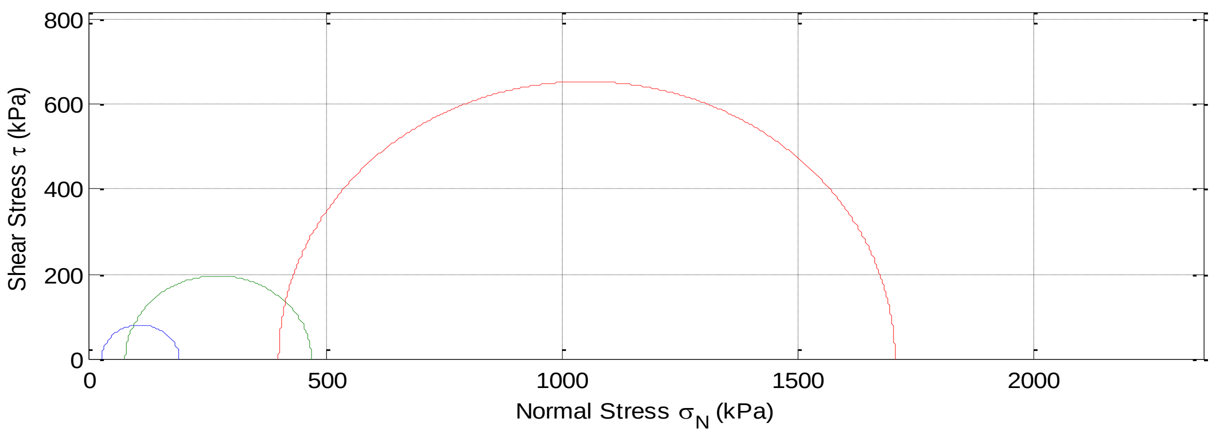
Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

Tested by:	Phil Li	Initial Moisture (%):	7.85	Strain Rate (mm/min):	0.01
Height (mm):	127.93	Final Moisture (%):	13.77	Skempton's (B):	1
Diameter (mm):	64.39	Bulk Density (t/m³):	1.90	Geology:	-
L/D Ratio:	1.99	Dry Density (t/m³):	1.76		

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	10.56	22.14	47.45
Angle of Shear Resistance Φ' (Degrees) :	44.13	37.23	35.75

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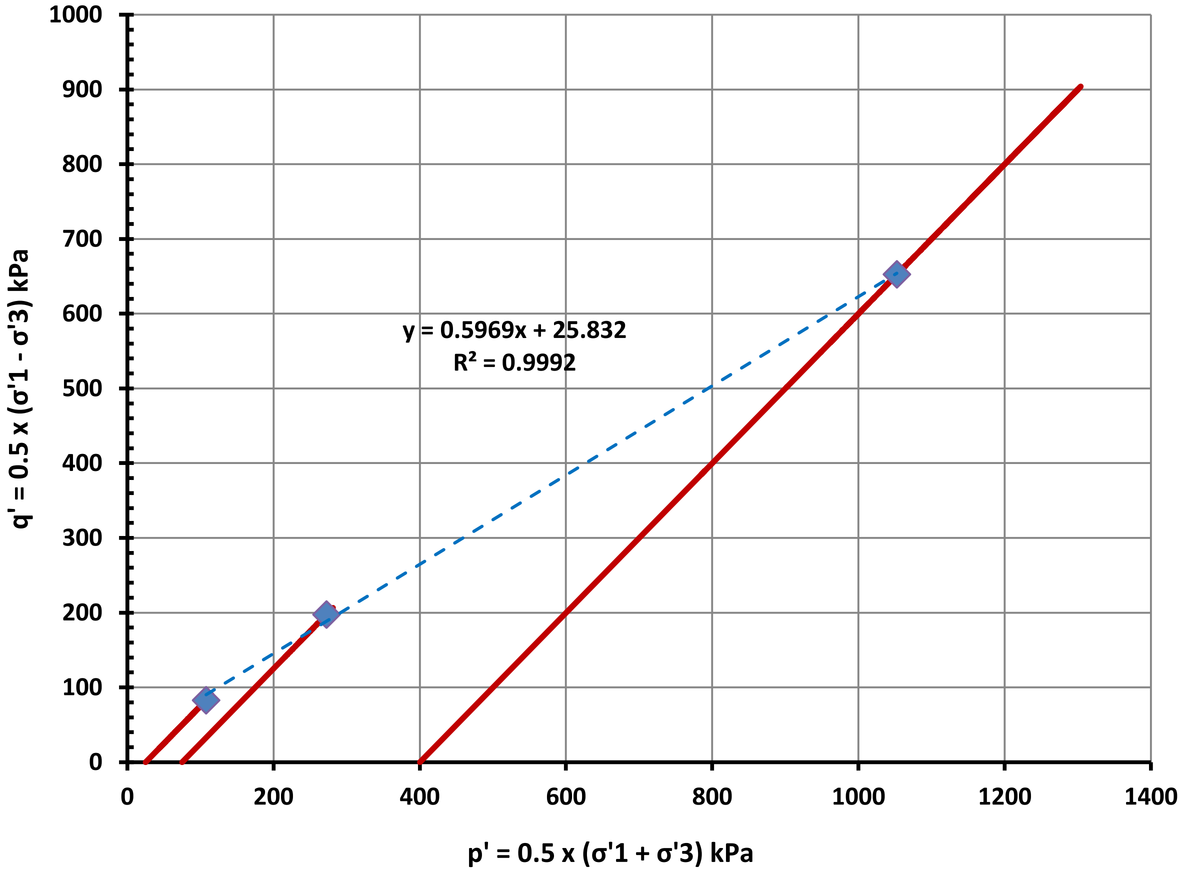
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**32.93**
Angle of Shear Resistance Φ' (Deg) :	**36.58**

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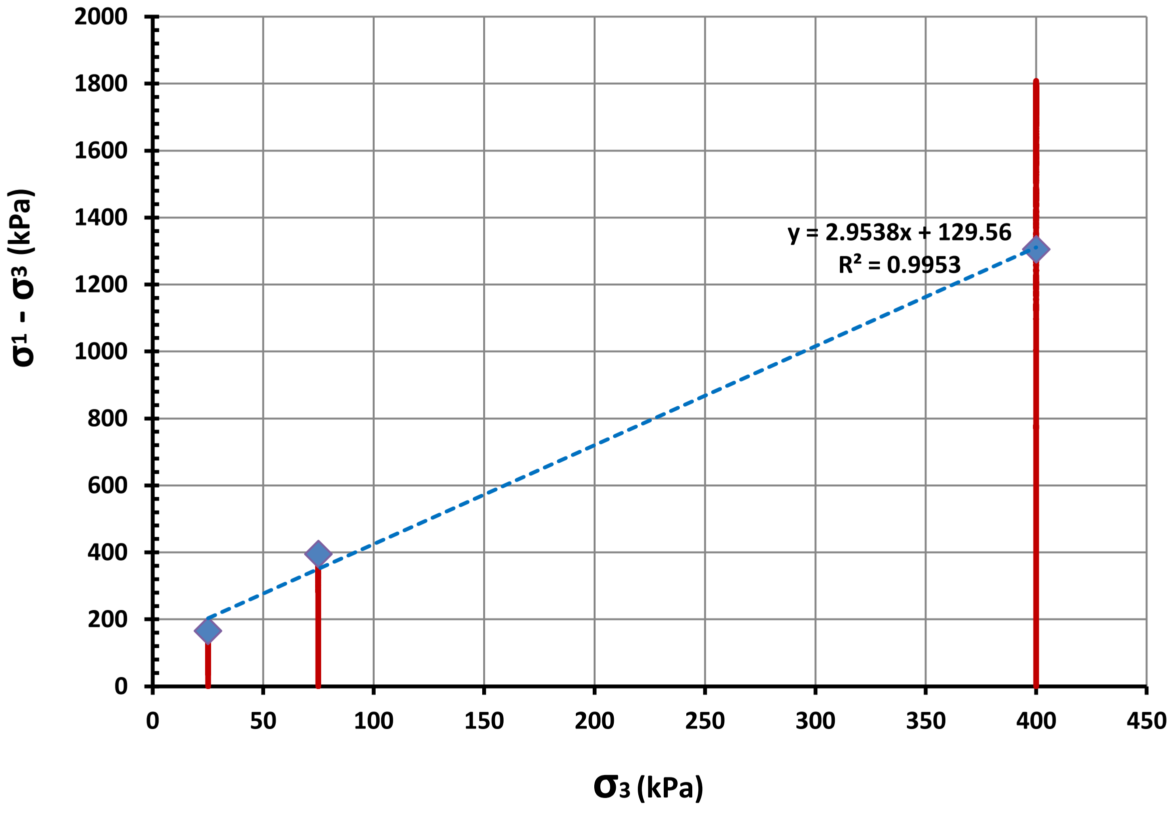
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	**33.36**
Angle of Shear Resistance Φ' (Deg) :	**36.58**

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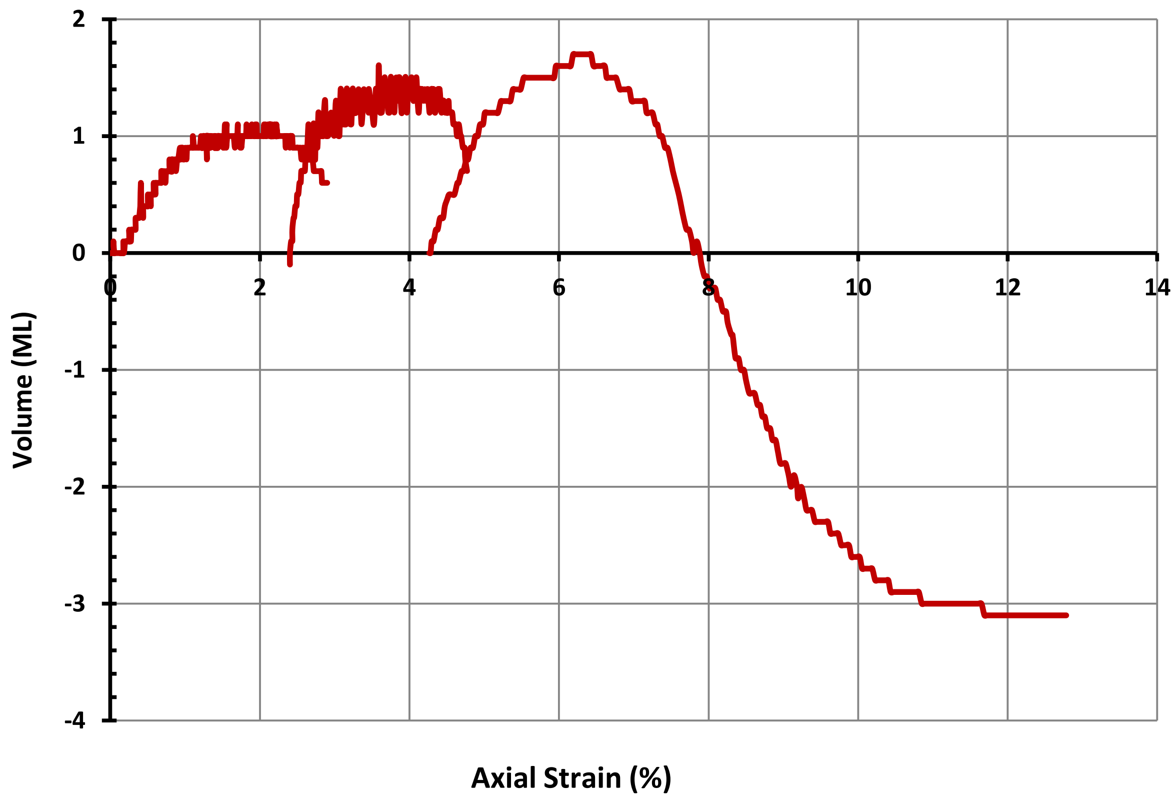
MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

Volume (ML) Vs Axial Strain (%)



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[redacted]

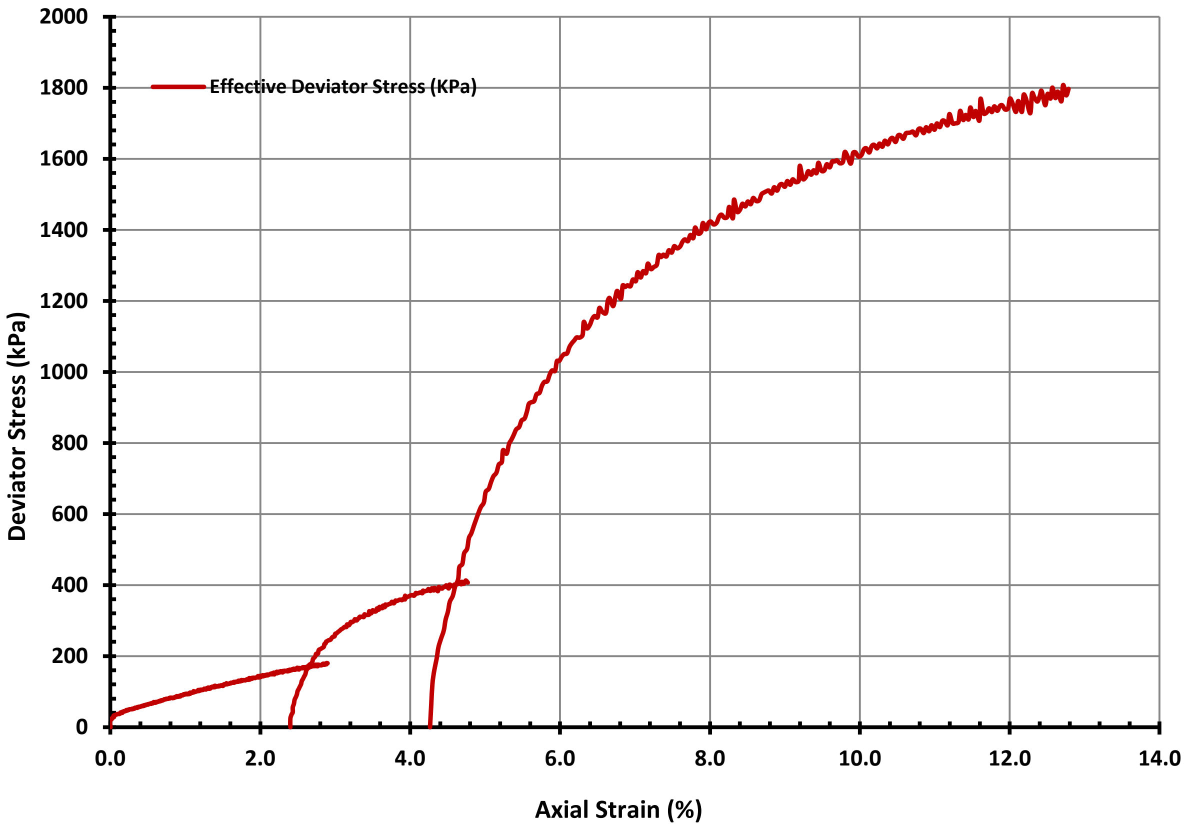
E-PRECISION LABORATORY

MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

Deviator Stress (kPa) Vs Strain Diagram (%)



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U'0	U'f	Principal Effective Stresses			σ'1 - σ'3	Strain (%)
				σ'1	σ'3	σ'1 / σ'3		
1	25	0	0	190	25	7.62	165	2.56
1	75	0	0	470	75	6.27	395	4.46
1	400	0	0	1705	400	4.26	1305	7.21

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[redacted]

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MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C

Photo After Test

Failure Mode: Bulging Failure

Notes:

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signatory (Geotechnical Engineer): [redacted]

Perth
16 Gympie Way, Willetton
WA 6155

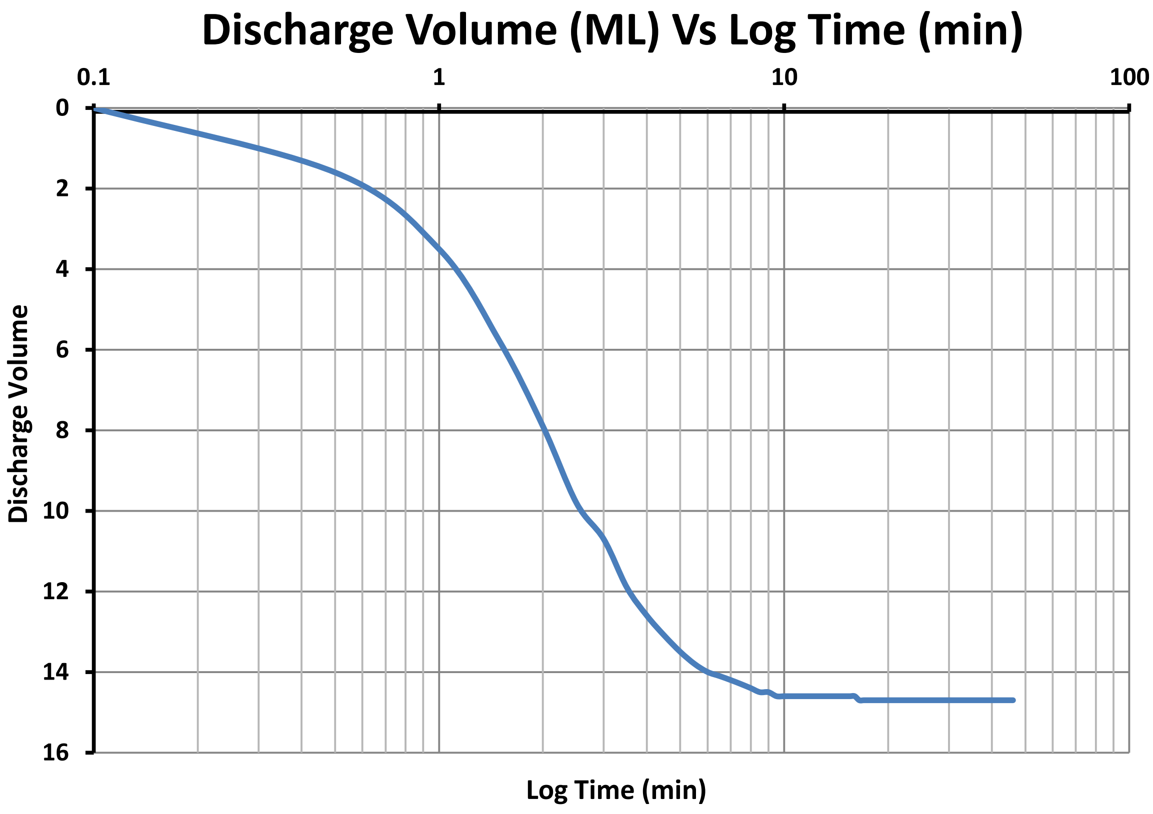
[redacted]

E-PRECISION LABORATORY

MULTISTAGE CONSOLIDATED DRAINED TRIAXIAL TEST

Method: In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB2	Lab:	EPLab
Sample ID:	CPTU_FB2_21.00_CU3		
Depth (m):	21	Room Temperature at Test:	~ 18°C



Cv (cm²/s): 0.636 based on $\mathbf{t_{90}}$

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WA 6155

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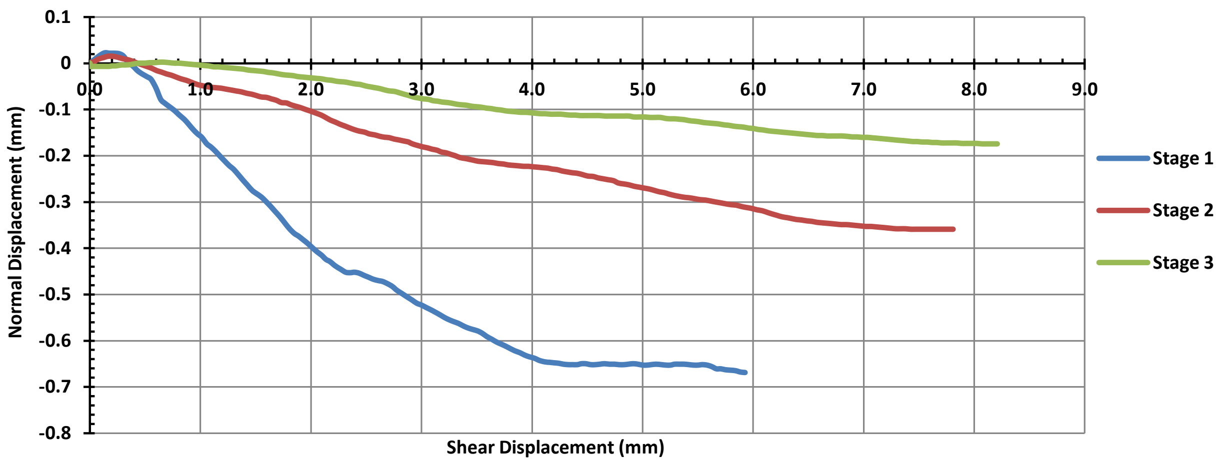
MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

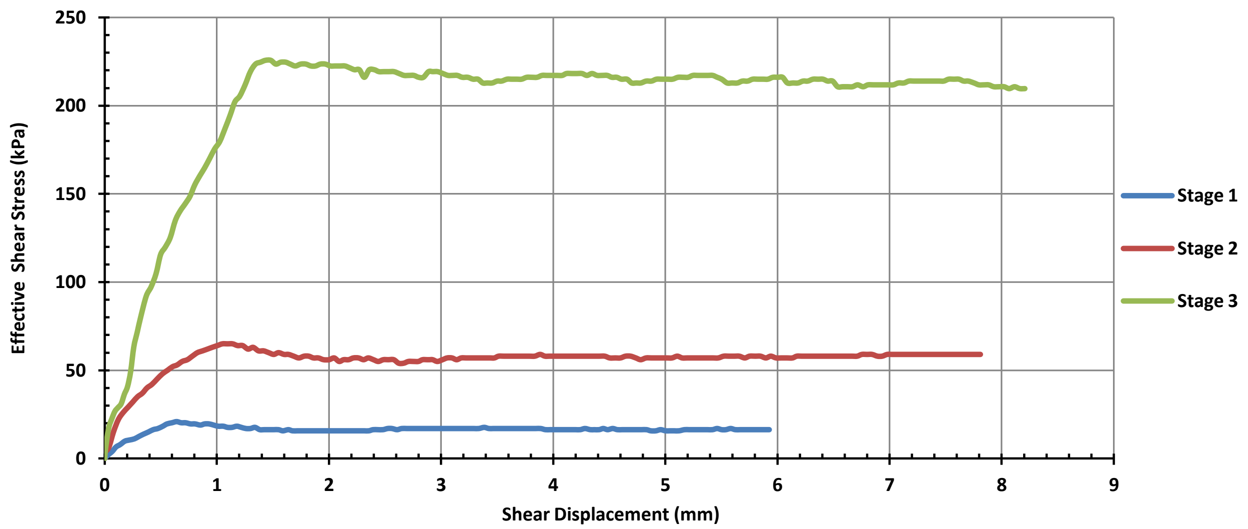
Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

Type of Test:	Multistage Drained Shearing	**Sample Description:**	-
Dimensions (mm):	61.80 x 61.80	**Shear Plane Dip Angle (°):**	N/A
Rate of Strain (mm/min):	0.015	**Initial Bulk Density (t/m³):**	1.76
Failure Criteria:	Horizontal Shear	**Moisture Content (%):**	7.22

Normal Displacement Vs Shear Displacement Plot



Effective Shear Stress Vs Shear Displacement Plot



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[redacted]

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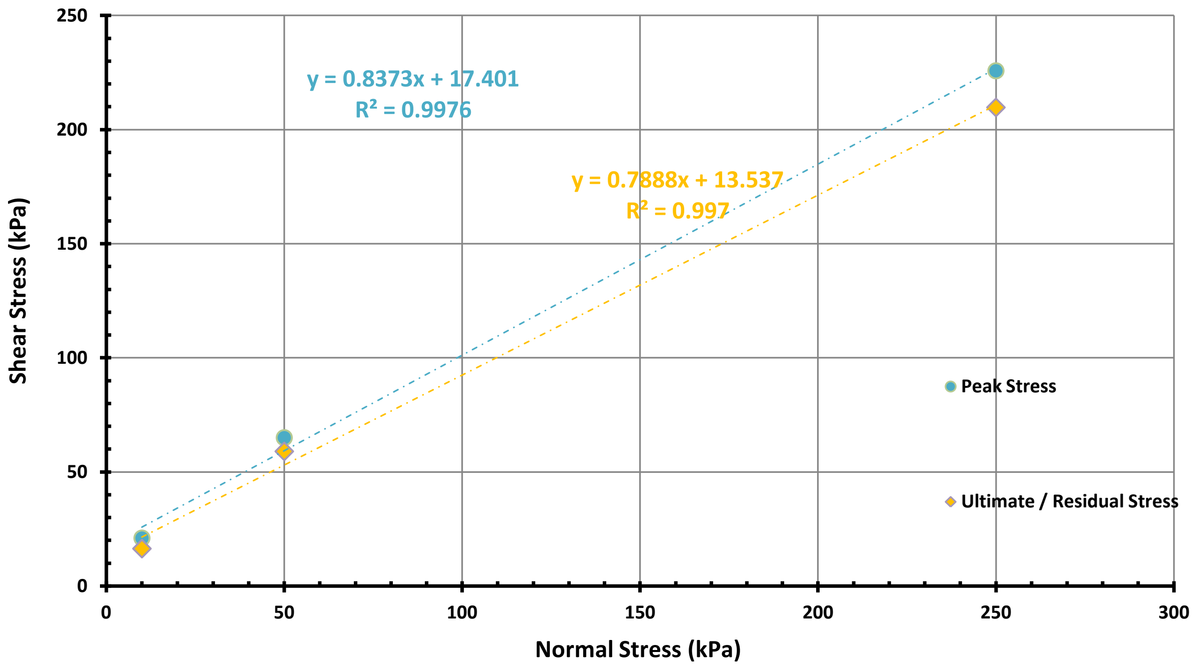
MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

(Peak / Ultimate) Normal Stress Vs Shear Stress (Effective Stresses)



Defect Surface: N/A

Dip Angle (°): N/A

Peak			Normal Stress (kPa)		Shear Stress (kPa)	
	Shear Angle (°)	40.03	Stage 1	10	Stage 1	21
	Cohesion (kPa)	17.40	Stage 2	50	Stage 2	65
	R^2	0.9976	Stage 3	250	Stage 3	226

Ultimate / Residual			Normal Stress (kPa)		Shear Stress (kPa)	
	Shear Angle (°)	38.31	Stage 1	10	Stage 1	16
	Cohesion (kPa)	13.54	Stage 2	50	Stage 2	59
	R^2	0.9970	Stage 3	250	Stage 3	210

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MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB1	Lab:	EPLab
Sample ID:	CPTU_FB1_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

Photo of Sample Post Testing

Notes:

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature (Geotechnical Engineer): [redacted]

Perth
16 Gympie Way, Willetton
WA 6155

[redacted]

E-Precision Laboratory

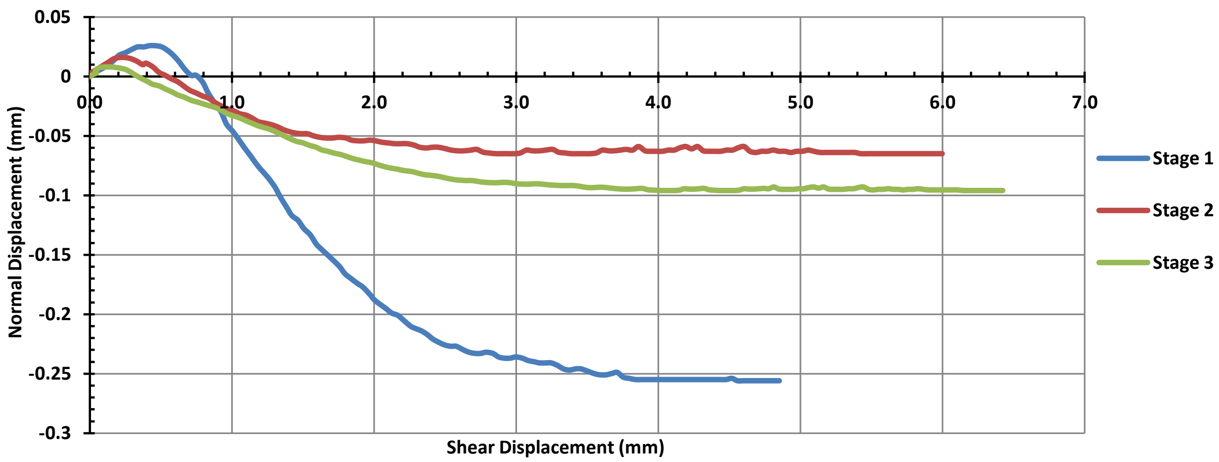
MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

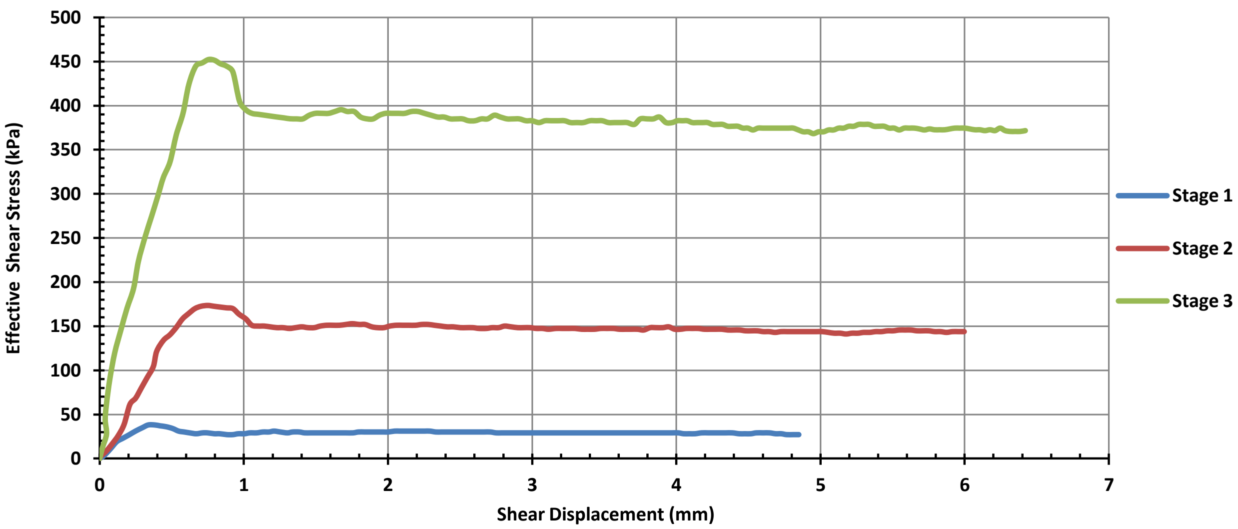
Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB3	Lab:	EPLab
Sample ID:	CPTU_FB3_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

Type of Test:	Multistage Drained Shearing	**Sample Description:**	-
Dimensions (mm):	61.80 x 61.80	**Shear Plane Dip Angle (°):**	N/A
Rate of Strain (mm/min):	0.015	**Initial Bulk Density (t/m³):**	1.76
Failure Criteria:	Horizontal Shear	**Moisture Content (%):**	6.23

Normal Displacement Vs Shear Displacement Plot



Effective Shear Stress Vs Shear Displacement Plot



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Perth
16 Gympie Way, Willetton
WA 6155
[redacted]

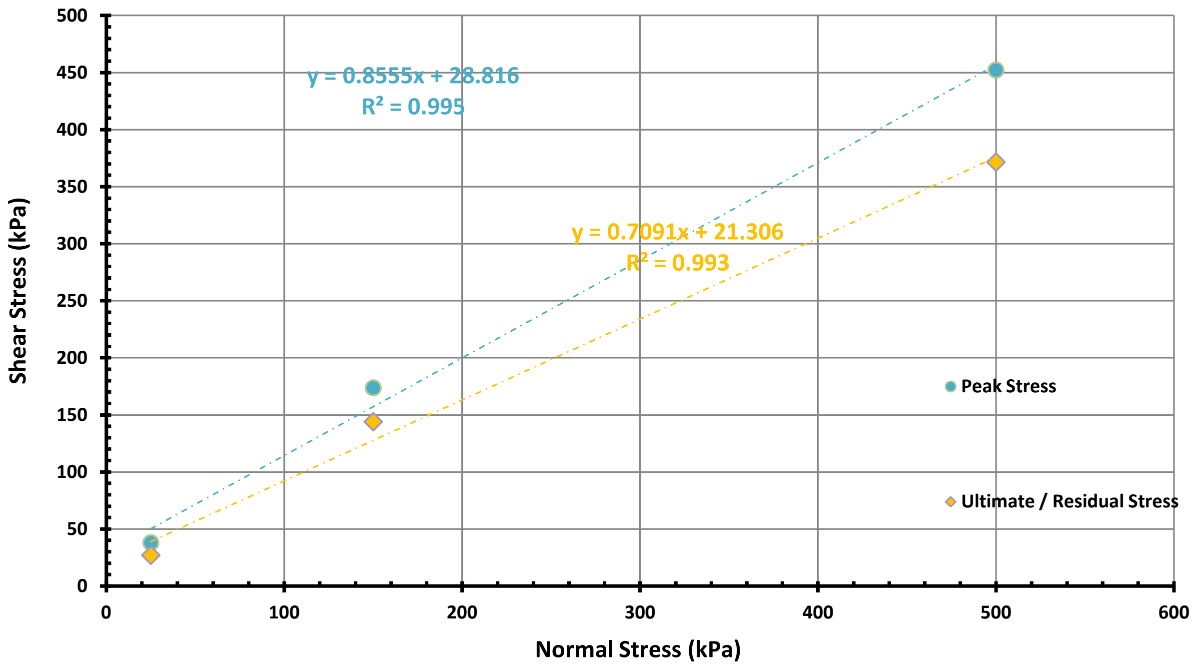
E-Precision Laboratory

MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB3	Lab:	EPLab
Sample ID:	CPTU_FB3_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

(Peak / Ultimate) Normal Stress Vs Shear Stress (Effective Stresses)



Defect Surface: N/A

Dip Angle (°): N/A

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	40.70	Stage 1	25	Stage 1	38
	Cohesion (kPa)	28.82	Stage 2	150	Stage 2	174
	R^2	0.9950	Stage 3	500	Stage 3	452

			Normal Stress (kPa)		Shear Stress (kPa)	
Ultimate / Residual	**Shear Angle (°)**	35.37	Stage 1	25	Stage 1	27
	Cohesion (kPa)	21.31	Stage 2	150	Stage 2	144
	R^2	0.9930	Stage 3	500	Stage 3	372

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WA 6155
[redacted]

E-PRECISION LABORATORY

MULTISTAGE DIRECT SHEAR TEST REPORT

Method: AS1289.6.2.2 / In-house Method

Client:	Geo Analytica	Date Tested:	02/09/2021
Project:	BC8 Futi Bagus Testing 2021	EP Lab Job Number:	GEO
Sample No:	CPTU_FB3	Lab:	EPLab
Sample ID:	CPTU_FB3_19.00_IDST3		
Depth (m):	19	Room Temperature at Test:	20°

Photo of Sample Post Testing

Notes:

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature (Geotechnical Engineer): [redacted]

Appendix C: Futi Bagus Dry historic tailings Analyses COA

CERTIFICATE OF ANALYSIS

Work Order	: **EP2502143**	Page	: 1 of 4
Client	: **ALS METALLURGY**	Laboratory	: Environmental Division Perth
Contact	: [redacted]	Contact	: Customer Services EP
Address	: 6 MACADAM PLACE BALCATTA WA 6021	[redacted]	
Telephone	: ----		
Project	: A26480	Date Samples Received	: 13-Feb-2025 13:10
Order number	: 136017	Date Analysis Commenced	: 18-Feb-2025
C-O-C number	: ----	Issue Date	: 24-Feb-2025 17:51
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]		Perth Inorganics, Wangara, WA
		Perth Inorganics, Wangara, WA
		Perth Inorganics, Wangara, WA
		Perth Inorganics, Wangara, WA

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG048G (Hexavalent Chromium by Alkaline Digestion): Poor spike recovery due to possible sample matrix interference. Confirmed by re-extraction and re-analysis.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	FB1 - 9m	FB1 - 13m	FB1 - 19mA	FB1 - 19mB	FB2 - 15.50m
			Sampling date / time	[13-Feb-2025]	[13-Feb-2025]	[13-Feb-2025]	[13-Feb-2025]	[13-Feb-2025]
Compound	CAS Number	LOR	Unit	EP2502143-001	EP2502143-002	EP2502143-003	EP2502143-004	EP2502143-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**0.6**	**0.6**	<0.1	<0.1	**1.0**
EG005(ED093)T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Chromium	7440-47-3	2	mg/kg	**88**	**95**	**53**	**56**	**89**
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
EG049: Trivalent Chromium								
Trivalent Chromium	16065-83-1	2	mg/kg	**88**	**95**	**53**	**56**	**89**
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	1	mg/kg	**48**	**133**	**88**	**78**	**217**
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser								
Weak Acid Dissociable Cyanide	----	1	mg/kg	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	FB2 - 21mA B- Core	FB2 - 21mB Fines	FB3 - 19m	----	----
			Sampling date / time	[13-Feb-2025]	[13-Feb-2025]	[13-Feb-2025]	----	----
Compound	*CAS Number*	*LOR*	*Unit*	EP2502143-006	EP2502143-007	EP2502143-008	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**0.4**	<0.1	<0.1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Chromium	7440-47-3	2	mg/kg	**66**	**55**	**55**	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EG049: Trivalent Chromium								
Trivalent Chromium	16065-83-1	2	mg/kg	**66**	**55**	**55**	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	1	mg/kg	**100**	**75**	**62**	----	----
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser								
Weak Acid Dissociable Cyanide	----	1	mg/kg	<1	<1	<1	----	----

Appendix D: Fingals Project Reconnaissance Flora/Vegetation and Basic Fauna Survey

Fingals Project
Reconnaissance Flora/ Vegetation and Basic Fauna Survey
Prepared for Black Cat Syndicate Ltd.

July 2021
Version 2

Prepared by:
Botanica Consulting Pty Ltd
33 Brewer Street, Perth, WA 6000

Disclaimer

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Quality Assurance

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

Document Job Number: 2021/60

[redacted]

Contents

Tables

Figures

Glossary

Acronym	Description
BAM Act	*Biosecurity and Agriculture Management Act 2007*, WA Government.
BC Act	*Biodiversity Conservation Act 2016*, WA Government.
Botanica	Botanica Consulting Pty Ltd.
BoM	Bureau of Meteorology.
DAFWA	Department of Agriculture and Food (now DPIRD), WA Government.
DAWE	Department of the Agriculture, Water and Environment (formerly known as DotEE), Australian Government.
DBCA	Department of Biodiversity, Conservation and Attractions (formerly DPaW), WA Government.
DEC	Department of Environment and Conservation (now DBCA), WA Government.
DER	Department of Environment Regulation (now DWER), WA Government.
DMIRS	Department of Mines, Industry Regulation and Safety (formerly DMP), WA Government
DotEE	Department of the Environment and Energy (now known as DAWE), Australian Government.
DoW	Department of Water (now DWER), WA Government.
DPaW	Department of Parks and Wildlife (now DBCA), WA Government.
DPIRD	Department of Primary Industries and Regional Development, WA Government
DWER	Department of Water and Environmental Regulation (formerly EPA, DER and DoW), WA Government
EP Act	Environmental Protection Act 1986, WA Government.
EP Regulations	Environmental Protection (Clearing of Native Vegetation) Regulations 2004, WA Government.
EPA	Environmental Protection Authority, WA Government.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*, Australian Government.
ESA	Environmentally Sensitive Area.
Ha	Hectare (10,000 square meters).
IBRA	Interim Biogeographic Regionalization for Australia.
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union.
JAMBA	*Japan Australia Migratory Bird Agreement 1981.*
Km	Kilometer (1,000 meters).
LGA	Local Government Area
NVIS	National Vegetation Information System.
PEC	Priority Ecological Community.
TEC	Threatened Ecological Community.
WA	Western Australia.
WAHERB	Western Australian Herbarium.
WAM	Western Australian Museum, WA Government.

Executive Summary

Botanica Consulting Pty Ltd (Botanica) was commissioned by Black Cat Syndicate Ltd. (Black Cat) to undertake a reconnaissance flora/ vegetation survey and basic fauna survey within the Fingals Project area. The survey area is 1,192 ha in extent and is located approximately 45 km south-east of Kalgoorlie in the City of Kalgoorlie-Boulder LGA, Western Australia. Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey on the 22nd November 2020, with the area traversed on foot and 4WD by Jim Williams (Director/Principal Botanist, Diploma of Horticulture). The survey was conducted to support a Native Vegetation Clearing Permit (NVCP) application and Mining Proposal with regards to the further development of the Fingals Project.

The survey area lies within the Eastern Goldfields (COO3) subregion of the Coolgardie Bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA).

The Eastern Goldfields subregion (5,102,428 ha) lies on the Yilgarn Craton's Eastern Goldfields Terrain, which is described as gently undulating plains with a subdued relief, interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite. The underlying geology is of gneisses and granites eroded into a flat plane covered with tertiary soils and with scattered exposures of bedrock. Calcareous earths are the dominant soil group and cover much of the plains and greenstone areas. A series of large playa lakes in the western half are the remnants of an ancient major drainage line (Cowan 2001).

The vegetation consists of Mallees, Acacia thickets and shrub-heaths on sandplains, with diverse *Eucalyptus* woodlands occurring around salt lakes, on ranges, and in valleys. Salt lake support dwarf shrublands of samphire. Woodlands and *Dodonaea* shrubland occur on basic granulite of the Fraser Range, and the area is rich in endemic Acacias.

The dominant land uses of the Eastern Goldfields subregion includes Unallocated Crown Land (UCL) and Crown reserves and pastoral grazing, with conservation areas and mining leases also present (Cowan, 2001). The survey area is located within the Mt Monger Pastoral Lease.

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

- Botanica (2012). Level 1 Flora and Vegetation Survey of the Fingals Mine Site Area. Prepared for Integra Mining Ltd, July 2012
- Botanica (2020). Reconnaissance Flora/ Vegetation Survey and Basic Fauna Survey L25/62. Prepared for Black Cat Syndicate, September 2020

In addition to the literature review, searches of the following databases were undertaken to aid in the compilation of a list of significant flora within the survey area:

- DBCA Threatened/ Priority Flora spatial data (DBCA, 2019);
- DBCA NatureMap database (DBCA, 2020); and
- EPBC Protected Matters search tool (DAWE, 2020a).

The NatureMap species search and EPBC Protected Matters search were conducted with a 40 km buffer from the survey area.

The desktop review identified 337 vascular flora species as occurring within 40 km of the survey area, representing 158 genera from 56 families. The most diverse families were Chenopodiaceae (43 species), Fabaceae (41 species) and Asteraceae (36 species). Significant genera were *Eucalyptus* (24 species), *Eremophila* (22 species) and *Acacia* (21 species).

The desktop review identified 42 introduced flora (weed) species as potentially occurring in the vicinity of the survey area. These species consist of 19 families, with the most commonly represented being Asteraceae (11 species), Brassicaceae (six species) and Poaceae (four species). Of these, three are listed as a Declared Pest on the Western Australian Organism List (WAOL) under the *Biosecurity and Agriculture Management* (BAM) *Act 2007*. Two of these, weeds are also listed as Weeds of National Significance, in addition to one WONS not listed as a Declared Pest, for a total of significant weed species.

The assessment of the DBCA Priority/ Threatened flora database (DBCA, 2019), NatureMap search (DBCA, 2020), Protected Matters searches (DAWE, 2020a) and previous relevant literature identified 15 significant flora species recorded within a 40 km radius of the survey area. These are comprised of one Threatened, nine Priority 1, two Priority 3 and three Priority 4 taxa. These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment identified one Priority 1 taxa as likely to occur in the survey area, *Eremophila arachnoides* subsp. *tenera*. Three taxa were assessed as possibly occurring in the survey area, consisting of one Priority 1, one Priority 2 and one Priority Four taxa.

The Protected Matters search (DAWE, 2020a) did not identify any Threatened Ecological Communities recorded within 40 km of the survey area. Analysis of the Priority Ecological Communities within the Goldfields region (DBCA, 2017) did not identify any significant vegetation assemblages as likely or possibly occurring within the survey area.

A total of 224 terrestrial fauna taxa have been recorded within a 40 km radius of the survey area, consisting of 110 bird, 24 mammal, 65 reptile, two amphibian and 23 invertebrate taxa. The desktop review identified eight terrestrial fauna species of conservation significance as previously being recorded in the regional area, consisting of five Threatened, one Priority 4 and two migratory species. In addition, numerous migratory wading/shorebirds were assessed collectively due to their similar habitat requirements.

Habitat and distribution data was used to determine the likelihood of occurrence within the survey area. The assessment identified two significant fauna species as potentially occurring in the survey area.

There are no DBCA managed lands located within the survey area.

There are no Environmentally Sensitive Areas located within the survey area.

There are no Nationally Important or RAMSAR wetlands located within the survey area.

The closest significant environmental feature is the Majestic Timber Reserve, which is DBCA-managed land located approximately 1 km north of the survey area. Disturbances within the survey area are unlikely to impact this area.

The field survey identified 67 flora taxa within the survey area, including six introduced (weed) species. These taxa represented 38 genera across 19 families, with the most diverse genera being *Eucalyptus* (10 species), *Eremophila* (seven species) and *Maireana* (six species). Dominant families include Chenopodiaceae (18 species), Myrtaceae (10 species), and Scrophulariaceae (seven species).

No Threatened or Priority flora species were recorded within the survey area.

A total of five broad-scale vegetation communities were identified within the survey area. Vegetation community descriptions and extents were determined from field survey results, aerial imagery interpretation and extrapolation of the communities. The survey found RS-EW1 was the most widespread community in the survey area, occupying 388 ha (32.6%), while RS-EW2 was the most restricted with 26 ha (2.2%).

No Threatened or Priority ecological communities or otherwise significant vegetation were identified within the survey area.

Based on vegetation and associated landforms identified during the flora and vegetation assessment, three broad scale terrestrial fauna habitats were identified as occurring within the survey area. No evidence of significant fauna species were observed during the survey, including no evidence of Malleefowl nesting mounds or other activity.

Native vegetation within the survey area was rated as 'good', which describes obvious signs of damage caused by human activity since European settlement, including impacts to vegetation structure and composition from low levels of grazing, changed fire regimes and/or slightly aggressive weeds. Cleared areas associated with current mining operations were rated as 'completely degraded'.

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

1 INTRODUCTION

1.1 Project Description

Botanica Consulting Pty Ltd (Botanica) was commissioned by Black Cat Syndicate Ltd. (Black Cat) to undertake a reconnaissance flora/ vegetation survey and basic fauna survey within the Fingals Project area (referred to as 'survey area') (Figure 1-1). The survey area is approximately 1,192 ha in extent and is located approximately 45 km south-east of Kalgoorlie in the City of Kalgoorlie-Boulder LGA, Western Australia. The survey was conducted to support a Native Vegetation Clearing Permit (NVCP) application and Mining Proposal with regards to the further development of the Fingals Project.

1.2 Objectives

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

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

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

- Gather background information on fauna in the survey area (literature review, database and map-based searches);
- Delineate and characterise the faunal assemblages and fauna habitats present in the survey area; and
- Assess the likelihood of significant fauna occurring within the survey area.

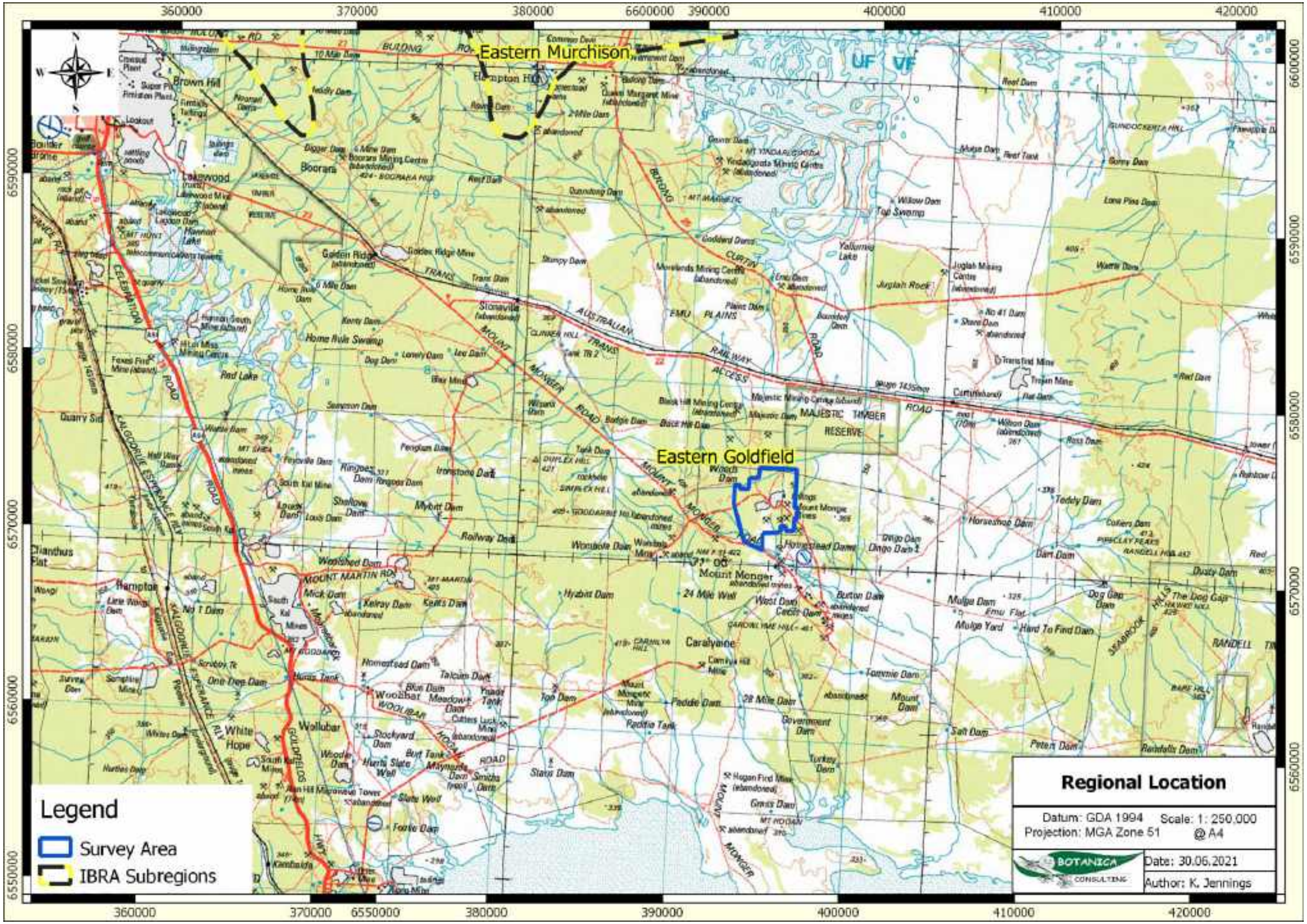


Figure 1-1: Regional map of the survey area

2 BIOPHYSICAL ENVIRONMENT

2.1 Regional Environment

The survey area lies within the Eastern Goldfields (COO3) subregion of the Coolgardie Bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA).

The Eastern Goldfields subregion (5,102,428 ha) lies on the Yilgarn Craton's Eastern Goldfields Terrain, which is described as gently undulating plains with a subdued relief, interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite. The underlying geology is of gneisses and granites eroded into a flat plane covered with tertiary soils and with scattered exposures of bedrock. Calcareous earths are the dominant soil group and cover much of the plains and greenstone areas. A series of large playa lakes in the western half are the remnants of an ancient major drainage line (Cowan 2001).

The vegetation consists of Mallees, Acacia thickets and shrub-heaths on sandplains, with diverse *Eucalyptus* woodlands occurring around salt lakes, on ranges, and in valleys. Salt lake support dwarf shrublands of samphire. Woodlands and *Dodonaea* shrubland occur on basic granulite of the Fraser Range, and the area is rich in endemic Acacias.

In accordance with Beard (1990) the survey area is located in the Coolgardie Botanical District of the Southwestern Interzone Province. The landscape is described as gently undulating with occasional ranges of low hills, with sandplains in the western part and some large playa lakes. Soils are principally brown calcareous earths, which overlays the Proterozoic granite and gneiss of the Fraser Range block and Archaean granite, with infolded volcanics and meta-sediments, of the Yilgarn block. Vegetation is predominately *Eucalyptus* woodlands, with slopes and flats containing *E*. *longicornis* alongside *E. salubris* and *E*. *salmonophloia*. Woodland understories range from tall sclerophyll shrubland dominated by *Melaleuca pauperiflora* to soft-leaved saltbush shrubland of *Atriplex vesicaria* and *A*. *nummularia*. Some hill slopes contain mallees of *E*. *livida* or *E*. *loxophleba*, while ironstone ridges are covered in thickets of *Acacia quadrimarginea*, *Allocasuarina acutivalvis* and *A*. *campestris*. Other vegetation assemblages include species-rich scrub-heaths and *Allocasuarina* thickets on sandplains, merging into *Acacia* thickets and Kwongan vegetation to the north.

2.2 Land Use

The dominant land uses of the Eastern Goldfields subregion includes Unallocated Crown Land (UCL) and Crown reserves and pastoral grazing, with conservation areas and mining leases also present (Cowan, 2001). The survey area is located within the Mt Monger Pastoral Lease.

2.3 Soils and Landscape Systems

The survey area lies within the Kalgoorlie Province, located in the southern Goldfields between Paynes Find, Menzies, Southern Cross and Balladonia. The landscape consists of undulating plains (with some sandplains, hills and salt lakes) on the granitic rocks and greenstone of the Yilgarn Craton. Soils range from calcareous loamy earths and red loamy earths with some salt lake soils to red deep sands, yellow sandy earths, shallow loams and loamy duplexes. Vegetation communities are predominately Eucalypt woodlands with some acacia-casuarina thickets, mulga shrublands, halophytic shrublands and spinifex grasslands.

The Kalgoorlie Province is further divided into six soil-landscape zones, with the survey area located within the Kambalda Zone (265). This zone is located in the south-eastern Goldfields between Menzies, Norseman and the Fraser Range and contains flat to undulating plains (with hills, ranges and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton. Soils consist of calcareous loamy earths and red loamy earths with salt lakes soils and some redbrown hardpan shallow loams and red sandy duplexes. Vegetation includes red mallee, blackbutt-salmon gum-gimlet woodlands with mulga and halophytic shrublands (and some spinifex grasslands).

The Kambalda Zone is further divided into soil landscape systems, with the survey area located within the Mx43 soil landscape systems, as shown in Table 2-1 and Figure 2-1, in accordance with soil landscape system mapping data (Government of Western Australia, 2019).

Table 2-1: Soil Landscape Systems within the survey area

Soil Landscape System	Description	Extent within Survey Area ha (%)
Mx43	Gently undulating valley plains and pediments; some outcrop of basic rock	1,192 ha (100%)

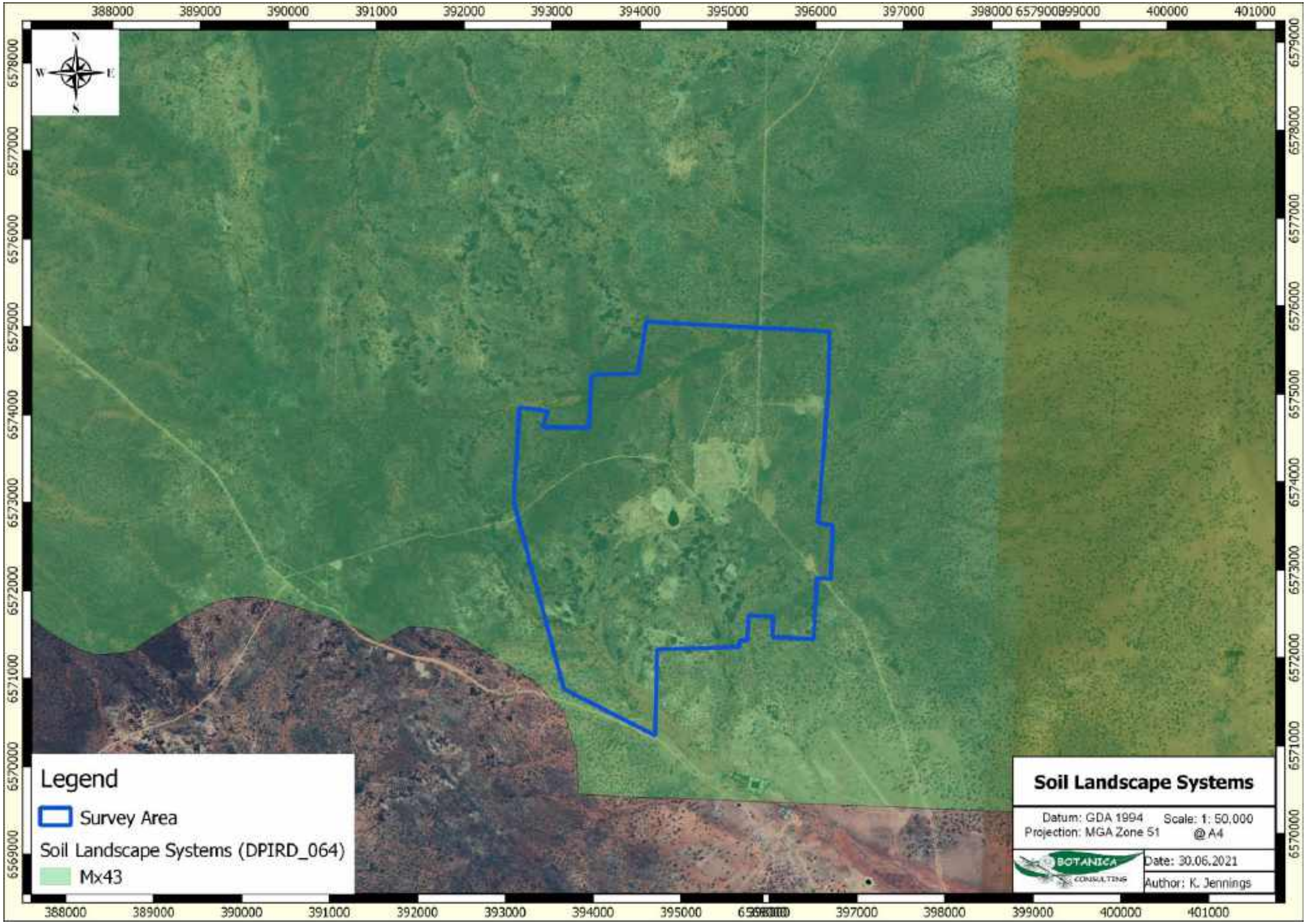


Figure 2-1: Soil Landscape Systems within the survey area

2.4 Regional Vegetation

In accordance with Tille (2006), the vegetation of the Kambalda Zone is typified by the preponderance of stony plains with acacia shrublands and halophytic shrublands, low hills with eucalypt or acacia woodlands with halophytic undershrubs, stony plains with acacia shrublands and alluvial plains with eucalypt woodlands and halophytic undershrubs rangeland.

More broadly, the vegetation of the Kalgoorlie Province is described by Tille (2006) as woodlands of redwood (*Eucalyptus transcontinentalis*), red mallee (*E. oleosa*), Dundas blackbutt (*E. dundasii*), merrit (*E. flocktoniae*) and salmon gum (*E. salmonophloia*), found on undulating plains over granite. There are also some hummock grasslands with red mallee over spinifex (*Triodia scariosa*) and thickets of *Acacia*, *Casuarina* and *Melaleuca* spp. Plains on greenstone have woodlands of York gum (*E. loxophleba*), salmon gum and gimlet (*E. salubris*). The valley plains have woodlands of salmon gum, red mallee, Goldfields blackbutt (*E. lesouefii*), gimlet, York gum and morrel (*E. longicornis*). These sometimes have an understorey of saltbush (*Atriplex* spp.), pearl bluebush (*Maireana sedifolia*), sago bluebush (*M. pyramidata*) and *Eremophila* spp. There are areas of spinifex grasslands with red mallee, mallees (e.g. *E. youngiana*) and marble gum (*E. gongylocarpa*). Low woodlands of mulga (*Acacia aneura*) and black sheoak (*Casuarina cristata*) over bluebush and saltbush are also present. Apart from the bare salt lake surfaces, saline valley floors have shrublands of samphire (*Halosarcia* spp.) and *Frankenia* spp. in lower areas, shrublands of saltbush and bluebush on red deep sandy duplexes, and woodlands of salmon gum, merrit, red mallee, gimlet and York gum. *Acacia neurophylla*, *A. beauverdiana* and *A. resinomarginea* thickets grow on gently sloping uplands on granite, with thickets of acacia, casuarina and melaleuca. There are also scrub-heaths and York gum-salmon gum-gimlet woodlands on these uplands. The hilly terrain on greenstone supports woodlands of salmon gum, Goldfields blackbutt, coral gum (*E. torquata*), York gum, gimlet, morrel, Dundas blackbutt and black sheoak. Thickets of granite wattle (*Acacia quadrimarginea*) are also present. The stony plains support scattered woodlands of Goldfields blackbutt, gimlet and salmon gum, along with shrublands of saltbush and bluebush. Sandplains in the west have acacia (*A. coolgardiensis, A. ramulosa, A. aneura, A. burkittii* and *A. tetragonophylla*) shrublands, commonly with patchy native pine (*Callitris glaucophylla C. preissii*) and mallees (*E. leptopoda, E. longicornis* and *E. loxophleba*). Native box (*Bursaria occidentalis*), *Melaleuca uncinata* and *Hakea recurva* may also be present. Hard spinifex (*T. basedowii*) grasslands with mulga, marble gum and mallees (e.g. *E. kingsmillii*) are found on sandplains to the east. The sandy-surfaced plains support acacia, casuarina and melaleuca thickets; woodlands of York gum, cypress pine (*Callitris columellaris*), salmon gum, gimlet and mulga; and shrublands of bowgada (*A. ramulosa*).

2.5 Conservation Values

The Eastern Goldfields subregion contains 16 vegetation associations, predominately open *Eucalyptus* woodlands, that have at least 85 per cent of their total extent in the bioregion (Cowan 2001) The subregion is considered a centre of endemism for Eucalypts in the Goldfields Woodlands region, and is also noted for the diversity of *Acacia* spp. and ephemeral flora communities of the tertiary sandplain shrublands and the valley floors of woodland areas.

The subregion contains one wetland of national importance: Rowles Lagoon System, located approximately 40 km east of the survey area. In addition, there are seven wetlands of subregional importance (Cowan, 2001). Other significant assemblages in the region include plant assemblages of the Fraser Range and the Woodline Hills.

No ecosystems are listed as threatened under WA State legislation occur within the subregion, but 18 communities and vegetation associations are thought to be at risk for a variety of reasons. Grazing from livestock, goats and rabbits and impacts from mining are the main threatening processes in the region, with changed fire regimes, erosion and sedimentation also causing significant impacts.

2.5.1 Great Western Woodlands

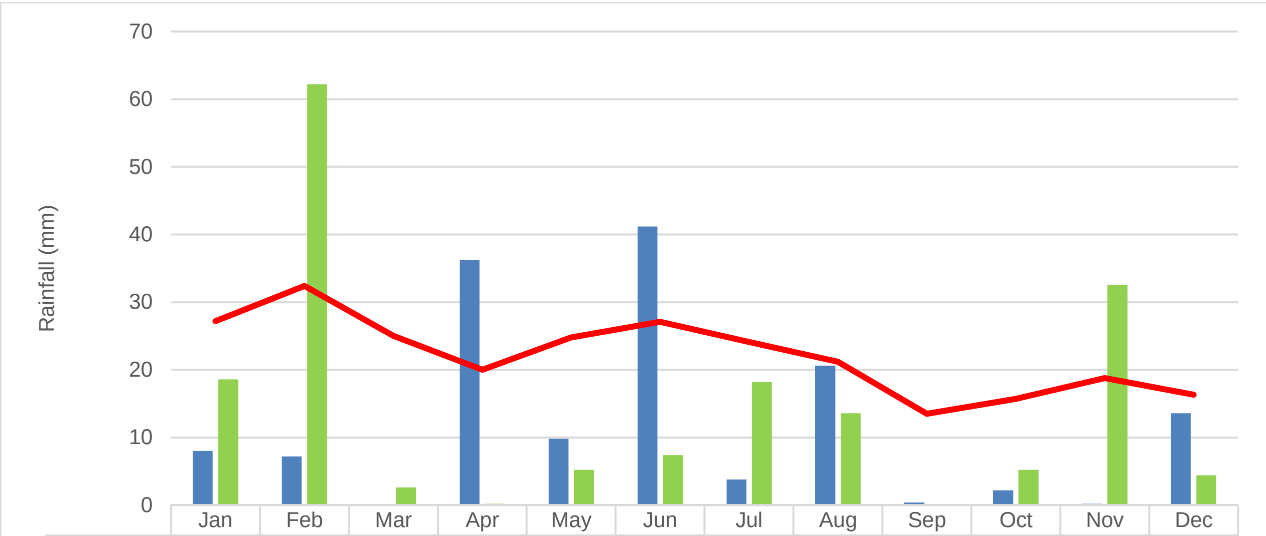
The survey area lies within the Great Western Woodlands, located approximately 30 km from the northern boundary. The Great Western Woodlands is considered by The Wilderness Society of WA to be of global biological and conservation importance as one of the largest and healthiest temperate woodlands on Earth, containing many endemic taxa. The region covers almost 16 million hectares (160,000 square kilometres), from the southern edge of the Western Australian Wheatbelt to the pastoral lands of the Mulga country in the north, the inland deserts to the northeast, and the treeless Nullarbor Plain to the east.

The Great Western Woodlands provides a connection between southwest forests and inland deserts (Gondwana Link) as well as linking the north-west passage to Shark Bay. The majority of the Great Western Woodlands is unallocated crown land (61.1%) with other interests including pastoral leases (20.4%), conservation reserves (15.4%) unallocated crown land, ex pastoral (2%) managed by the Department of Biodiversity, Conservation and Attractions (DBCA) and private land (approximately 1%) (Watson *et. al.,* 2008).

No specific management strategy or formal conservation status applies to the Great Western Woodlands. The Great Western Woodlands currently includes towns, highways, roads, railways, private property, Crown Reserves, agricultural activities and mining tenements.

2.6 Climate

The climate of the Eastern Goldfields subregion is characterised as arid to semi-arid with 200-300 mm of rainfall, sometimes in summer but usually in winter (Cowan 2001). Rainfall data for the Kalgoorlie airport weather station (#12038) located approximately 45 km north-west of the survey area is shown in Graph 2-1 (BoM, 2020). Mean monthly rainfall ranges from 31.6 mm in February to 13.7 mm in September, with a mean annual rainfall of 264.9 mm. The survey was conducted in November 2020 during a period of above average rainfall, however the preceding months (September and October) were characterised by below average rainfall. Although climate conditions are not considered optimal for the presence of flowering material and ephemeral species, this is unlikely to be a major survey constraint.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	8	7.2	0	36.2	9.8	41.2	3.8	20.6	0.4	2.2	0.2	13.6
2020	18.6	62.2	2.6	0.2	5.2	7.4	18.2	13.6	0	5.2	32.6	4.4
Mean	27.2	32.4	25	20	24.8	27.1	24.1	21.2	13.5	15.7	18.8	16.3

Graph 2-1: Average and monthly rainfall for the Kalgoorlie-Boulder Airport weather station (BoM, 2020)

2.7 Hydrology

According to the Geoscience Australia database (2015), there are no permanent or ephemeral inland waters within the survey area. Multiple minor ephemeral drainage lines intersect the survey area (Figure 2-2).

Groundwater Dependent Ecosystems (GDE) includes biological assemblages of species such as wetlands or woodlands that use groundwater either opportunistically or as their primary water source. For the purposes of this report, a GDE is defined as any vegetation community that derives part of its water budget from groundwater and must be assumed to have some degree of groundwater dependency. In accordance with the BoM *Atlas of Groundwater Dependent Ecosystems* (BoM, 2020b) database, there are no potential terrestrial or aquatic GDE's within the survey area.

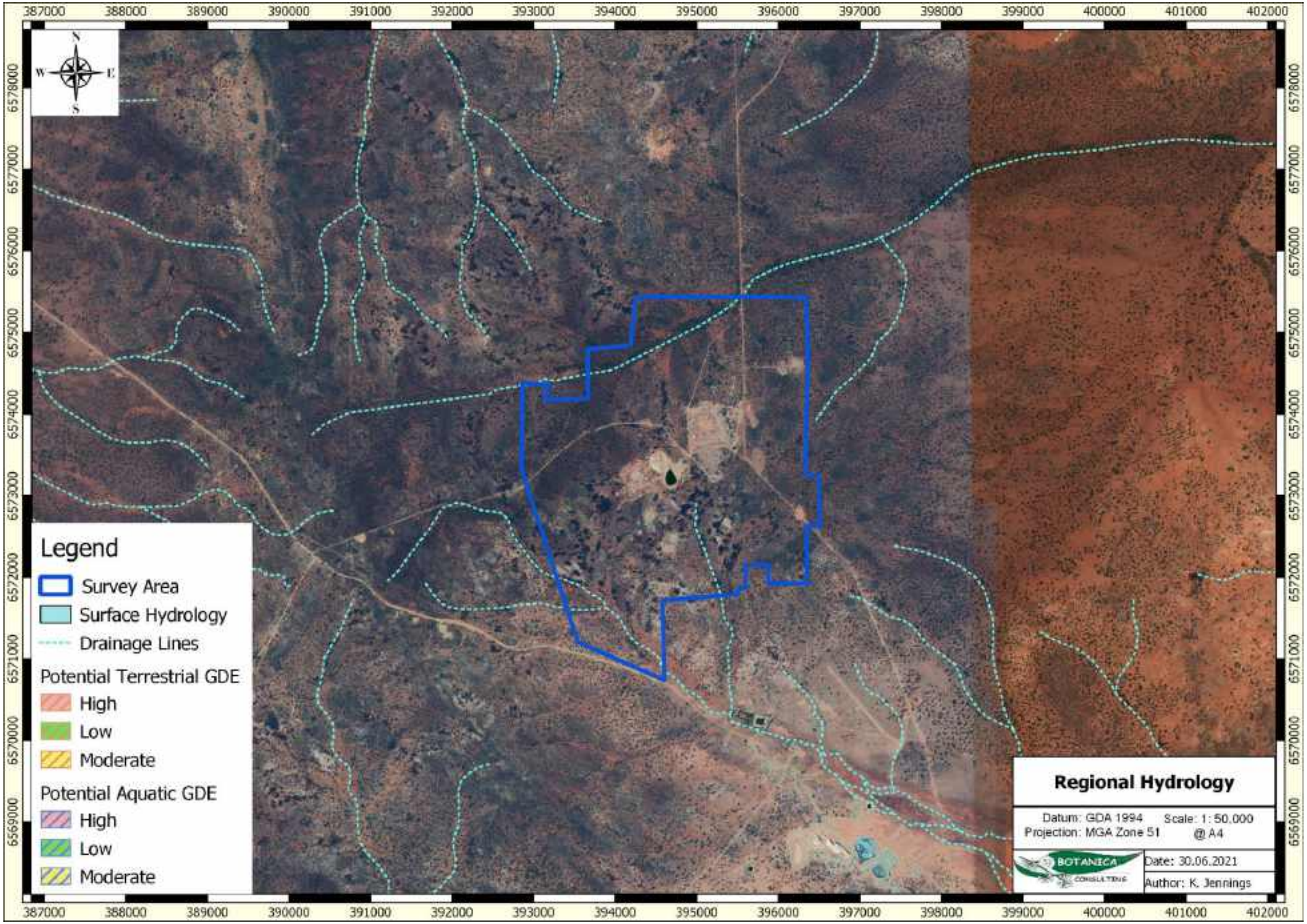


Figure 2-2: Surface Hydrology of the survey area

3 SURVEY METHODOLOGY

3.1 Desktop Assessment

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

- Botanica (2012). *Level 1 Flora and Vegetation Survey of the Fingals Mine Site Area*. Prepared for Integra Mining Ltd, July 2012
- Botanica (2020). Reconnaissance Flora/ Vegetation Survey and Basic Fauna Survey L25/62. Prepared for Black Cat Syndicate, September 2020

In addition to the literature review, searches of the following databases were undertaken to aid in the compilation of a list of significant flora within the survey area:

- DBCA Threatened/ Priority Flora spatial database (DBCA, 2019);
- DBCA NatureMap database (DBCA, 2020); and
- EPBC Protected Matters search tool (DAWE, 2020a).

The NatureMap species search and EPBC Protected Matters search were conducted with a 40 km buffer from the survey area.

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

The assessment categorised flora species as follows:

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

Fauna species were categorised as follows:

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

    - Locally Extinct: Populations no longer occur within a small part of the species natural range, in this case within 10 or 20km of the survey area. Populations do however persist outside of this area.

    - Regionally Extinct: Populations no longer occur in a large part of the species natural range, in this case within the Goldfields region. Populations do however persist outside of this area.

- Unlikely to Occur: The survey area is outside of the currently documented distribution for the species in question, or no suitable habitat (type, quality and extent) was identified as being present during the field assessment. Individuals of some species may occur occasionally as vagrants/transients especially if suitable habitat is located nearby but the site itself would not support a population or part population of the species.

- Possibly Occurs: Survey area is within the known distribution of the species in question and habitat of at least marginal quality was identified as likely to be present during the field survey and literature review, supported in some cases by recent records being documented in literature from within or near the survey area. In some cases, while a species may be classified as possibly being present at times, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

- Known to Occur: The species in question has been positively identified as being present (for sedentary species) or as using the survey area as habitat for some other purpose (for non-sedentary/mobile species) during field surveys within or near the survey area. This information may have been obtained by direct observation of individuals or by way of secondary evidence (e.g. tracks, foraging debris, scats). In some cases, while a species may be classified as known to occur, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

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

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

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

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

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

Most but not all migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as Matters of National Environmental Significance (MNES) under the EPBC Act. Descriptions of conservation significant species and communities are provided in Appendix 1.

3.2 Field Assessment

Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey on the 22nd November 2020, with the area traversed on foot and 4WD by Jim Williams (Director/Principal Botanist, Diploma of Horticulture).

3.2.1 Flora Assessment

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

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

Unknown specimens collected during the survey were identified with the aid of samples housed at the Botanica Herbarium and Western Australian Herbarium. Vegetation was classified in accordance with NVIS classifications.

3.2.2 Fauna Assessment

Vegetation and landform units identified during the flora assessment have been used to define broad fauna habitat types across the site. This information has been supplemented with observations made during the fauna assessment.

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

The main aim of the fauna habitat assessment was to determine the likelihood of fauna species of conservation significance utilizing the areas that may be impacted during site development. The habitat information obtained was also used to aid in finalizing the overall potential fauna list.

As part of the desktop literature review, available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area was researched. During the field survey, the habitats within the study area were assessed and specific elements identified, if present, to determine the likelihood of listed threatened species utilizing the area and its significance to them.

Opportunistic observations of fauna species were made during all field survey work which involved a series of transects across the study area during the day including observations of bird species with binoculars. Secondary evidence of a species presence such as tracks, scats, skeletal remains, foraging evidence or calls were also noted if observed/heard.

3.2.3 Scientific Licences

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

Licensed staff	Permit Number	Valid Until
[redacted]	FB62000108 (Licence to flora for scientific purposes)	27/05/2022

3.3 Survey Limitations and Constraints

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

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

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

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

Table 3-2: Limitations and constraints associated with the survey

Variable	Potential Impact on Survey	Details
Access problems	Not a constraint	The survey was conducted via 4WD and on foot. Numerous tracks were located within the survey area, providing ease of access.
Competency/ Experience	Not a constraint	The BC personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Botanist/ Zoologist:** Jim Williams **Data Interpretation:** Jim Williams and Kelby Jennings.
Timing of survey, weather & season	Not a constraint	Fieldwork was undertaken within the EPA's recommended survey period (September - November) for the South-West and Interzone Province.
Area disturbance	Not a constraint	The area has been disturbed from exploration and mining operations, cattle grazing and other human impacts; however, vegetation was mostly intact and comprised of native vegetation.
Survey Effort/ Extent	Not a constraint	Survey intensity was appropriate for the size/significance of the area with a reconnaissance survey completed to identify vegetation types/fauna habitats and conservation significant species/communities.
Availability of contextual information at a regional and local scale	Not a constraint	Threatened flora database searches provided by the DBCA were used to identify any potential locations of Threatened/Priority taxa. BoM, DWER, DPIRD, DBCA and DAWE databases were reviewed to obtain appropriate regional desktop information on the biophysical environment of the local region. Previous Flora/ Fauna surveys within the local area have been assessed for pertinent information and environmental context of the regional area.
Completeness	Not a constraint	In the opinion of Botanica, the survey area was covered sufficiently in order to identify vegetation assemblages. All observed flora individuals were able to be identified to species level. The vegetation types for this study were based on visual descriptions of locations in the field. The distribution of these vegetation communities/ fauna habitats outside the study area is not known, however vegetation types identified were categorised via comparison to vegetation distributions throughout WA specified in the NVIS Major Vegetation Groups (DotEE, 2017b).

4 RESULTS

4.1 Desktop Assessment

4.1.1 Flora

The desktop review identified 337 vascular flora species as occurring within 40 km of the survey area, representing 158 genera from 56 families. The most diverse families were Chenopodiaceae (43 species), Fabaceae (41 species) and Asteraceae (36 species). Significant genera were *Eucalyptus* (24 species), *Eremophila* (22 species) and *Acacia* (21 species). This total includes 39 introduced (weed) species.

4.1.1.1 Introduced Flora

The desktop review identified 42 introduced flora (weed) species as potentially occurring in the vicinity of the survey area. These species consist of 19 families, with the most commonly represented being Asteraceae (11 species), Brassicaceae (six species) and Poaceae (four species). Of these, three are listed as a Declared Pest on the Western Australian Organism List (WAOL) under the *Biosecurity and Agriculture Management* (BAM) *Act 2007*. Two of these, weeds are also listed as Weeds of National Significance, in addition to one WONS not listed as a Declared Pest, for a total of significant weed species (Table 4-1).

The full list of potential weed species is contained in Appendix 2.

Table 4-1: Potentially occurring Declared Pests and WoNS

Taxon	Common Name	WAOL Status	Control Category	WONS
Echium plantagineum	Paterson's Curse	Declared Pest - s22(2)	No Control Category, Whole of State	No
Cylindropuntia fulgida var. mamillata		Declared Pest - s22(2)	C3 Management, Whole of State	Yes
Lycium ferocissimum	African Boxthorn	Permitted - s11	No Control Category	Yes
Lantana camara	Common Lantana	Declared Pest - s22(2)	C3 Management, Whole of State	Yes

4.1.1.2 Significant Flora

The assessment of the DBCA Priority/ Threatened flora database (DBCA, 2019), NatureMap search (DBCA, 2020), Protected Matters searches (DAWE, 2020a) and previous relevant literature identified 15 significant flora species recorded within a 40 km radius of the survey area. These are comprised of one Threatened, eight Priority 1, one Priority 2, two Priority 3 and three Priority 4 taxa (Appendix 3).

These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment identified one Priority 1 taxa as likely to occur in the survey area, *Eremophila arachnoides* subsp. *tenera*. Three taxa were assessed as possibly occurring in the survey area, consisting of one Priority 1, one Priority 2 and one Priority Four taxa (Table 4-2). The full flora likelihood assessment is listed in Appendix 3. The locations of the DBCA database records are illustrated spatially in Figure 4-1.

Table 4-2: Potentially occurring significant flora species

Species	Rank	Habitat	Comments	Likelihood
Eremophila arachnoides subsp. *tenera*	P1	Flat calcareous plain.	Records within 5 km, habitat likely to be present.	Likely
Eremophila praecox	P2	Red/brown sandy loam. Undulating plains.	Potential habitat may be present, occurs within regional context.	Possible
Eremophila xantholaema	P1	-	Occurs within regional context.	Possible
Eucalyptus x brachyphylla	P4	Sandy loam. Granite outcrops.	Regional records, potential habitat may be present.	Possible

4.1.1.3 Significant Ecological Communities

The Protected Matters search (DAWE, 2020a) did not identify any Threatened Ecological Communities recorded within 40 km of the survey area. Analysis of the Priority Ecological Communities within the Goldfields region (DBCA, 2020) did not identify any significant vegetation assemblages as likely or possibly occurring within the survey area.

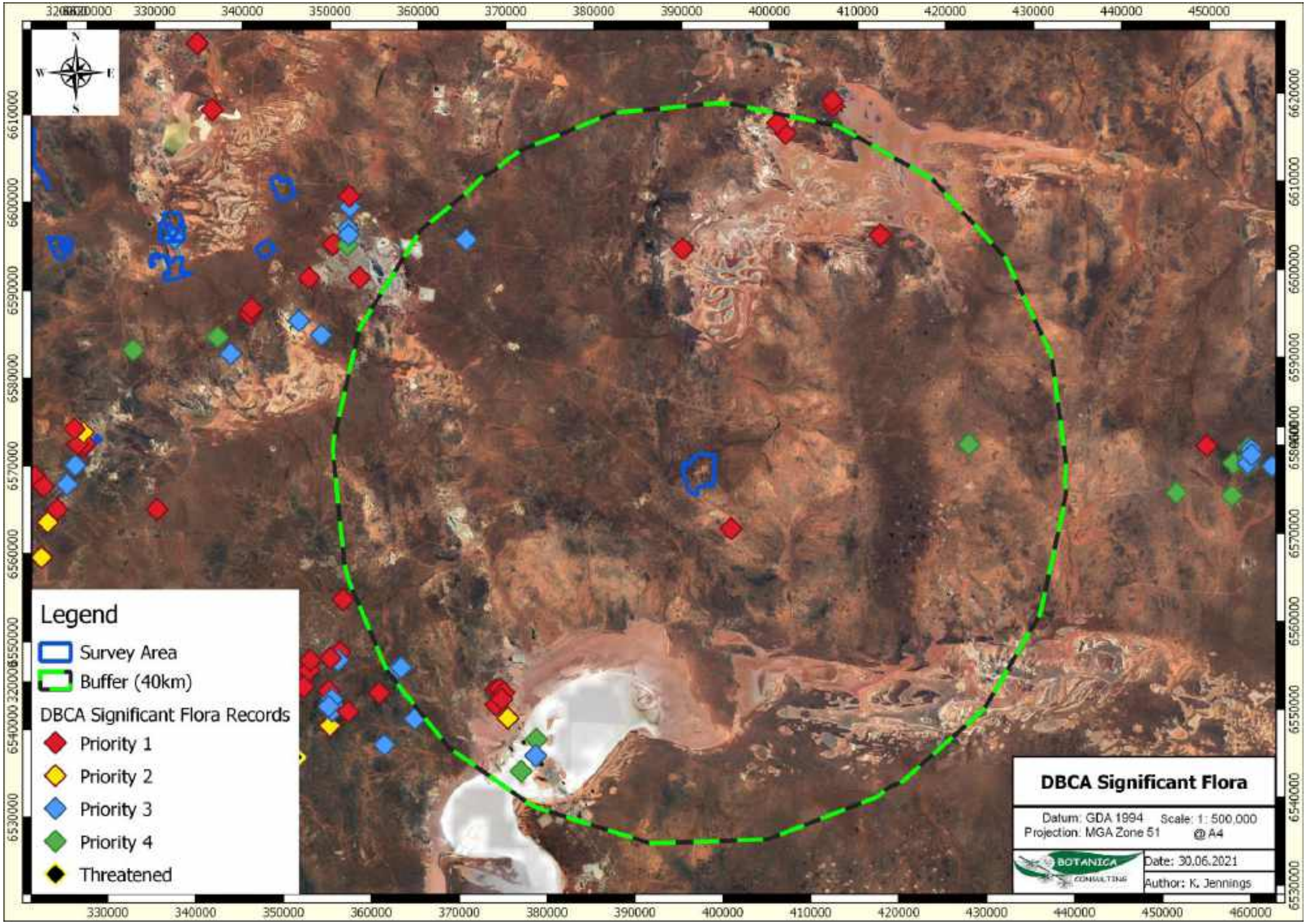


Figure 4-1: DBCA significant flora records

4.1.2 Vegetation Associations

The Pre-European vegetation association spatial mapping dataset (DPIRD, 2018) identifies three vegetation associations as occurring within the survey area (Figure 4-2). The association descriptions and their remaining extent, as specified in the 2018 Statewide Vegetation Statistics (DBCA, 2019) are provided in Table 4-3. Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered “endangered” (EPA, 2000). All vegetation associations >97% of their Pre-European extent. Development within the survey area will not significantly reduce the pre-European extent of these vegetation associations.

Table 4-3: Pre-European Vegetation Associations within the survey area

Vegetation Association	Current Extent (ha)	Pre-European extent remaining (%)	% in DBCA managed lands	Floristic Description	Extent within Survey Area ha (%)
Randell 9	235,162	97.8	1.53	Goldfields; gimlet, redwood etc. *E. salubris*, *E. oleosa*. Riverine; rivergum *E. camaldulensis*.	283.6 ha (23.8%)
Randell 1241	10,389	99.1	-	*Atriplex* spp. *Maireana* spp. communities on alkaline soils	109.4 ha (9.2%)
Randell 468	583,903	98.6	4.11	Goldfields; gimlet, redwood etc. *E. salubris*, *E. oleosa*. Riverine; rivergum *E. camaldulensis*.	799.6 ha (67.0%)

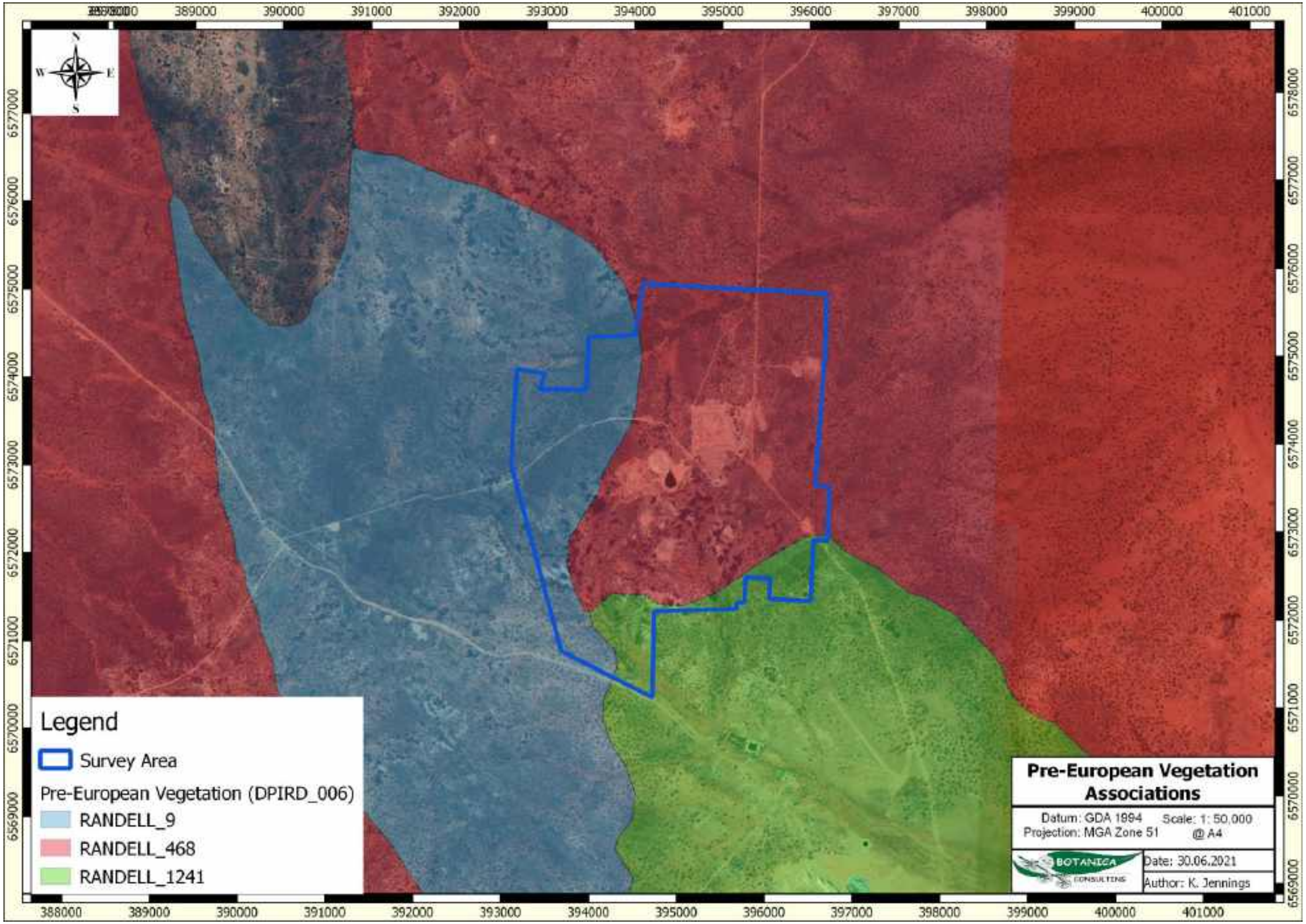


Figure 4-2: Pre-European Vegetation Associations within the survey area

4.1.3 Fauna

According to the results of the NatureMap search (DBCA, 2020), a total of 224 terrestrial fauna taxa have been recorded within a 40 km radius of the survey area, consisting of 110 bird, 24 mammal, 65 reptile, two amphibian and 23 invertebrate taxa. This total includes seven introduced (feral) species.

4.1.3.1 Introduced (Feral) Fauna

The NatureMap and EPBC database searches identified 11 feral fauna species, representing seven families, as potentially occurring in the survey area (Table 4-4).

Table 4-4: Potentially Occurring Introduced Fauna

Family	Taxon	Common Name
Bovidae	*Bos taurus*	European Cattle
	Capra hircus	Goat
Camelidae	*Camelus dromedarius*	Dromedary Camel
Canidae	*Canis lupus familiaris*	Domestic Dog
	Vulpes vulpes	Red Fox
Columbidae	*Columba livia*	Domestic Pigeon
	Streptopelia chinensis	Spotted Turtle-Dove
	Streptopelia senegalensis	Laughing Turtle-Dove
Felidae	*Felis catus*	Cat
Leporidae	*Oryctolagus cuniculus*	Rabbit
Muridae	*Mus musculus*	House Mouse

4.1.3.2 Conservation Significant Fauna

The desktop review identified eight terrestrial fauna species of conservation significance as previously being recorded in the regional area, consisting of five Threatened, one Priority 4 and two migratory species. In addition, numerous migratory wading/shorebirds were assessed collectively due to their similar habitat requirements. The full fauna likelihood assessment is listed in Appendix 4

Habitat and distribution data was used to determine the likelihood of occurrence within the survey area. The assessment identified two significant fauna species as potentially occurring in the survey area (Table 4-5 4-5).

Table 4-5: Significant fauna species potentially occurring in survey area

Species	Status	Likelihood
Grey Falcon (*Falco hypoleucos*)	T (VU)	Possible
Malleefowl (*Leipoa ocellata*)	T (VU)	Possible

4.1.4 Conservation Areas

There are no proposed or vested Conservation Reserves located within the survey area. There are no DBCA managed land located within the survey area. There are no Environmentally Sensitive Areas located within the survey area. There are no Nationally Important or RAMSAR wetlands located within the survey area.

The closest significant environmental feature is the Majestic Timber Reserve, which is DBCA-managed land located approximately 1 km north of the survey area. Disturbances within the survey area are unlikely to impact this area. The location of conservation areas in relation to the survey area is provided in Figure 4-3.

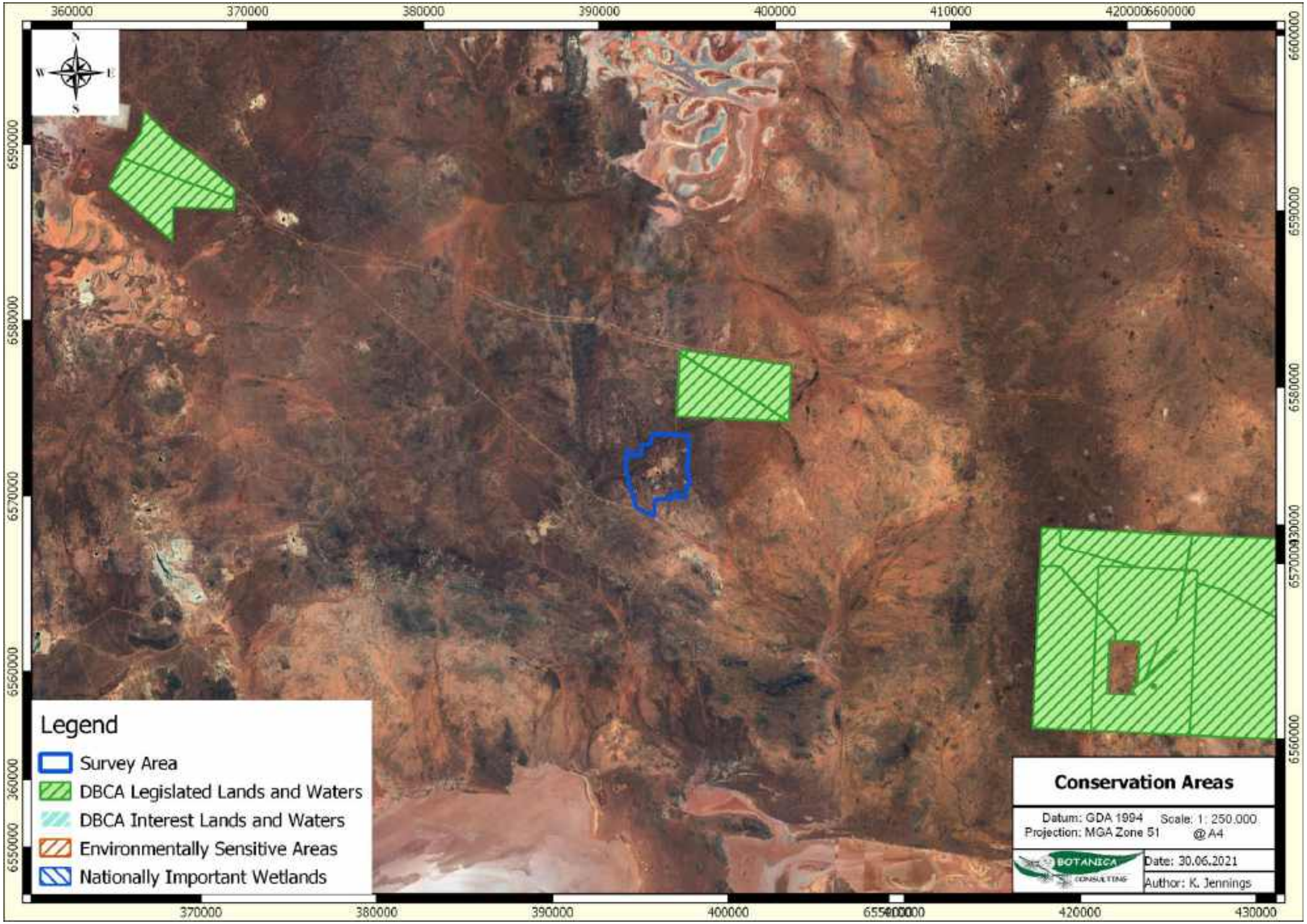


Figure 4-3: Conservation Areas

4.2 Field Assessment

4.2.1 Flora

The field survey identified 67 flora taxa within the survey area, including six introduced (weed) species. These taxa represented 38 genera across 19 families, with the most diverse genera being *Eucalyptus* (10 species), *Eremophila* (seven species) and *Maireana* (six species). Dominant families include Chenopodiaceae (18 species), Myrtaceae (10 species), and Scrophulariaceae (seven species). The full field species inventory is listed in Appendix 5.

4.2.1.1 Introduced Flora

Six species of introduced flora were recorded within the survey area (Table 4-6). None of these species are listed as a Weed of National Significance or a Declared Pest in Western Australia.

Table 4-6: Introduced flora species within the survey area

Family	Taxon
Asteraceae	*Centaurea melitensis*
Asteraceae	*Dittrichia graveolens*
Asteraceae	*Oligocarpus calendulaceus*
Lamiaceae	*Salvia verbenaca*
Solanaceae	*Nicotiana glauca*
Solanaceae	*Solanum nigrum*

4.2.1.2 Significant Flora

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

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

No Threatened or Priority flora species were recorded within the survey area. No other significant flora (as described above) were identified within the survey area.

4.2.2 Vegetation Communities

A total of five broad-scale vegetation communities were identified within the survey area. Vegetation community description and extent are listed below in Table 4-7 and illustrated spatially in Figure 4-4. Vegetation community descriptions and extents were determined from field survey results, aerial imagery interpretation and extrapolation of the communities.

The survey found RS-EW1 was the most widespread community in the survey area, occupying 388 ha (32.6%), while RS-EW2 was the most restricted with 26 ha (2.2%).

Table 4-7: Vegetation Community Descriptions and Extent

Vegetation Community	Broad Floristic Formation (NVIS III)	Vegetation Description (NVIS V)	Landform	Image
DD-CF1 31 ha (2.6%)	*Casuarina* low forest	*Casuarina pauper* low forest over *Eremophila decipiens* open shrubland over *Maireana triptera* low sparse shrubland.	Drainage Channel	
CLP-EW1 314 ha (26.3%)	*Eucalyptus* low open woodland	*Eucalyptus lesouefii* low open woodland over *Senna artemisioides* subsp. *filifolia* and *Maireana triptera* low open shrubland.	Clay/loam plain.	

Vegetation Community	Broad Floristic Formation (NVIS III)	Vegetation Description (NVIS V)	Landform	Image
CLP-EW2 315 ha (26.4%)	*Eucalyptus* open woodland	*Eucalyptus ravida* low open woodland over *Maireana triptera* low open shrubland.	Clay/loam plain.	
RS-EW1 388 ha (32.6%)	*Eucalyptus* low open woodland	*Eucalyptus lesouefii*, *E. salmonophloia* and *E. salubris* woodland over *Tecticornia disarticulata* low open shrubland.	Lower rocky slopes	

Vegetation Community	Broad Floristic Formation (NVIS III)	Vegetation Description (NVIS V)	Landform	Image
RS-EW2 26 ha (2.2%)	*Eucalyptus* low woodland	*Eucalyptus stricklandii* low woodland over *Melaleuca sheathiana* shrubland.	Upper rocky slopes	

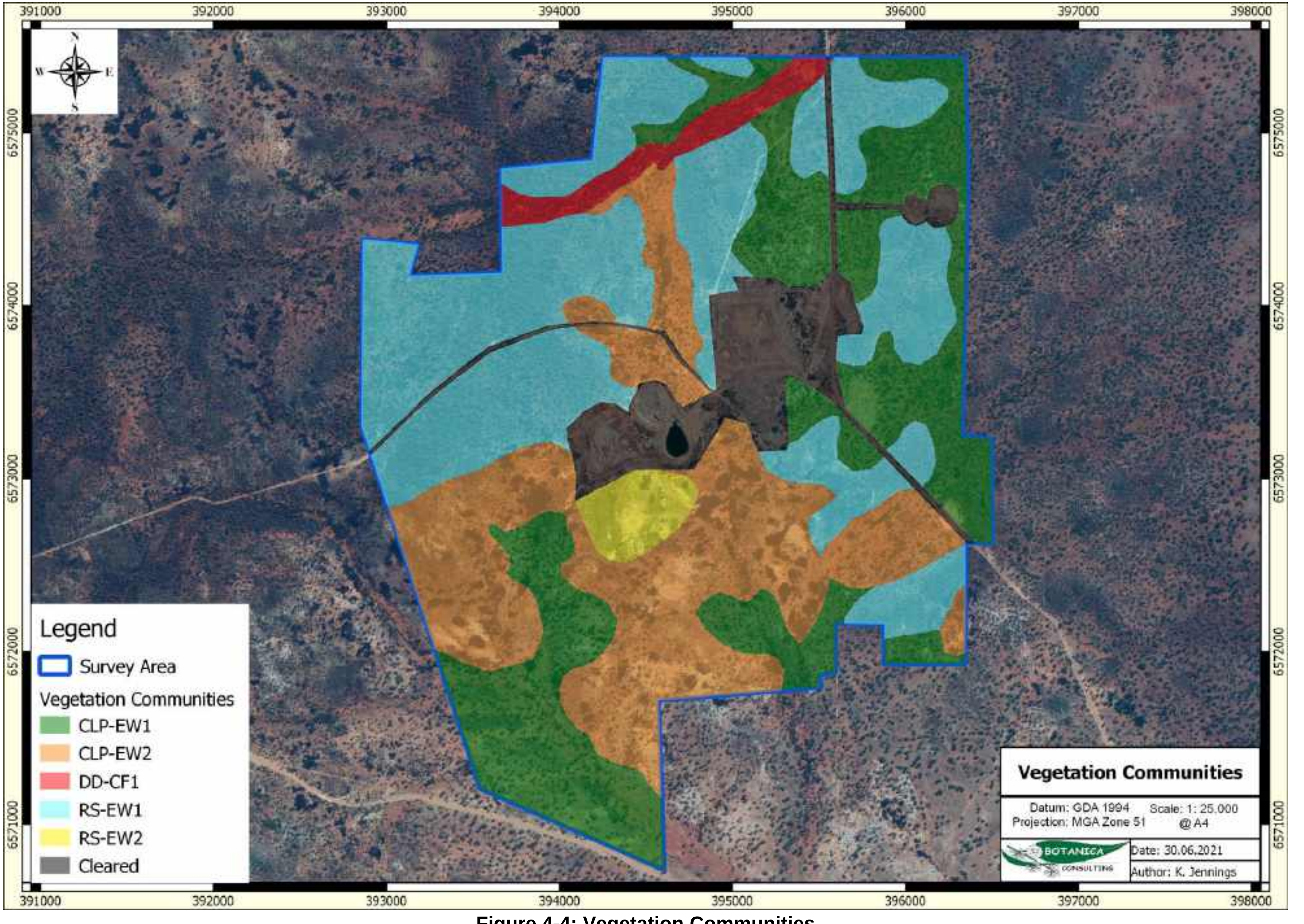


Figure 4-4: Vegetation Communities

4.2.3 Vegetation Condition

Based on the vegetation condition rating scale adapted from Keighery (1994) and Trudgen, (1988), native vegetation within the survey area was rated as 'good' (Table 4-8, Figure 4-5). 'Good' condition depicts more obvious signs of damage caused by human activity since European settlement, including impacts to vegetation structure and composition from low levels of grazing, changed fire regimes and/or slightly aggressive weeds. Cleared areas associated with current mining operations and road infrastructure/ easements were rated as 'completely degraded'.

Table 4-8: Vegetation Condition within the survey area

Condition Rating	Area (ha)	Area (%)
Good	1,074	90.1
Completely Degraded	118	9.9
Total	**1,192**	**100**

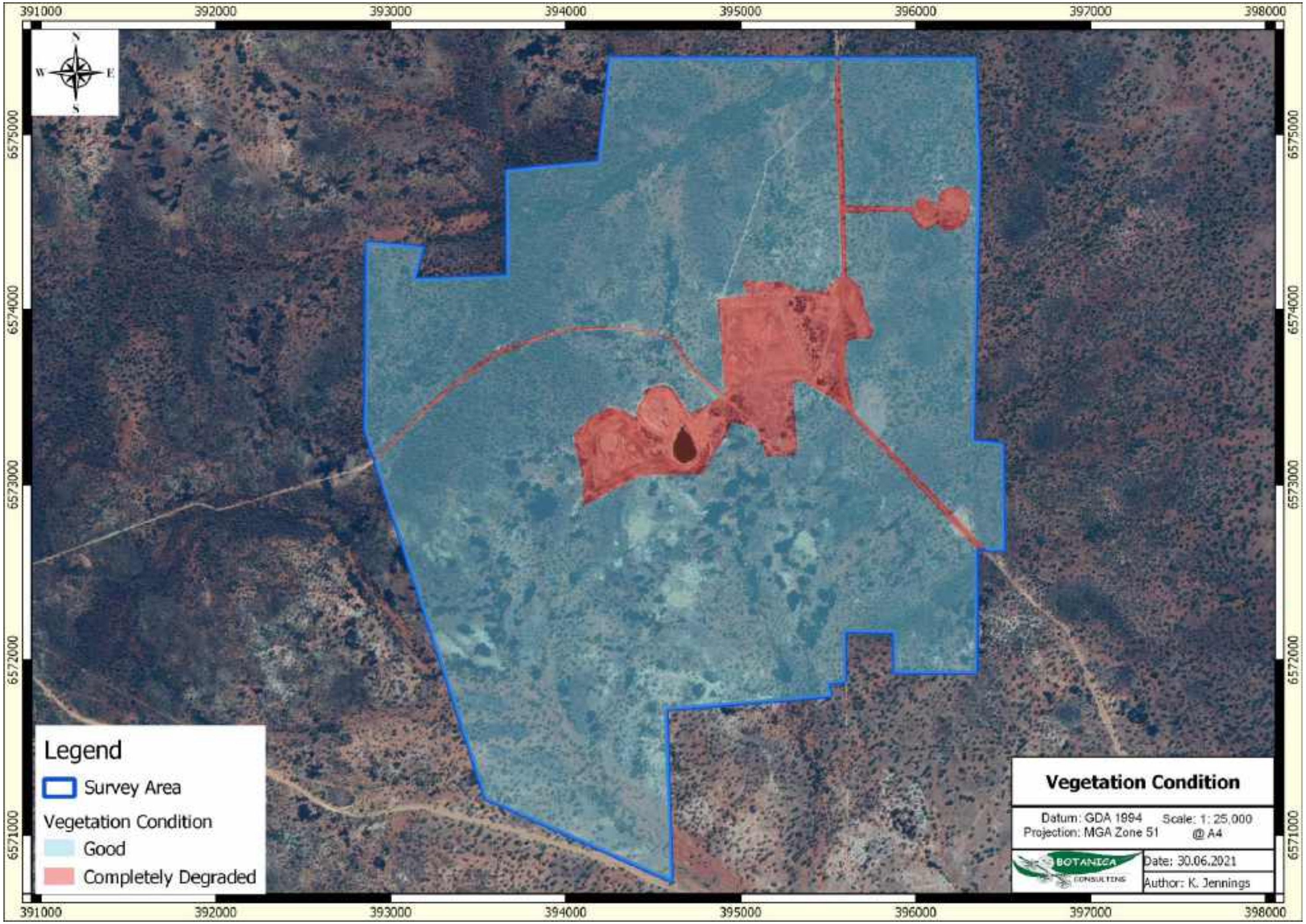


Figure 4-5: Vegetation Condition within the survey area

4.2.4 Significant Vegetation

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

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

No Threatened or Priority ecological communities or otherwise significant vegetation were identified within the survey area.

4.2.5 Fauna Habitat

Based on vegetation and associated landforms identified during the flora and vegetation assessment, three broad scale terrestrial fauna habitats were identified as occurring within the survey area. Table 4-9 provides a visual representation of this habitat type, and the extent of fauna habitat is shown spatially in Figure 4-6.

Table 4-9: Terrestrial Fauna Habitats within the survey area

Fauna Habitat	Example Image
Eucalyptus woodland on clay-loam plain Area: 629 ha (52.8%)	

Fauna Habitat	Example Image
Eucalyptus woodland on rocky slope Area: 414 ha (34.7%)	
Casuarina forest in drainage depression Area: 31 ha (2.6%)	

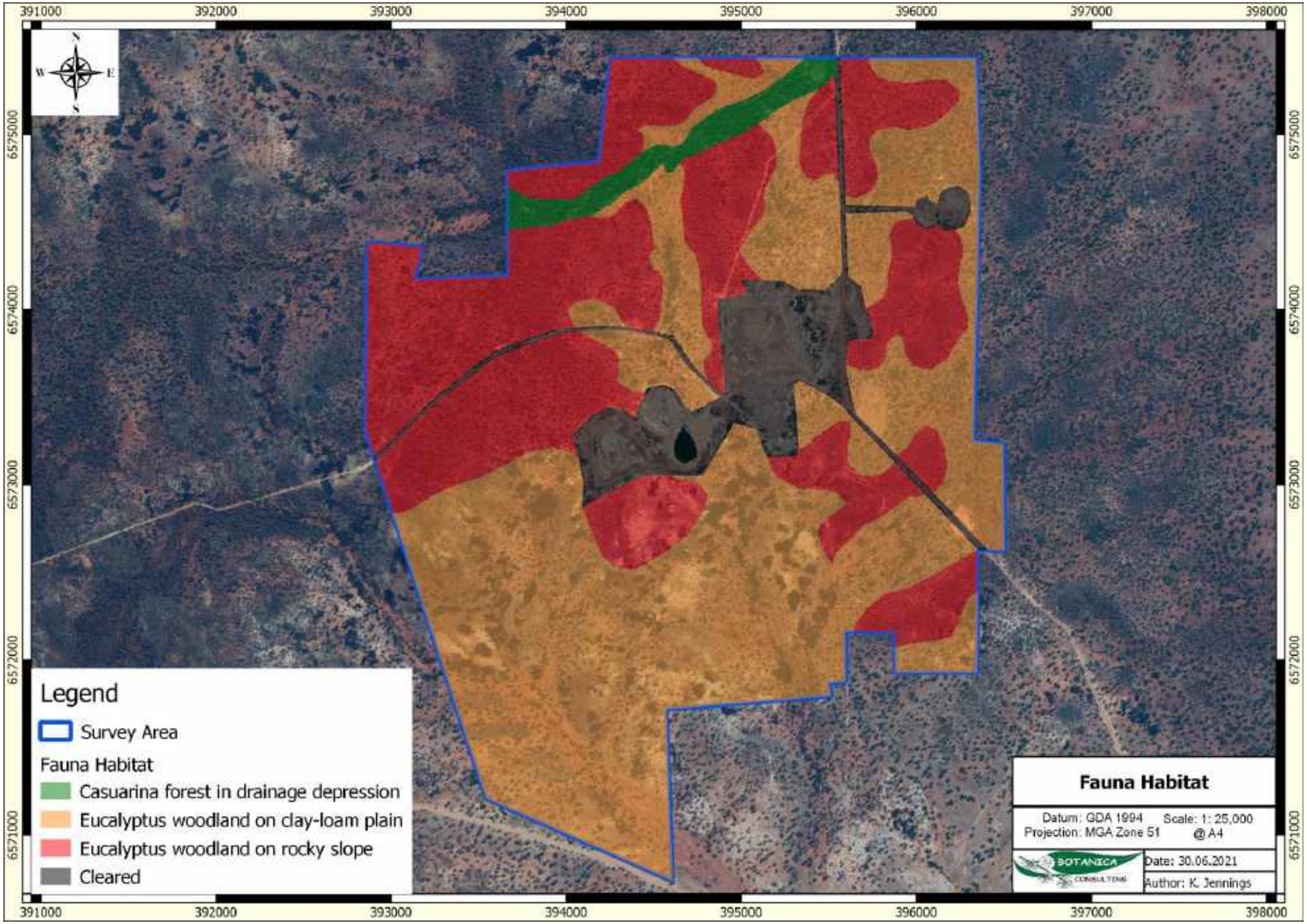


Figure 4-6: Terrestrial Fauna Habitats

4.2.6 Significant Fauna

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

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

No evidence of significant fauna species were observed during the survey, including no evidence of Malleefowl nesting mounds or other activity.

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

- **Malleefowl (*Leipoa ocellata)* - Vulnerable (EPBC Act and BC Act)**
  This species is occasionally recorded in the Eastern Goldfields subregion. Habitat appears marginal/or unsuitable for breeding, however occasional transients could potentially occur. No evidence of malleefowl activity (inactive or active mounds, tracks, feathers or bird observations etc.) were observed within the survey area. Significant impact unlikely.

- **Grey Falcon (*Falco hypoleucos)* - Vulnerable (EPBC Act and BC Act)**
  This species is sparsely recorded throughout inland Australia. Suitable habitat likely to be present but in unlikely to represent critical habitat. Significant impact unlikely.

It should be noted that while habitats onsite for one or more of the species listed above are considered possibly suitable, some or all may be marginal in extent/quality and therefore the fauna species considered as possibly occurring may in fact only visit the area for short periods as infrequent vagrants.

4.3 Matters of National Environmental Significance

4.3.1 *Environment Protection and Biodiversity Conservation Act 1999*

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

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

No matters of national environmental significance as defined by the Commonwealth EPBC Act were identified within the survey area.

4.4 Matters of State Environmental Significance

4.4.1 Environmental Protection Act WA 1986

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

Under Section 51C of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations (Regulations) WA 2004* any clearing of native vegetation in Western Australia that is not eligible for exemption under Schedule 6 of the *EP Act 1986* or under the Regulations 2004 requires a clearing permit from the DWER or DMIRS. Under Section 51A of the *EP Act 1986* native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent. Section 51A of the *EP Act 1986* defines clearing as "the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above". Exemptions under Schedule 6 of the EP Act and the EP Regulations do not apply in ESAs as declared under Section 51B of the EP Act or TEC listed under State and Commonwealth legislation.

No evidence of the survey area containing any TEC or Threatened flora or fauna was found during the survey period. The survey area is not located within an ESA.

4.4.2 Biodiversity Conservation Act 2016

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

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

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

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

4.5 Native Vegetation Clearing Principles

Based on the outcomes from the survey undertaken, Botanica assessed the results of the desktop and field survey with regards to the native vegetation clearing principles listed under Schedule 5 of the EP Act (Table 4-10). The assessment found that the proposed vegetation clearing activities may be at variance with clearing principle (f).

Table 4-10: Assessment against native vegetation clearing principles

Letter	Principle Native vegetation should not be cleared if it:	Assessment	Outcome
(a)	comprises a high level of biological diversity.	Vegetation identified within the survey area is not considered to be of high biological diversity and is well represented outside of the survey area. The survey area does not occur within any mapped Priority Ecological Communities (PECs), Threatened Ecological Communities (TECs) or associated buffer zones and does not contain any Banded Ironstone Formations. No Threatened Flora taxa listed under the BC Act and EPBC Act are located within the survey area. No Priority Flora taxa were identified within the survey area.	Clearing is unlikely to be at variance to this principle
(b)	comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	No significant fauna were observed within the survey area. No significant fauna habitat was observed within the survey area.	Clearing is unlikely to be at variance to this principle
(c)	includes, or is necessary for the continued existence of rare flora.	No Threatened Flora taxa, pursuant to the BC Act and the EPBC Act were identified within the survey area.	Clearing is not at variance to this principle

Letter	Principle Native vegetation should not be cleared if it:	Assessment	Outcome
(d)	comprises the whole or part of or is necessary for the maintenance of a threatened ecological community (TEC).	No TEC listed under the EPBC Act or by the BC Act occur within the survey area.	Clearing is not at variance to this principle
(e)	is significant as a remnant of native vegetation in an area that has been extensively cleared	All vegetation associations in the survey area retains >97% of their original pre-European vegetation extent.	Clearing is unlikely to be at variance to this principle
(f)	is growing, in, or in association with, an environment associated with a watercourse or wetland	Multiple minor ephemeral drainage lines intersect the survey area which were mostly associated with vegetation community DD-CF1, which accounts for 2.6% of the survey area.	Clearing may be at variance to this principle
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The survey area and surrounding region has not been extensively cleared. Clearing within the survey area is not considered likely to lead to land degradation issues such as salinity, water logging or acidic soils.	Clearing is unlikely to be at variance to this principle
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The survey area is not located within a proposed or vested conservation area. The closest conservation area is the Majestic Timber Reserve, which is DBCA-managed land located approximately 1 km north of the survey area. Disturbances within the survey area are unlikely to impact this area.	Clearing may be at variance to this principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	No surface water bodies are located within the survey area. Clearing in ephemeral drainage lines is unlikely to result in significant impacts to water quality.	Clearing is unlikely to be at variance to this principle
(j)	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding	Rainfall in the Eastern Goldfields subregion has an average rainfall of 200-300mm and an evaporation rate of 2400 mm. Rainfall data for Kalgoorlie-Boulder indicates that rainfall is spread throughout the year and rainfall events are unlikely to result in localised flooding. Clearing within the survey area is not likely to increase the incidence or intensity of flooding within the survey area or surrounds.	Clearing is unlikely to be at variance to this principle

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Appendix 1: Conservation Ratings BC Act and EPBC Act

Definitions of Conservation Significant Species

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

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

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

Definitions of Conservation Significant Communities

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

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

Appendix 2: Potentially Occurring Introduced (Weed) Flora Species

Family	Taxon	Common Name	WAOL Status	Control Category	WONS
Aizoaceae	*Mesembryanthemum crystallinum*	Iceplant	Permitted - s11	No Control Category	No
	Mesembryanthemum nodiflorum	Slender Iceplant	Permitted - s11	No Control Category	No
Asteraceae	*Carduus tenuiflorus*	Winged Slender Thistle	Permitted - s11	No Control Category	No
	Carthamus lanatus	Saffron Thistle	Permitted - s11	No Control Category	No
	Centaurea melitensis	Maltese Cockspur, Malta Thistle	Permitted - s11	No Control Category	No
	Gazania linearis		Permitted - s11	No Control Category	No
	Leontodon rhagadioloides		Permitted - s11	No Control Category	No
	Monoculus monstrosus		Permitted - s11	No Control Category	No
	Oligocarpus calendulaceus		Permitted - s11	No Control Category	No
	Oncosiphon suffruticosum	Calomba Daisy	Permitted - s11	No Control Category	No
	Sonchus oleraceus	Common Sowthistle	Permitted - s11	No Control Category	No
	Symphyotrichum squamatum	Bushy Starwort	Permitted - s11	No Control Category	No
	Dittrichia graveolens	Stinkwort	Permitted - s12	No Control Category	No
Boraginaceae	*Echium plantagineum*	Paterson's Curse	Declared Pest - s22(2)	No Control Category, Whole of State	No
	Heliotropium europaeum	Common Heliotrope	Permitted - s11	No Control Category	No
	Heliotropium supinum	Prostrate Heliotrope	Permitted - s11	No Control Category	No
Brassicaceae	*Alyssum linifolium*	Flax-leaf Alyssum	Permitted - s11	No Control Category	No
	Carrichtera annua	Ward's Weed	Permitted - s11	No Control Category	No
	Lepidium africanum	Rubble Peppercress	Permitted - s11	No Control Category	No
	Sisymbrium erysimoides	Smooth Mustard	Permitted - s11	No Control Category	No
	Sisymbrium irio	London Rocket	Permitted - s11	No Control Category	No
	Sisymbrium orientale	Indian Hedge Mustard	Permitted - s11	No Control Category	No
Cactaceae	*Cylindropuntia fulgida var. mamillata*		Declared Pest - s22(2)	C3 Management, Whole of State	Yes
Chenopodiaceae	*Chenopodium album*	Fat Hen	Permitted - s11	No Control Category	No
Crassulaceae	*Bryophyllum delagoense*		Permitted - s11	No Control Category	No
Cucurbitaceae	*Citrullus colocynthis*		Permitted - s11	No Control Category	No

Family	Taxon	Common Name	WAOL Status	Control Category	WONS
Fabaceae	*Medicago polymorpha*	Burr Medic	Permitted - s11	No Control Category	No
Geraniaceae	*Erodium cicutarium*	Common Storksbill	Permitted - s11	No Control Category	No
Lamiaceae	*Salvia verbenaca*	Wild Sage	Permitted - s11	No Control Category	No
Martyniaceae	*Proboscidea louisianica*	Purple Flower Devil's Claw	Permitted - s11	No Control Category	No
Papaveraceae	*Argemone ochroleuca* subsp. *ochroleuca*		Permitted - s11	No Control Category	No
Poaceae	*Bromus diandrus*	Great Brome	Permitted - s11	No Control Category	No
	Cenchrus ciliaris	Buffel Grass	Permitted - s11	No Control Category	No
	Cenchrus setaceus	Fountain Grass	Permitted - s11	No Control Category	No
	Hordeum glaucum	Northern Barley Grass	Permitted - s11	No Control Category	No
Polygonaceae	*Rumex vesicarius*	Ruby Dock	Permitted - s11	No Control Category	No
Primulaceae	*Lysimachia arvensis*	Pimpernel	Permitted - s11	No Control Category	No
Resedaceae	*Reseda luteola*	Wild Mingnonette	Permitted - s11	No Control Category	No
Solanaceae	*Nicotiana glauca*	Tree Tobacco	Permitted - s11	No Control Category	No
	Lycium ferocissimum	African Boxthorn	Permitted - s11	No Control Category	Yes
	Solanum nigrum	Deadly Nightshade	Permitted - s13	No Control Category	No
Verbenaceae	*Lantana camara*	Common Lantana	Declared Pest - s22(2)	C3 Management, Whole of State	Yes

Appendix 3: Significant Flora Likelihood Assessment

Taxon	Conservation Status	Habitat	Comments	Likelihood
Austrostipa sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)	P1	Rocky basalt hillslopes and crests.	Widespread but sparse records, habitat unlikely to be present.	Unlikely
Calandrinia lefroyensis		Red sandy loam soil. Saline flats, edge of salt lakes.	Outside known range, potential habitat likely marginal.	Unlikely
Cyathostemon divaricatus		Rocky hillslope. Red loam over laterite.	Outside known range, habitat unlikely to occur.	Unlikely
Eremophila arachnoides subsp. *tenera*		Flat calcareous plain.	Records within 5 km, habitat likely to be present.	Likely
Eremophila xantholaema		-	Occurs within regional context.	Possible
Eucalyptus websteriana subsp. *norsemanica*		Rocky rises.	Outside known range.	Unlikely
Ptilotus rigidus		Quartz and ironstone hillsides, outcrops. Near salt lakes.	Outside known range, habitat unlikely to occur.	Unlikely
Ricinocarpos digynus		Rocky hillslopes.	Outside known range, potential habitat likely marginal.	Unlikely
Tecticornia flabelliformis		Clay. Saline flats.	Outside known range, habitat unlikely to occur.	Unlikely
Eremophila praecox	P2	Red/brown sandy loam. Undulating plains.	Potential habitat may be present, occurs within regional context.	Possible
Melaleuca coccinea	P3	Sandy loam over granite. Granite outcrops, sandplain, river valleys.	Outside known range, habitat unlikely to occur.	Unlikely
Styphelia rectiloba		Granite outcrops and breakaways.	Outside known range, habitat unlikely to occur.	Unlikely
Eucalyptus kruseana	P4	Sandy loam. Granite outcrops & hills.	Outside known range, habitat unlikely to occur.	Unlikely
Eucalyptus x brachyphylla		Sandy loam. Granite outcrops.	Regional records, potential habitat may be present.	Possible
Sowerbaea multicaulis		Yellow-brown sand.	Outside known range, habitat unlikely to occur.	Unlikely

Appendix 4: Significant Fauna Likelihood Assessment

Taxon	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Night Parrot *Pezoporus occidentalis*	EN	CR	-	Most habitat records are of Triodia (Spinifex) grasslands and/or chenopod shrublands in the arid and semi-arid zones, or *Astrebla* spp. (Mitchell grass), shrubby samphire and chenopod associations, scattered trees and shrubs, *Acacia aneura* (Mulga) woodland, treeless areas and bare gibber are associated with sightings of the species. Roosting and nesting sites are consistently reported as within clumps of dense vegetation, primarily old and large Spinifex (*Triodia*) clumps, but sometimes other vegetation types (DAWE, 2020b).	Would not occur. Very marginal habitat.	Would Not Occur
Grey Falcon *Falco hypoleucos*	VU	VU	-	The Grey Falcon occurs at low densities across inland Australia. The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter. While breeding Grey Falcons feed almost exclusively on birds. Prey species include doves, pigeons, small parrots and cockatoos and finches, but a variety of other bird prey species has been recorded. Nonavian prey recorded by direct observation include small mammals and lizards.	Possibly Occurs. Survey area may form part of larger home range.	Possible
Malleefowl *Leipoa ocellata*	VU	VU	-	Scrublands and woodlands dominated by mallee and wattle species (DAWE, 2020b).	Possibly Occurs. Habitat likely marginal and unsuitable for breeding. Occasional transients only.	Possible
Fork-tailed Swift *Apus pacificus*	MI	MI	-	Low to very high airspace over varied habitat from rainforest to semi desert (Birdlife Australia, 2019).	Unlikely to occur. Very occasional transients only.	Unlikely
Migratory Shorebirds (Various species)	IA/MI	IA/MI	P3-P4	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland (DAWE, 2020b).	Habitat would not be present.	Would Not Occur
Grey Wagtail *Motacilla cinerea*	MI	MI	-	Running water in disused quarries, sandy, rocky streams in escarpments and rainforest, sewerage ponds, ploughed fields and airfields (Morecombe 2004).	Would Not Occur. No suitable habitat.	Would Not Occur

Taxon	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Thick-billed Grasswren (Western) *Amytornis textilis* subsp. *textilis*	-	-	P4	The western subspecies of the Thick-billed Grasswren occurs in semi-arid shrubland on coastal dunes, plains and drainage lines. In non-coastal areas, it occurs in fire-affected shrublands dominated by Ptilotus obovatus and Solanum orbiculatum following uncontrolled fires, low shrublands on calcareous sandplains, dominated by Acacia spp., Exocarpos spp., and other shrubs such as Thryptomene spp., and Ptilotus spp., mixed with hummocks of spinifex Triodia spp., and sometimes with Atriplex spp., and in dense thickets of Muehlenbeckia cunninghamii, Atriplex spp. and Eremophila spp. growing in drainage lines.	Potential habitat unlikely to occur or, if present, to represent critical habitat.	Unlikely
Chuditch, Western Quoll *Dasyurus geoffroii*	VU	VU	-	Previously occurred throughout arid and semi-arid Australia but is now restricted to south-west Western Australia. (DAWE, 2020b).	Unlikely to Occur. Considered to be locally extinct.	Unlikely
Western Spiny-tailed Skink *Egernia stokesii* subsp. *badia*	EN	EN	-	The Western Spiny-tailed Skink is known to occur in a broad semi-arid area in south-west WA, between Shark Bay and Minnivale and east to Cue. Most records of the brown form Western Spiny-tailed Skink are in York Gum (Eucalyptus loxophleba) woodland with some records in Gimlet (E. salubris) and Salmon Gum (E. salmonophloia) woodland. Populations persist in woodland patches as small as one hectare and completely surrounded by wheatfields. Sites with the greatest number of individuals contain numerous fallen logs and were subjected to low-intensity grazing by domestic stock. Hollow logs are used as refuge sites in woodland habitat . Preferred refuges consist of piles of several, overlapping, hollow logs providing a combination of basking and shelter sites. An increasing number of skinks are being located in altered habitat under piles of wood, scrap metal or under buildings on private property (SPRAT, 2020).	Potential habitat may occur, but likely to be considered marginal. Not widely recorded in region.	Unlikely

Appendix 5: List of species identified within each vegetation type

(A) blue text-denotes annual taxa; (W) green text-denotes introduced taxa (WAHERB, 2021)

Family	Taxon	DD-CF1	CLP-EW1	CLP-EW2	RS-EW1	RS-EW2
Amaranthaceae	*Ptilotus exaltatus (A)*		*			
	Ptilotus helichrysoides					*
	Ptilotus obovatus	*	*	*		
Asteraceae	*Centaurea melitensis (W)*	*				
	Dittrichia graveolens (W)	*				
	Olearia muelleri				*	*
	Oligocarpus calendulaceus (W)	*				
Boraginaceae	*Halgania andromedifolia*				*	
Casuarinaceae	*Casuarina pauper*	*	*		*	
Chenopodiaceae	*Atriplex codonocarpa (A)*				*	
	Atriplex nummularia		*		*	
	Dissocarpus paradoxus					
	Enchylaena tomentosa		*			
	Eriochiton sclerolaenoides		*		*	
	Maireana georgei		*	*		
	Maireana oppositifolia		*			
	Maireana pentatropis				*	
	Maireana pyramidata		*		*	
	Maireana sedifolia		*		*	
	Maireana triptera	*	*	*	*	
	Melaleuca sheathiana		*		*	*
	Rhagodia eremaea		*			
	Salsola australis (A)				*	
	Sclerolaena diacantha		*		*	
	Sclerolaena eriacantha		*			
	Sclerolaena parvifolia		*		*	
	Tecticornia disarticulata				*	
Fabaceae	*Acacia sp. narrow phyllode*				*	*
	Acacia tetragonophylla	*				
	Senna artemisioides subsp. *filifolia*	*	*		*	
	Swainsona canescens				*	
Geraniaceae	*Erodium crinitum*					
Goodeniaceae	*Scaevola spinescens*					*
Lamiaceae	*Salvia verbenaca (W)*	*				
Malvaceae	*Sida calyxhymenia*					
Myrtaceae	*Eucalyptus celastroides*			*	*	*
	Eucalyptus ewartiana					
	Eucalyptus gracilis	*				
	Eucalyptus griffithsii		*			
	Eucalyptus lesouefii		*		*	
	Eucalyptus ravida			*	*	
	Eucalyptus salmonophloia			*	*	
	Eucalyptus salubris	*			*	
	Eucalyptus stricklandii				*	*
	Eucalyptus transcontinentalis				*	
Nitrariaceae	*Nitraria billardierei*				*	
Pittosporaceae	*Pittosporum angustifolium*	*			*	

Family	Taxon	DD-CF1	CLP-EW1	CLP-EW2	RS-EW1	RS-EW2
Poaceae	*Austrostipa nitida*		*			
	Grevillea nematophylla					*
Santalaceae	*Exocarpos aphyllus*	*			*	*
	Santalum acuminatum			*		*
	Santalum spicatum	*				*
Sapindaceae	*Alectryon oleifolius*					
	Dodonaea lobulata		*			
	Dodonaea microzyga					
Scrophulariaceae	*Eremophila alternifolia*	*				
	Eremophila angustifolia		*	*	*	
	Eremophila clarkei					
	Eremophila decipiens	*				
	Eremophila glabra				*	
	Eremophila interstans		*	*	*	
	Eremophila scoparia		*	*	*	
Solanaceae	*Lycium australis*				*	
	Nicotiana glauca (W)			*		
	Solanum nigrum (W)	*				
	Solanum lasiophyllum					
Zygophyllaceae	*Roepera eremaea (A)*		*			

Appendix 6: Vegetation Condition Rating

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

Appendix 7: NatureMap Species List (40km buffer)

NatureMap Species Report

Created By Guest user on 24/11/2020

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	121° 54' 13" E,30° 57' 50" S
Buffer	40km
Group By	Family

Family	Species	Records
Acanthizidae	7	302
Acarosporaceae	3	3
Accipitridae	4	25
Aegothelidae	1	12
Agamidae	9	71
Agaricaceae	1	1
Aizoaceae	5	6
Amaranthaceae	6	11
Anatidae	9	67
Apocynaceae	2	3
Araneidae	1	2
Ardeidae	1	1
Artamidae	3	30
Asparagaceae	1	1
Asphodelaceae	1	4
Asteraceae	36	62
Boidae	1	3
Boraginaceae	6	8
Bothriuridae	1	3
Bovidae	2	3
Branchipodidae	1	1
Brassicaceae	10	15
Burramyidae	1	32
Buthidae	1	6
Cacatuidae	1	4
Cactaceae	1	2
Campephagidae	2	31
Caprimulgidae	1	3
Carphodactylidae	1	2
Caryophyllaceae	1	1
Casuariidae	1	31
Casuarinaceae	2	9
Celastraceae	1	1
Centropagidae	1	1
Charadriidae	4	8
Chenopodiaceae	43	129
Cladoniaceae	1	1
Colchicaceae	1	1
Collemataceae	2	5
Columbidae	4	43
Convolvulaceae	2	2
Corvidae	2	82
Cracticidae	4	140
Crassulaceae	1	2
Cuculidae	3	7
Cucurbitaceae	1	1
Cupressaceae	1	2
Cyperaceae	2	2
Daphniidae	1	6
Dasyuridae	7	134
Dicaeidae	1	6
Dicruridae	3	44
Dilleniaceae	1	1
Diplodactylidae	7	155
Elapidae	13	83
Estrilidae	1	6
Euphorbiaceae	5	5
Fabaceae	41	68
Falconidae	3	26
Felidae	1	3
Frankeniaceae	7	10
Garypidae	3	7
Gekkonidae	4	138
Geraniaceae	2	3
Goodeniaceae	6	7
Graphidaceae	3	6
Gyrostemonaceae	1	1
Halcyonidae	1	4
Haloragaceae	4	6
Hirundinidae	4	44
Icmadophilaceae	1	1
Idiopidae	1	1
Lamiaceae	7	11
Lamponidae	1	1
Leporidae	1	18
Limnodynastidae	2	20
Loranthaceae	3	9

Lycosidae	5	43
Macropodidae	1	12
Maluridae	4	64
Malvaceae	10	18
Martyniaceae	1	1
Megalosporaceae	2	5
Megapodiidae	1	14
Meliphagidae	10	530
Meropidae	1	22
Molluginaceae	1	1
Montiaceae	3	4
Muridae	3	161
Myrtaceae	33	129
Nemesiidae	2	3
Neosittidae	1	3
Nicodamidae	1	2
Orchidaceae	1	1
Pachycephalidae	4	148
Papaveraceae	1	1
Pardalotidae	3	107
Parmeliaceae	23	37
Petroicidae	5	52
Phalacrocoracidae	3	8
Phasianidae	1	2
Physciaceae	1	1
Pittosporaceae	1	3
Plantaginaceae	1	4
Poaceae	21	25
Podargidae	1	5
Podicipedidae	2	18
Polygonaceae	2	4
Pomatostomidae	1	25
Pottiaceae	1	1
Primulaceae	1	2
Proteaceae	7	12
Psittacidae	3	57
Psoraceae	2	8
Pteridaceae	1	1
Pygopodidae	4	14
Rallidae	2	7
Recurvirostridae	2	6
Resedaceae	1	1
Rhamnaceae	2	2
Ruppiaceae	1	1
Rutaceae	1	1
Salticidae	1	1
Santalaceae	2	3
Sapindaceae	4	12
Scincidae	24	235
Scolopacidae	3	3
Scolopendridae	2	7
Scrophulariaceae	25	63
Scutigeridae	1	1
Solanaceae	8	11
Sparassidae	1	1
Tachyglossidae	1	5
Teloschistaceae	3	4
Theridiidae	1	2
Thymelaeaceae	1	1
Triopsidae	1	4
Trochanteriidae	1	1
Turnicidae	1	1
Typhaceae	1	1
Urodacidae	1	14
Ustilaginaceae	1	1
Varanidae	2	17
Verbenaceae	1	1
Vespertilionidae	7	23
Violaceae	1	1
Zosteropidae	1	2
Zygophyllaceae	3	3
TOTAL	**607**	**3990**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Acanthizidae					
1.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
2.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
3.	24264	*Acanthiza robustirostris (Slaty-backed Thornbill)*			
4.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
5.	25528	*Aphelocephala leucopsis (Southern Whiteface)*			
6.	24278	*Pyrrholaemus brunneus (Redthroat)*			
7.	30948	*Smicrornis brevirostris (Weebill)*			
Acarosporaceae					
8.	27574	*Acarospora citrina*			
9.	27576	*Acarospora nodulosa*			
10.	28195	*Acarospora nodulosa var. reagens*			
Accipitridae					
11.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
12.	25536	*Accipiter fasciatus (Brown Goshawk)*			
13.	24285	*Aquila audax (Wedge-tailed Eagle)*			
14.		*Elanus axillaris*			
Aegothelidae					
15.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
Agamidae					
16.	25458	*Ctenophorus caudicinctus (Ring-tailed Dragon)*			
17.	24871	*Ctenophorus cristatus (Bicycle Dragon)*			
18.	24873	*Ctenophorus fordi (Mallee Sand Dragon)*			
19.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
20.	24888	*Ctenophorus salinarum (Salt Pan Dragon)*			
21.	24904	*Moloch horridus (Thorny Devil)*			
22.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
23.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
24.	30814	*Tympanocryptis cephalus (Pebble Dragon)*			
Agaricaceae					
25.	38765	*Battarrea stevenii*			
Aizoaceae					
26.	11681	*Disphyma crassifolium subsp. clavellatum*			
27.	2807	*Gunniopsis quadrifida (Sturts Pigface)*			
28.	2813	*Mesembryanthemum crystallinum (Iceplant)*	Y		
29.	2814	*Mesembryanthemum nodiflorum (Slender Iceplant)*	Y		
30.	2822	*Tetragonia eremaea*			
Amaranthaceae					
31.	2707	*Ptilotus carlsonii*			
32.	2721	*Ptilotus exaltatus (Tall Mulla Mulla)*			
33.	2732	*Ptilotus holosericeus*			
34.	2747	*Ptilotus obovatus (Cotton Bush)*			
35.	31252	*Ptilotus rigidus*		P1	
36.	43203	*Surreya diandra*			
Anatidae					
37.	24312	*Anas gracilis (Grey Teal)*			
38.	24315	*Anas rhynchotis (Australasian Shoveler)*			
39.	24316	*Anas superciliosa (Pacific Black Duck)*			
40.	24318	*Aythya australis (Hardhead)*			
41.	24319	*Biziura lobata (Musk Duck)*			
42.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
43.	24322	*Cygnus atratus (Black Swan)*			
44.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
45.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
Apocynaceae					
46.	12949	*Marsdenia australis*			
47.	48986	*Vincetoxicum lineare*			
Araneidae					
48.		*Araneus senicaudatus*			
Ardeidae					
49.		*Egretta novaehollandiae*			

NatureMap
Mapping Western Australia's biodiversity

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Artamidae					
50.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
51.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
52.	24356	*Artamus personatus (Masked Woodswallow)*			
Asparagaceae					
53.	1338	*Thysanotus manglesianus (Fringed Lily)*			
Asphodelaceae					
54.	1366	*Bulbine semibarbata (Leek Lily)*			
Asteraceae					
55.	7836	*Angianthus tomentosus (Camel-grass)*			
56.	7846	*Asteridea athrixioides*			
57.	7847	*Asteridea chaetopoda*			
58.	7880	*Brachyscome lineariloba*			
59.	7905	*Calotis multicaulis (Many-stemmed Burr-daisy)*			
60.	7910	*Carduus tenuiflorus (Slender Thistle, Winged Slender Thistle, Sheep Thistle)*	Y		
61.	7911	*Carthamus lanatus (Saffron Thistle)*	Y		
62.	7916	*Centaurea melitensis (Maltese Cockspur, Malta Thistle)*	Y		
63.	7922	*Cephalipterum drummondii (Pompom Head)*			
64.	7949	*Cratystylis conocephala (Greybush)*			
65.	7950	*Cratystylis microphylla (Small-leaved Grey Bush)*			
66.	7951	*Cratystylis subspinescens (Australian Sage, Spiny Grey Bush)*			
67.	12720	*Erymophyllum glossanthus*			
68.	16311	*Gazania linearis*	Y		
69.	12743	*Hyalosperma glutinosum*			
70.	15447	*Hyalosperma glutinosum subsp. glutinosum*			
71.	8087	*Isoetopsis graminifolia (Cushion Grass)*			
72.	12628	*Lemooria burkittii*			
73.	44490	*Leontodon rhagadioloides*	Y		
74.	8107	*Minuria cunninghamii (Bush Minuria)*			
75.	29418	*Monoculus monstrosus*	Y		
76.	8140	*Olearia muelleri (Goldfields Daisy)*			
77.	19828	*Oligocarpus calendulaceus*	Y		
78.	20661	*Oncosiphon suffruticosum (Calomba Daisy)*	Y		
79.	8173	*Podolepis capillaris (Wiry Podolepis)*			
80.	8192	*Pterocaulon sphacelatum (Apple Bush, Fruit Salad Plant)*			
81.	13241	*Rhodanthe chlorocephala subsp. rosea*			
82.	13301	*Rhodanthe floribunda*			
83.	13254	*Rhodanthe stricta*			
84.	8200	*Schoenia cassiniana (Schoenia)*			
85.	8207	*Senecio glossanthus (Slender Groundsel)*			
86.	25881	*Senecio lacustrinus*			
87.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
88.	8238	*Streptoglossa liatroides*			
89.	25902	*Symphyotrichum squamatum (Bushy Starwort)*	Y		
90.	12652	*Trichanthodium skirrophorum*			
Boidae					
91.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
Boraginaceae					
92.	6681	*Echium plantagineum (Paterson's Curse)*	Y		
93.	29840	*Halgania cyanea var. Allambi Stn (B.W. Strong 676)*			
94.	31117	*Halgania cyanea var. Charleville (R.W. Purdie +111)*			
95.	6707	*Heliotropium curassavicum (Smooth Heliotrope)*			
96.	6710	*Heliotropium europaeum (Common Heliotrope)*	Y		
97.	6717	*Heliotropium supinum (Prostrate Heliotrope)*	Y		Y
Bothriuridae					
98.		*Cercophonius michaelseni*			
Bovidae					
99.	24251	*Bos taurus (European Cattle)*	Y		
100.	24253	*Capra hircus (Goat)*	Y		
Branchipodidae					
101.		*Parartemia veronicae*			Y
Brassicaceae					
102.	2990	*Alyssum linifolium (Flax-leaf Alyssum)*	Y		
103.	2992	*Arabidella trisecta*			
104.	3008	*Carrichtera annua (Ward's Weed)*	Y		
105.	3018	*Lepidium africanum (Rubble Peppercress)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
			Y		
106.	3033	*Lepidium oxytrichum*			
107.	3069	*Sisymbrium erysimoides (Smooth Mustard)*	Y		
108.	3070	*Sisymbrium irio (London Rocket)*	Y		
109.	3072	*Sisymbrium orientale (Indian Hedge Mustard)*	Y		
110.	3076	*Stenopetalum filifolium*			
111.	3079	*Stenopetalum pedicellare*			

Burramyidae

112.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			

Buthidae

113.		*Isometroides vescus*			

Cacatuidae

114.		*Eolophus roseicapillus*			

Cactaceae

115.	20759	*Cylindropuntia fulgida var. mamillata*	Y		

Campephagidae

116.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
117.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			

Caprimulgidae

118.	24368	*Eurostopodus argus (Spotted Nightjar)*			

Carphodactylidae

119.	24966	*Nephrurus laevissimus*			

Caryophyllaceae

120.	8900	*Spergularia marina*			

Casuariidae

121.	24470	*Dromaius novaehollandiae (Emu)*			

Casuarinaceae

122.	1730	*Allocasuarina helmsii*			
123.	12658	*Casuarina pauper (Black Oak)*			

Celastraceae

124.	29813	*Stackhousia sp. Mt Keith (G. Cockerton & G. O'Keefe 11017)*			

Centropagidae

125.		*Calamoecia sp.*			

Charadriidae

126.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
127.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
128.	48135	*Thinornis rubricollis (Hooded Plover, Hooded Dotterel)*		P4	
129.	24386	*Vanellus tricolor (Banded Lapwing)*			

Chenopodiaceae

130.	2449	*Atriplex acutibractea (Toothed Saltbush)*			
131.	11435	*Atriplex acutibractea subsp. acutibractea*			
132.	2450	*Atriplex amnicola (Swamp Saltbush)*			
133.	2453	*Atriplex codonocarpa (Flat-topped Saltbush)*			
134.	2455	*Atriplex eardleyae*			
135.	2459	*Atriplex holocarpa (Pop Saltbush)*			
136.	2468	*Atriplex nana*			
137.	11516	*Atriplex nummularia subsp. spathulata (Old Man Saltbush)*			
138.	2475	*Atriplex semibaccata (Berry Saltbush)*			
139.	2479	*Atriplex stipitata (Mallee Saltbush)*			
140.	2481	*Atriplex vesicaria (Bladder Saltbush)*			
141.	2483	*Chenopodium album (Fat Hen)*	Y		
142.	2487	*Chenopodium curvispicatum*			
143.	2498	*Didymanthus roei*			
144.	2502	*Dysphania kalpari (Rat's Tail, Kalpari)*			
145.	2514	*Eriochiton sclerolaenoides (Woolly Bindii)*			
146.	2533	*Maireana amoena*			
147.	2535	*Maireana appressa*			
148.	2542	*Maireana erioclada*			
149.	2545	*Maireana glomerifolia (Ball Leaf Bluebush)*			
150.	2553	*Maireana oppositifolia*			
151.	2555	*Maireana pentatropis*			
152.	2557	*Maireana platycarpa (Shy Bluebush)*			
153.	2568	*Maireana trichoptera (Downy Bluebush)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
154.	2581	*Rhagodia drummondii*			
155.	2599	*Sclerolaena brevifolia*			
156.	2609	*Sclerolaena diacantha (Grey Copperburr)*			
157.	2610	*Sclerolaena drummondii*			
158.	2612	*Sclerolaena eurotioides (Fluffy Bindii)*			
159.	2625	*Sclerolaena obliquicuspis (Limestone Bindii)*			
160.	2641	*Tecticornia arborea (Bulli Bulli)*			
161.	31719	*Tecticornia chartacea*			
162.	31492	*Tecticornia disarticulata*			
163.	46513	*Tecticornia doliiformis*			
164.	31834	*Tecticornia flabelliformis*		P1	
165.	33319	*Tecticornia indica subsp. bidens*			
166.	31674	*Tecticornia peltata*			
167.	33297	*Tecticornia pergranulata subsp. pergranulata (Blackseed Samphire)*			
168.	31618	*Tecticornia pruinosa*			
169.	33218	*Tecticornia pterygosperma subsp. pterygosperma*			
170.	31716	*Tecticornia syncarpa*			
171.	31494	*Tecticornia triandra (Desert Glasswort)*			
172.	31717	*Tecticornia undulata*			
Cladoniaceae					
173.	48176	*Cladia beaugleholei*			
Colchicaceae					
174.	1403	*Wurmbea tenella (Eight Nancy)*			
Collemataceae					
175.	27703	*Collema coccophorum*			
176.	48194	*Collema novozelandicum*			
Columbidae					
177.	24399	*Columba livia (Domestic Pigeon)*	Y		
178.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
179.	24409	*Phaps chalcoptera (Common Bronzewing)*			
180.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
Convolvulaceae					
181.	6614	*Convolvulus remotus*			
182.	6659	*Wilsonia humilis (Silky Wilsonia)*			
Corvidae					
183.	24416	*Corvus bennetti (Little Crow)*			
184.	25592	*Corvus coronoides (Australian Raven)*			
Cracticidae					
185.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
186.	25595	*Cracticus tibicen (Australian Magpie)*			
187.	25596	*Cracticus torquatus (Grey Butcherbird)*			
188.	25597	*Strepera versicolor (Grey Currawong)*			
Crassulaceae					
189.	19376	*Bryophyllum delagoense*	Y		
Cuculidae					
190.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
191.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
192.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
Cucurbitaceae					
193.	7369	*Citrullus colocynthis*	Y		
Cupressaceae					
194.	8466	*Callitris columellaris (White Cypress Pine)*			
Cyperaceae					
195.	765	*Chrysitrix distigmatosa*			
196.	34969	*Eleocharis acutangula*			Y
Daphniidae					
197.		*Daphnia carinata*			
Dasyuridae					
198.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
199.	24094	*Ningaui ridei (Wongai Ningaui)*			
200.	24108	*Sminthopsis crassicaudata (Fat-tailed Dunnart)*			
201.	24109	*Sminthopsis dolichura (Little long-tailed Dunnart)*			
202.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
203.		*Sminthopsis murina*			
204.	24117	*Sminthopsis ooldea (Ooldea Dunnart)*			

Dicaeidae

205.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			

Dicruridae

206.	24443	*Grallina cyanoleuca (Magpie-lark)*			
207.	48096	*Rhipidura albiscapa (Grey Fantail)*			
208.	25614	*Rhipidura leucophrys (Willie Wagtail)*			

Dilleniaceae

209.	19692	*Hibbertia ancistrophylla*			

Diplodactylidae

210.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
211.	25469	*Diplodactylus granariensis*			
212.	24940	*Diplodactylus pulcher*			
213.	30938	*Lucasium damaeum*			
214.	30935	*Lucasium maini*			
215.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
216.	24923	*Strophurus assimilis (Goldfields Spiny-tailed Gecko)*			

Elapidae

217.	25247	*Demansia psammophis subsp. psammophis (Yellow-faced Whipsnake)*			
218.	25251	*Echiopsis curta (Bardick)*			
219.	25301	*Furina ornata (Moon Snake)*			
220.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
221.	25253	*Parasuta gouldii*			
222.	25254	*Parasuta monachus*			
223.	25261	*Pseudechis australis (Mulga Snake)*			
224.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
225.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
226.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
227.	25264	*Pseudonaja nuchalis (Gwardar, Northern Brown Snake)*			
228.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
229.	25269	*Suta fasciata (Rosen's Snake)*			

Estrilidae

230.	30870	*Taeniopygia guttata (Zebra Finch)*			

Euphorbiaceae

231.	4598	*Beyeria lechenaultii (Pale Turpentine Bush)*			
232.	4626	*Euphorbia drummondii (Caustic Weed, Piwi)*			
233.	12097	*Euphorbia tannensis subsp. eremophila (Desert Spurge)*			
234.	19587	*Monotaxis grandiflora var. obtusifolia*			
235.	45075	*Ricinocarpos sp. Eastern Goldfields (A. Williams 3)*		P1	

Fabaceae

236.	3200	*Acacia acuminata (Jam, Mangard)*			
237.	3217	*Acacia aneura (Mulga, Wanari)*			
238.	37260	*Acacia aptaneura*			
239.	3248	*Acacia burkittii (Sandhill Wattle)*			
240.	44514	*Acacia collegialis*			
241.	16120	*Acacia donaldsonii*			
242.	3324	*Acacia erinacea*			
243.	3366	*Acacia hemiteles*			
244.	16164	*Acacia inceana subsp. inceana*			
245.	3393	*Acacia jennerae*			
246.	14610	*Acacia kalgoorliensis*			
247.	13503	*Acacia masliniana*			
248.	36416	*Acacia mulganeura*			
249.	3452	*Acacia murrayana (Sandplain Wattle)*			
250.	3463	*Acacia nyssophylla*			
251.	3473	*Acacia oswaldii (Miljee, Nelia)*			
252.	3495	*Acacia prainii (Prain's Wattle)*			
253.	16145	*Acacia resinosa*			
254.		*Acacia sp.*			
255.	3599	*Acacia warramaba*			
256.	16157	*Acacia xerophila var. brevior*			
257.	13114	*Chorizema racemosum*			
258.	17417	*Cullen discolor*			
259.	8977	*Daviesia aphylla*			
260.	3802	*Daviesia croniniana*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
261.	3813	*Daviesia grahamii*			
262.	3943	*Glycyrrhiza acanthocarpa (Native Liquorice)*			
263.	14779	*Jacksonia arida*			
264.	4079	*Medicago polymorpha (Burr Medic)*	Y		
265.	4089	*Mirbelia depressa*			
266.	4094	*Mirbelia microphylla*			
267.	17645	*Senna artemisioides*			
268.	12276	*Senna artemisioides subsp. filifolia*			
269.	12315	*Senna pleurocarpa var. angustifolia*			
270.	18446	*Senna stowardii*			
271.	12355	*Swainsona affinis*			
272.	4217	*Swainsona beasleyana*			
273.	4220	*Swainsona canescens (Grey Swainsona)*			
274.	4221	*Swainsona colutoides (Bladder Vetch)*			
275.	4231	*Swainsona kingii*			
276.	35841	*Templetonia incrassata*			

Falconidae

277.	25621	*Falco berigora (Brown Falcon)*			
278.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
279.	25623	*Falco longipennis (Australian Hobby)*			

Felidae

280.	24041	*Felis catus (Cat)*	Y		

Frankeniaceae

281.	5191	*Frankenia cinerea*			
282.	5197	*Frankenia desertorum*			
283.	5204	*Frankenia interioris*			
284.	11592	*Frankenia interioris var. interioris*			
285.	11969	*Frankenia interioris var. parviflora*			
286.	5209	*Frankenia pauciflora (Seaheath)*			
287.	5212	*Frankenia setosa (Bristly Frankenia)*			

Garypidae

288.		*Synsphyronus dorothyae*			
289.		*Synsphyronus lathrius*			
290.		*Synsphyronus mimulus*			

Gekkonidae

291.	24957	*Gehyra purpurascens*			
292.	24959	*Gehyra variegata*			
293.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
294.	24983	*Underwoodisaurus milii (Barking Gecko)*			

Geraniaceae

295.	4333	*Erodium cicutarium (Common Storksbill)*	Y		
296.	4335	*Erodium cygnorum (Blue Heronsbill)*			

Goodeniaceae

297.	7419	*Coopernookia strophiolata*			
298.	13155	*Dampiera latealata*			
299.	7477	*Dampiera stenostachya (Narrow-spiked Dampiera)*			
300.	7514	*Goodenia havilandii*			
301.	7527	*Goodenia mimuloides*			
302.	7644	*Scaevola spinescens (Currant Bush, Maroon)*			

Graphidaceae

303.	27723	*Diploschistes scruposus*			
304.	27725	*Diploschistes thunbergianus*			
305.	44221	*Xalocoa ocellata*			

Gyrostemonaceae

306.	2778	*Codonocarpus cotinifolius (Native Poplar, Kundurangu)*			

Halcyonidae

307.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			

Haloragaceae

308.	33620	*Glischrocaryon angustifolium*			
309.	11801	*Gonocarpus confertifolius var. helmsii*			
310.	6174	*Haloragis gossei*			
311.	6180	*Haloragis trigonocarpa*			

Hirundinidae

312.	47909	*Cheramoeca leucosterna (White-backed Swallow)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
313.	24491	*Hirundo neoxena (Welcome Swallow)*			
314.	48060	*Petrochelidon ariel (Fairy Martin)*			
315.	48061	*Petrochelidon nigricans (Tree Martin)*			
Icmadophilaceae					
316.	28060	*Siphula coriacea*			
Idiopidae					
317.		*Anidiops villosus*			
Lamiaceae					
318.	6751	*Cyanostegia microphylla (Tinsel Flower)*			
319.	6771	*Dicrastylis parvifolia*			
320.	17206	*Physopsis viscida*			
321.	15822	*Prostanthera althoferi subsp. althoferi*			
322.	6917	*Prostanthera incurvata*			
323.	6929	*Salvia verbenaca (Wild Sage)*	Y		
324.	9247	*Westringia rigida (Stiff Westringia)*			
Lamponidae					
325.		*Asadipus phaleratus*			
Leporidae					
326.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
Limnodynastidae					
327.	25425	*Neobatrachus kunapalari (Kunapalari Frog)*			
328.	25427	*Neobatrachus sutor (Shoemaker Frog)*			
Loranthaceae					
329.	2369	*Amyema benthamii*			
330.	2380	*Amyema miquelii (Stalked Mistletoe)*			
331.	2383	*Amyema preissii (Wireleaf Mistletoe)*			
Lycosidae					
332.		*Hoggicosa castanea*			
333.		*Hoggicosa storri*			
334.		*Hogna salifodina*			
335.		*Mainosa longipes*			
336.		*Tasmanicosa leuckartii*			
Macropodidae					
337.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
Maluridae					
338.	24541	*Amytornis textilis subsp. textilis (Western Grasswren, Thick-billed Grasswren (western))*		P4	
339.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
340.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
341.	25654	*Malurus splendens (Splendid Fairy-wren)*			
Malvaceae					
342.	4999	*Brachychiton gregorii (Desert Kurrajong, Ngalta)*			
343.	4955	*Lawrencia glomerata*			
344.	4956	*Lawrencia helmsii (Dunna Dunna)*			
345.	4957	*Lawrencia repens*			
346.	4959	*Lawrencia squamata*			
347.	31351	*Malva preissiana*			
348.	4964	*Radyera farragei (Knobby Hibiscus)*			
349.	4970	*Sida calyxhymenia (Tall Sida)*			
350.	4981	*Sida intricata (Tangled Sida)*			
351.	16924	*Sida spodochroma*			
Martyniaceae					
352.	7121	*Proboscidea louisianica (Purple Flower Devil's Claw)*	Y		
Megalosporaceae					
353.	27587	*Aspicilia calcarea*			
354.		*Aspicilia sp.*			
Megapodiidae					
355.	24557	*Leipoa ocellata (Malleefowl)*		T	
Meliphagidae					
356.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
357.	24561	*Anthochaera carunculata (Red Wattlebird)*			
358.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
359.	24567	*Epthianura albifrons (White-fronted Chat)*			

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360.	24570	*Epthianura tricolor (Crimson Chat)*			
361.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
362.	25661	*Lichmera indistincta (Brown Honeyeater)*			
363.	24583	*Manorina flavigula (Yellow-throated Miner)*			
364.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
365.	42344	*Purnella albifrons (White-fronted Honeyeater)*			

Meropidae

366.	24598	*Merops ornatus (Rainbow Bee-eater)*			

Molluginaceae

367.	48203	*Hypertelis cerviana*			

Montiaceae

368.	48774	*Calandrinia lefroyensis*		P1	
369.	2860	*Calandrinia polyandra (Parakeelya)*			
370.	30396	*Calandrinia translucens*			

Muridae

371.	24223	*Mus musculus (House Mouse)*	Y		
372.	24232	*Pseudomys bolami (Bolam's Mouse)*			
373.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			

Myrtaceae

374.	44082	*Cyathostemon divaricatus*		P1	
375.	35618	*Darwinia sp. Karonie (K. Newbey 8503)*			
376.	14300	*Eucalyptus celastroides subsp. celastroides (Mirret)*			
377.	5588	*Eucalyptus ceratocorys*			
378.	5665	*Eucalyptus griffithsii (Griffith's Grey Gum)*			
379.	5673	*Eucalyptus horistes*			
380.	19324	*Eucalyptus hypolaena*			
381.	5687	*Eucalyptus kruseana (Bookleaf Mallee)*		P4	
382.	5697	*Eucalyptus lesouefii (Goldfields Blackbutt)*			
383.	20802	*Eucalyptus longissima*			
384.	13037	*Eucalyptus loxophleba subsp. lissophloia*			
385.	20091	*Eucalyptus oleosa subsp. oleosa*			
386.	18580	*Eucalyptus planipes*			
387.	5747	*Eucalyptus platycorys (Boorabbin Mallee)*			
388.	12380	*Eucalyptus ravida (Silver-topped Gimlet)*			
389.	5766	*Eucalyptus salmonophloia (Salmon Gum, Wurak)*			
390.	5767	*Eucalyptus salubris (Gimlet)*			
391.	5780	*Eucalyptus stricklandii (Strickland's Gum)*			
392.	5792	*Eucalyptus torquata (Coral Gum)*			
393.	5793	*Eucalyptus transcontinentalis (Redwood, Pungul)*			
394.	34775	*Eucalyptus vittata*			
395.	5798	*Eucalyptus websteriana (Webster's Mallee)*			
396.	13053	*Eucalyptus websteriana subsp. norsemanica*		P1	
397.	13054	*Eucalyptus websteriana subsp. websteriana*			
398.	18269	*Eucalyptus x brachyphylla*		P4	
399.	5802	*Eucalyptus yilgarnensis (Yorrell)*			
400.	5891	*Melaleuca coccinea (Goldfields Bottlebrush)*		P3	
401.	15603	*Melaleuca fulgens subsp. fulgens*			
402.	19486	*Melaleuca hamata*			
403.	5925	*Melaleuca lateriflora (Gorada)*			
404.	5966	*Melaleuca sheathiana (Boree, Buri)*			
405.	19787	*Micromyrtus monotaxis*			
406.	19699	*Thryptomene australis subsp. brachyandra*			

Nemesiidae

407.		*Aname mainae*			
408.		*Aname tepperi*			

Neosittidae

409.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			

Nicodamidae

410.		*Nicodamus mainae*			

Orchidaceae

411.	48481	*Pterostylis tryphera*			

Pachycephalidae

412.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
413.	24618	*Oreoica gutturalis (Crested Bellbird)*			
414.	24619	*Pachycephala inornata (Gilbert's Whistler)*			

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415.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
Papaveraceae					
416.	17797	*Argemone ochroleuca subsp. ochroleuca*	Y		
Pardalotidae					
417.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
418.	25682	*Pardalotus striatus (Striated Pardalote)*			
419.	24630	*Pardalotus striatus subsp. westraliensis (Striated Pardalote)*			
Parmeliaceae					
420.	42107	*Austroparmelina elixiana*			
421.	28103	*Xanthoparmelia amphixantha*			
422.	28105	*Xanthoparmelia antleriformis*			
423.	18001	*Xanthoparmelia dayiana*		P3	
424.	29031	*Xanthoparmelia hueana*			
425.	29032	*Xanthoparmelia imitatrix*			
426.	28142	*Xanthoparmelia incerta*			
427.	28143	*Xanthoparmelia incrustata*			
428.	28144	*Xanthoparmelia isidiigera*			
429.	29021	*Xanthoparmelia loxodella*			
430.	28331	*Xanthoparmelia luteonotata*			
431.	28158	*Xanthoparmelia neorimalis*			
432.	28166	*Xanthoparmelia pertinax*			
433.	28167	*Xanthoparmelia praegnans*			
434.	29036	*Xanthoparmelia pulla*			
435.	28172	*Xanthoparmelia reptans*			
436.	44326	*Xanthoparmelia rimalis*			
437.	28174	*Xanthoparmelia scabrosa*			
438.	28327	*Xanthoparmelia semiviridis*			
439.	44936	*Xanthoparmelia torulosa*			
440.	28356	*Xanthoparmelia verrucella*			
441.	28186	*Xanthoparmelia versicolor*			
442.	18002	*Xanthoparmelia xanthomelanoides*		P2	
Petroicidae					
443.	24650	*Drymodes brunneopygia (Southern Scrub-robin)*			
444.	24651	*Eopsaltria australis subsp. griseogularis (Western Yellow Robin)*			
445.	47997	*Melanodryas cucullata (Hooded Robin)*			
446.	25693	*Microeca fascinans (Jacky Winter)*			
447.	24659	*Petroica goodenovii (Red-capped Robin)*			
Phalacrocoracidae					
448.		*Microcarbo melanoleucos*			
449.	25697	*Phalacrocorax carbo (Great Cormorant)*			
450.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
Phasianidae					
451.	24671	*Coturnix pectoralis (Stubble Quail)*			
Physciaceae					
452.	27968	*Physcia albicans*			
Pittosporaceae					
453.	19744	*Pittosporum angustifolium*			
Plantaginaceae					
454.	7300	*Plantago drummondii (Sago Weed)*			
Poaceae					
455.	207	*Aristida contorta (Bunched Kerosene Grass)*			
456.	17236	*Austrostipa drummondii*			
457.	17237	*Austrostipa elegantissima*			
458.	17246	*Austrostipa nitida*			
459.	19588	*Austrostipa nodosa*			
460.	36283	*Austrostipa sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)*		P1	
461.	249	*Bromus diandrus (Great Brome)*	Y		
462.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
463.	41568	*Cenchrus setaceus (Fountain Grass)*	Y		
464.	357	*Enneapogon caerulescens (Limestone Grass)*			
465.	358	*Enneapogon cylindricus (Jointed Nineawn)*			
466.	365	*Enneapogon polyphyllus (Leafy Nineawn)*			
467.	368	*Enteropogon ramosus (Windmill Grass, Curly Windmill Grass)*			
468.	381	*Eragrostis falcata (Sickle Lovegrass)*			
469.	448	*Hordeum glaucum (Northern Barley Grass)*	Y		

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470.	504	*Panicum effusum (Hairy Panic Grass)*			
471.	521	*Paspalidium gracile (Slender Panic)*			
472.	40431	*Rytidosperma acerosum*			
473.	40425	*Rytidosperma caespitosum*			
474.	688	*Triodia irritans (Porcupine Grass)*			
475.	699	*Triodia scariosa*			
Podargidae					
476.	25703	*Podargus strigoides (Tawny Frogmouth)*			
Podicipedidae					
477.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
478.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
Polygonaceae					
479.	11052	*Persicaria prostrata*			
480.	2443	*Rumex vesicarius (Ruby Dock)*	Y		
Pomatostomidae					
481.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
Pottiaceae					
482.	32341	*Crossidium davidai*			
Primulaceae					
483.	36375	*Lysimachia arvensis (Pimpernel)*	Y		
Proteaceae					
484.	1949	*Grevillea acuaria*			
485.	19314	*Grevillea hookeriana subsp. apiciloba*			
486.	19541	*Grevillea nematophylla subsp. nematophylla*			
487.	2055	*Grevillea oncogyne*			
488.	13458	*Grevillea sarissa subsp. sarissa*			
489.	2104	*Grevillea teretifolia (Round Leaf Grevillea)*			
490.	2196	*Hakea preissii (Needle Tree, Dandjin)*			
Psittacidae					
491.		*Barnardius zonarius*			
492.	24748	*Platycercus varius (Mulga Parrot)*			
493.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
Psoraceae					
494.	27999	*Psora crystallifera*			
495.	28000	*Psora decipiens*			
Pteridaceae					
496.	31	*Cheilanthes austrotenuifolia*			
Pygopodidae					
497.	24995	*Delma australis*			
498.	24997	*Delma butleri*			
499.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
500.	25005	*Lialis burtonis*			
Rallidae					
501.	25727	*Fulica atra (Eurasian Coot)*			
502.	48141	*Tribonyx ventralis (Black-tailed Native-hen)*			
Recurvirostridae					
503.	25734	*Himantopus himantopus (Black-winged Stilt)*			
504.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
Resedaceae					
505.	3085	*Reseda luteola (Wild Mingnonette)*	Y		
Rhamnaceae					
506.	16185	*Cryptandra graniticola*			
507.	16200	*Stenanthemum stipulosum*			
Ruppiaceae					
508.	116	*Ruppia polycarpa*			
Rutaceae					
509.	4501	*Phebalium lepidotum*			
Salticidae					
510.		*Clynotis albobarbatus*			
Santalaceae					
511.	10977	*Exocarpos aphyllus (Leafless Ballart)*			

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512.	2359	*Santalum spicatum (Sandalwood, Wilarak)*			

Sapindaceae

513.	11730	*Alectryon oleifolius subsp. canescens*			
514.	4769	*Dodonaea lobulata (Bead Hopbush)*			
515.	4770	*Dodonaea microzyga*			
516.	4780	*Dodonaea stenozyga*			

Scincidae

517.	30893	*Cryptoblepharus buchananii*			
518.	25020	*Cryptoblepharus plagiocephalus*			
519.	25026	*Ctenotus atlas*			
520.	25052	*Ctenotus leonhardii*			
521.	25074	*Ctenotus schomburgkii*			
522.	25465	*Ctenotus uber (Spotted Ctenotus)*			
523.	25089	*Cyclodomorphus melanops subsp. elongatus (Slender Blue-tongue)*			
524.	25092	*Egernia depressa (Southern Pygmy Spiny-tailed Skink)*			
525.	25094	*Egernia formosa*			
526.	25107	*Egernia stokesii subsp. badia (Western Spiny-tailed Skink, Gidgee Skink)*		T	
527.	25109	*Eremiascincus richardsonii (Broad-banded Sand Swimmer)*			
528.	25115	*Hemiergis initialis subsp. initialis*			
529.	25117	*Hemiergis peronii subsp. peronii*			
530.		*Lerista kingi*			
531.	25155	*Lerista muelleri*			
532.	25162	*Lerista picturata*			
533.	42411	*Lerista timida*			
534.	41411	*Liopholis inornata (Desert Skink)*			
535.	41413	*Liopholis multiscutata (Bull Skink)*			
536.	25184	*Menetia greyii*			
537.	25188	*Morethia adelaidensis*			
538.	25190	*Morethia butleri*			
539.	25192	*Morethia obscura*			
540.	25519	*Tiliqua rugosa*			

Scolopacidae

541.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
542.	24780	*Calidris alba (Sanderling)*		IA	
543.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	

Scolopendridae

544.		*Scolopendra laeta*			
545.		*Scolopendra morsitans*			

Scrophulariaceae

546.	7180	*Eremophila alternifolia (Poverty Bush)*			
547.	11769	*Eremophila arachnoides subsp. tenera*		P1	
548.	7189	*Eremophila clarkei (Turpentine Bush)*			
549.	14895	*Eremophila decipiens subsp. decipiens*			
550.	7195	*Eremophila dempsteri*			
551.	7211	*Eremophila georgei*			
552.	14340	*Eremophila glabra subsp. glabra*			
553.	7219	*Eremophila granitica (Thin-leaved Poverty Bush)*			
554.	15112	*Eremophila interstans subsp. interstans*			
555.	15111	*Eremophila interstans subsp. virgata*			
556.	7226	*Eremophila ionantha (Violet-flowered Eremophila)*			
557.	16363	*Eremophila maculata subsp. brevifolia (Native Fuchsia)*			
558.	7242	*Eremophila miniata (Kopi Poverty Bush)*			
559.	15003	*Eremophila oldfieldii subsp. angustifolia*			
560.	18570	*Eremophila oppositifolia subsp. angustifolia*			
561.	7250	*Eremophila pantonii*			
562.	14594	*Eremophila parvifolia subsp. auricampa*			
563.	14516	*Eremophila praecox*		P1	
564.	7259	*Eremophila pustulata (Warted Eremophila)*			
565.	15172	*Eremophila rugosa*			
566.	7267	*Eremophila scoparia (Broom Bush ())*			
567.	49080	*Eremophila xantholaema*		P1	Y
568.	17158	*Myoporum montanum (Native Myrtle)*			
569.	7293	*Myoporum platycarpum (Sugarwood)*			
570.	18259	*Myoporum platycarpum subsp. platycarpum*			

Scutigeridae

571.		*Thereuopoda lesueurii*			

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Solanaceae					
572.	6967	*Lycium australe (Australian Boxthorn)*			
573.	6974	*Nicotiana glauca (Tree Tobacco)*	Y		
574.	11331	*Nicotiana occidentalis subsp. obliqua*			
575.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
576.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
577.	7023	*Solanum nummularium (Money-leaved Solanum)*			
578.	7028	*Solanum petrophilum (Rock Nightshade)*			
579.	7030	*Solanum plicatile*			
Sparassidae					
580.		*Holconia nigrigularis*			
Tachyglossidae					
581.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
Teloschistaceae					
582.	44945	*Caloplaca hnatiukii*			
583.	44983	*Fulgensia cranfieldii*			
584.	27754	*Fulgensia subbracteata*			
Theridiidae					
585.		*Latrodectus hasseltii*			
Thymelaeaceae					
586.	5231	*Pimelea angustifolia (Narrow-leaved Pimelea)*			
Triopsidae					
587.	39407	*Triops australiensis (Shield Shrimp)*			
Trochanteriidae					
588.		*Longrita grasspatch*			
Turnicidae					
589.	24851	*Turnix velox (Little Button-quail)*			
Typhaceae					
590.	99	*Typha orientalis (Bulrush, Cumbungi)*			
Urodacidae					
591.		*Urodacus armatus*			
Ustilaginaceae					
592.	45897	*Ustilago comburens*			
Varanidae					
593.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
594.	25526	*Varanus tristis (Racehorse Monitor)*			
Verbenaceae					
595.	6733	*Lantana camara (Common Lantana)*	Y		
Vespertilionidae					
596.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
597.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
598.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
599.	24199	*Scotorepens balstoni (Inland Broad-nosed Bat)*			
600.	24202	*Vespadelus baverstocki (Inland Forest Bat)*			
601.	24205	*Vespadelus finlaysoni (Finlayson's Cave Bat)*			
602.	24206	*Vespadelus regulus (Southern Forest Bat)*			
Violaceae					
603.	11973	*Hybanthus floribundus subsp. curvifolius*			
Zosteropidae					
604.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			
Zygophyllaceae					
605.	48885	*Roepera aurantiaca subsp. aurantiaca*			
606.	48892	*Roepera glauca (Pale Twinleaf, Pale Twin-leaf)*			
607.	48899	*Roepera reticulata*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix 8: EPBC Protected Matters Search (40km buffer)

Australian Government

Department of Agriculture, Water and the Environment

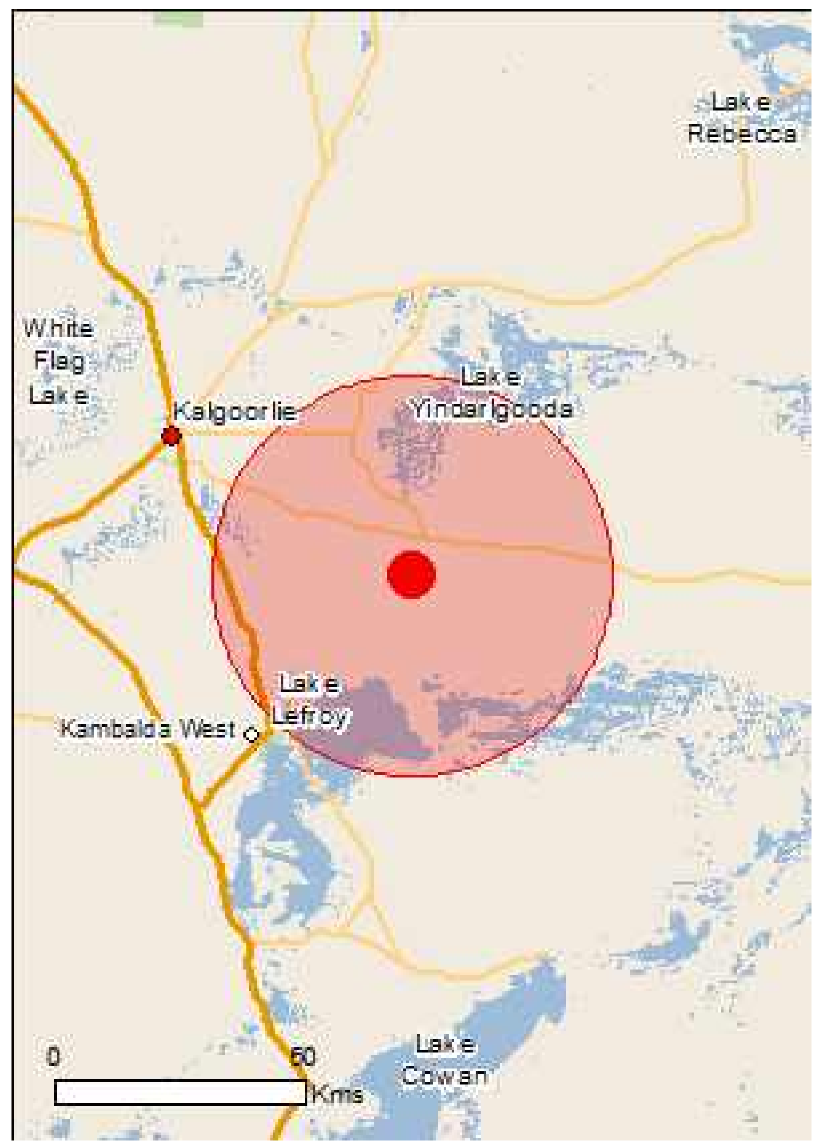
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

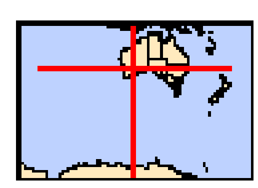
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/11/20 06:40:24



Coordinates
Buffer: 40.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	6
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	12
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
Plants		
Tecticornia flabelliformis Bead Glasswort [82664]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Kambalda	WA
Lakeside Timber Reserve	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua Ward's Weed [9511]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Cylindropuntia spp. Prickly Pears [85131]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-30.96467 121.90331

Acknowledgements

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

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

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

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

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Appendix E: Memorandum: Arid Bronze Azure Butterfly and Inland Hairstreak desktop assessment

[redacted]

ABN 47141175297

28th April 2022

[redacted]ead
Black Cat Syndicate
PO Box 184, West Perth WA 6872
[redacted]

(BC reference 2022/038)

Memorandum: Arid Bronze Azure Butterfly and Inland Hairstreak desktop assessment

Botanica Consulting Pty Ltd (Botanica) was commissioned by Black Cat Syndicate (Black Cat) to undertake a desktop assessment of the Fingals Project area to determine if the Arid Bronze Azure Butterfly (ABAB) and the Inland Hairstreak would be present.

Black Cat had commissioned Bennelongia Environmental Consultants to undertake a desktop assessment to determine the prevalence of SRE invertebrate species in the Project area and within a 100 x 100 km square area centered on the Project. This assessment identified two species of butterflies that were recorded in a desktop search area, the Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*) and the Inland Hairstreak (*Jalmenus aridus*). The arid bronze azure butterfly is a threatened species that is listed as critically endangered under the national *Environment Protection and Biodiversity Protection Act 1999* and the state *Biodiversity Conservation Act 2016*. The Inland Hairstreak is listed as Priority 1 fauna under the state *Biodiversity Conservation Act 2016*.

Project Setting

Black Cat is looking to recommence gold mining at the Fingals Project, which was last mined in the early 1990's. The Project is located in the goldfields, 40km southeast of Kalgoorlie (Figure 1). Proposed operations will involve cutback and expansion of the existing open cut pits as well as the construction of associated mine infrastructure. The disturbance footprint is estimated at 230 ha of which, approximately 60 ha is formerly disturbed.

The Project is situated within the Mt Monger Pastoral Lease in the Eastern Goldfields in the Coolgardie Bioregion. The landscape consists of undulating plains separated by low hills and sandplains. There are also salt lake systems in the area. Vegetation is predominantly eucalypt woodlands, mulga shrublands, acacia-casuarina thickets, spinifex grassland and halophytic shrublands.

Botanica completed a reconnaissance flora/ vegetation survey and basic fauna survey within the Fingals Project area in November 2020, covering approximately 1,192 ha. The survey identified five broad-scale vegetation communities within the survey area. The survey found the *Eucalyptus* low open woodland on lower rocky slopes was the most widespread community in the survey area, occupying 388 ha (32.6%).

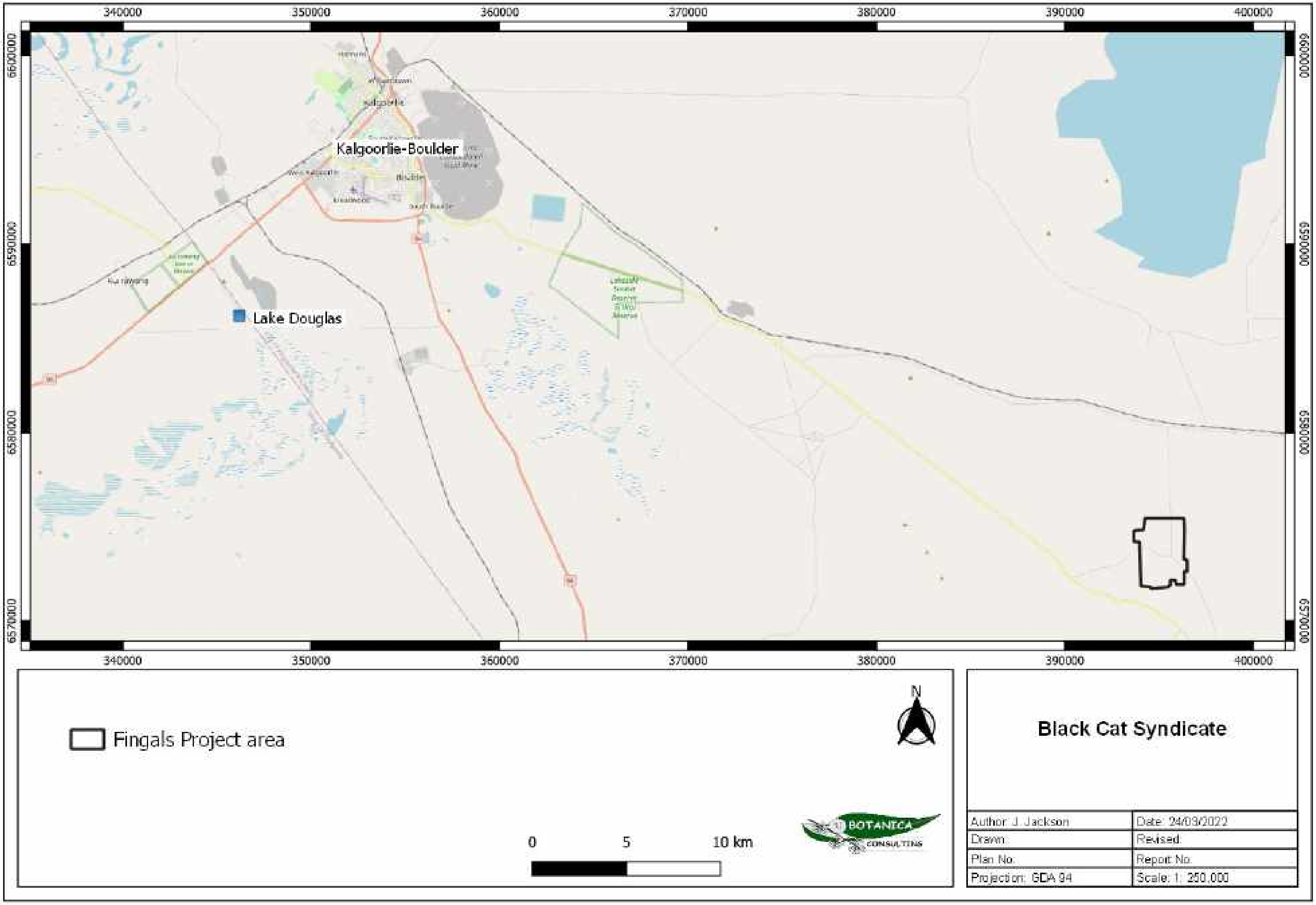

Figure 1. Regional Map showing the location of the Fingals Project area

Arid Bronze Azure Butterfly and *Camponotus terebrans*

The arid bronze azure butterfly (ABAB) (*Ogyris subterrestris petrina*) is a threatened species that is listed as critically endangered under the national *Environment Protection and Biodiversity Protection Act 1999* and the state *Biodiversity Conservation Act 2016*. The ABAB is listed due to its severely fragmented distribution with only two extant subpopulations being recorded in Western Australia. These subpopulations are at Barbalin Nature Reserve west of Mukinbudin in the Western Australian wheatbelt, and at a second site ~100 km from Barbalin. A third subpopulation (the first discovered, in the 1980s) occurred near Lake Douglas, 12 km southwest of Kalgoorlie but is now locally extinct and no ABAB have been recorded there since 1993 (DBCA, 2020a). In late 2020, Zoologist Greg Harewood sighted an ABAB north of Kalgoorlie within similar habitat to the extinct Lake Douglas population (*E. concinna* mallee woodland). Due to the sensitive nature of this record which potentially represents a new population of this species, specific location details will not be presented here, and a reference will be withheld.

The ABAB has an obligate association with a sugar ant *Camponotus* sp. nr. *terebrans*. The ABAB's larvae live entirely within the ant's nest during their development. The ants protect the larvae from predators and are thought to be rewarded with secretions produced by the larvae. The most critical factor for habitat occupancy by the butterfly is the presence of large colonies of the host ant; only large colonies can support the ABAB because, being a parasitic species, it requires large numbers of hosts.

Camponotus terebrans, also known as the brown-headed sugar ant, are relatively distinctive in that they have a dark brown head and matching abdomen (pictured below). The ant is approximately 8 millimetres long with some variation between minor workers (smaller) and major workers (larger) (Harewood, 2020).

Camponotus terebrans is one of the most common ants in sandy soils of southern Australia and is one of the first ant species to colonise disturbed sites (McArthur et al, 1997).

At the two known extant sites where the ABAB occurs, the vegetation is mature mixed gimlet *Eucalyptus salubris* / Salmon gum *E. salmonophloia* woodlands on red-brown loam soils, with an open understorey. In addition to gimlet and salmon gum, other smooth-barked eucalyptus at these sites which have basal ant colonies include wandoo *E. capillosa* subsp. wandoo, smooth-barked York gum *E. loxophleba* subsp. *lissophloia* and ribbon barked mallee *E. sheathiana*. The habitat at the locally extinct Lake Douglas site differs from the other sites but is also dominated by mature smooth-barked eucalypt woodland, particularly Victoria Desert mallee *E. concinna* (DBCA, 2020a). The host ant colonies occur at the base of mature smooth-barked eucalypts. To determine if the host ant is present at a site, and in what numbers, a random sample of trees is examined and assessed for ant presence/absence. DBCA has published survey guidelines for the ABAB and these outline the recommend survey techniques to determine the presence of this species.

Previous surveys completed by Botanica for the *Camponotus* sp. nr. *terebrans* has identified three colonies from nearly 700 trees sampled. Two of these were at the base of *E. salmonophloia,* the other was at the base of a *E. yilgarnensis*. *E. yilgarnensis* is typically a mallee that grows to about 6 m high. The bark is usually rough, fibrous, or flaky at the base of the trunk, this is known as a 'stocking', and the rest of the trunk is smooth above (DBCA, 2021). In this case, this *E. yilgarnensis* was mostly smooth barked and did not have a stocking. Soils and landscapes where these colonies were found were described as a sandy clay textured soil on a flat plain.

Inland Hairstreak

The Inland Hairstreak (*Jalmenus aridus)* is endemic to Western Australia and is listed as Priority 1 fauna under the state *Biodiversity Conservation Act 2016*. Only 16 collections are known, 15 of these are from near Kalgoorlie, one is from the Gibson desert (ALA, 2020). It was last sighted in Western Australia at Karamindie, which is about 28 km south of Kalgoorlie (DBCA, 2021a). Little is known about its biology or ecology. Based on the historical records, the larva of this species is thought to feed on leaves and flowers of young shrubs of *Senna nemophila* (recent taxonomic revisions classify as *Senna artemisioides* subsp. × *coriacea*) and mature trees of *Acacia tetragonophylla*, which grow in shallow gullies with gentle slopes (Braby, 2016). The larvae of the butterfly are attended by the Froglet ant *Froggatella kirbii*. The adults are likely to stay close to the breeding habitats. There are likely two generations per year, although adults are absent in some years (Braby, 2016). There are no published survey guidelines for the Inland Hairstreak, however due to this species association with *Froggattella kirbii,* it is recommended to search for these near known habitat trees for the species (*Acacia tetragonophylla* and *Senna artemisioides* subsp. x *coriacea*).

Previous surveys completed by Botanica for the Inland Hairstreak has not found any colonies or individuals.

Assessment of the Project Area as Potential Habitat for the ABAB

The 2020 Botanica survey of the Fingals Project area identified a total of five broad-scale vegetation communities. Of these five vegetation communities, only two were considered possible to suit the soil type where the *Camponotus* sp. nr. *terebrans* are likely to be found. These were the two Eucalypt woodland communities growing on clay loam plain.

Ten species of Eucalypts were identified across these five vegetation communities. Of these ten, only four are smooth barked at the base and therefore considered potential habitat trees for the *Camponotus* sp. nr. *terebrans* (Table 1).

An assessment of each of these vegetation communities is presented in Table 2. It is unlikely that the Fingals Project area would support the *Camponotus* sp. nr. *terebrans,* or the ABAB.

Table 1: Eucalypts identified in the Fingals Project area

Family	*Taxon*	DD-CF1	CLP-EW1	CLP-EW2	RS-EW1	RS-EW2
Myrtaceae	*Eucalyptus celastroides*			*	*	*
	Eucalyptus ewartiana					
	Eucalyptus gracilis	*				
	Eucalyptus griffithsii		*			
	Eucalyptus lesouefii		*		*	
	Eucalyptus ravida			*	*	
	Eucalyptus salmonophloia			*	*	
	Eucalyptus salubris	*			*	
	Eucalyptus stricklandii				*	*
	Eucalyptus transcontinentalis				*	

*Green shading indicates a smooth bark Eucalypt.

Table 2: Assessment of vegetation communities for ABAB habitat potential

Vegetation Community	Broad Floristic Formation (NVIS III)	Vegetation Description (NVIS V)	Landform	Assessment for ABAB habitat potential
DD-CF1 31 ha (2.6%)	*Casuarina* low forest	*Casuarina pauper* low forest over *Eremophila decipiens* open shrubland over *Maireana triptera* low sparse shrubland.	Drainage Channel	Very unlikely. Casuarina woodlands are not known to support the ant *Camponotus* sp. nr. *terebrans,* or the ABAB.
CLP-EW1 314 ha (26.3%)	*Eucalyptus* low open woodland	*Eucalyptus lesouefii* low open woodland over *Senna artemisioides* subsp. *filifolia* and *Maireana triptera* low open shrubland.	Clay/loam plain.	Unlikely. The soil type may support *Camponotus* sp. nr. *terebrans* but given that no smooth bark Eucalypts were identified in this vegetation community (Table 1), and *E. lesouefii* is listed as the dominant tree it is unlikely to support *Camponotus* sp. nr. *terebrans,* or the ABAB.
CLP-EW2 315 ha (26.4%)	*Eucalyptus* open woodland	*Eucalyptus ravida* low open woodland over *Maireana triptera* low open shrubland.	Clay/loam plain.	Unlikely. The soil type may support *Camponotus* sp. nr. *terebrans* but only two species of smooth bark Eucalypts were identified in this vegetation community (Table 1), and *E. ravida* was listed as the dominant tree in this community. Although a smooth bark Eucalypt, *E. ravida* is not mentioned in any literature indicating that it supports colonies of *Camponotus* sp. nr. *terebrans. E. salmonophloia* was present but in low numbers. It is unlikely this community would support *Camponotus* sp. nr. *terebrans,* or the ABAB.
RS-EW1 388 ha (32.6%)	*Eucalyptus* low open woodland	*Eucalyptus lesouefii*, *E. salmonophloia* and *E. salubris* woodland over *Tecticornia disarticulata* low open shrubland.	Lower rocky slopes	Very unlikely. Rocky soil substrates are not known to support the ant *Camponotus* sp. nr. *terebrans,* or the ABAB.
RS-EW2 26 ha (2.2%)	*Eucalyptus* low woodland	*Eucalyptus stricklandii* low woodland over *Melaleuca sheathiana* shrubland.	Upper rocky slopes	Very unlikely. Rocky soil substrates are not known to support the ant *Camponotus* sp. nr. *terebrans,* or the ABAB.

Assessment of the Project Area as Potential Habitat for the Inland Hairstreak

The 2020 Botanica survey of the Fingals Project area identified *Acacia tetragonophylla* to be present in the *Casuarina* low forest in a drainage channel vegetation community. This community was estimated to cover approximately 31 ha (2.6%) in the northwestern corner of the Project area (as identified in vegetation community type DD-CF1 in Figure 2). It is not known if these *A. tetragonophylla* were old mature trees, as described by Braby (2016) as the preferred trees for the larvae to feed on. No *Senna artemisioides* subsp. × *coriacea* were identified in the Project area.

It is difficult to assess an area for its potential as habitat for the Inland Hairstreak, as little is known about this species and its general ecology. Botanica would rate this vegetation community as being likely to be potential habitat for the Inland Hairstreak, and its larvae may use this species for a food source but considers that there is a very low probability of them being present in the Project area. Furthermore, the proposed mine development footprint is illustrated in Figure 2, overlaying this with the potential habitat of the Inland Hairstreak demonstrates that any mine development would not encroach on this habitat and would not impact any population of the Inland Hairstreak if present.

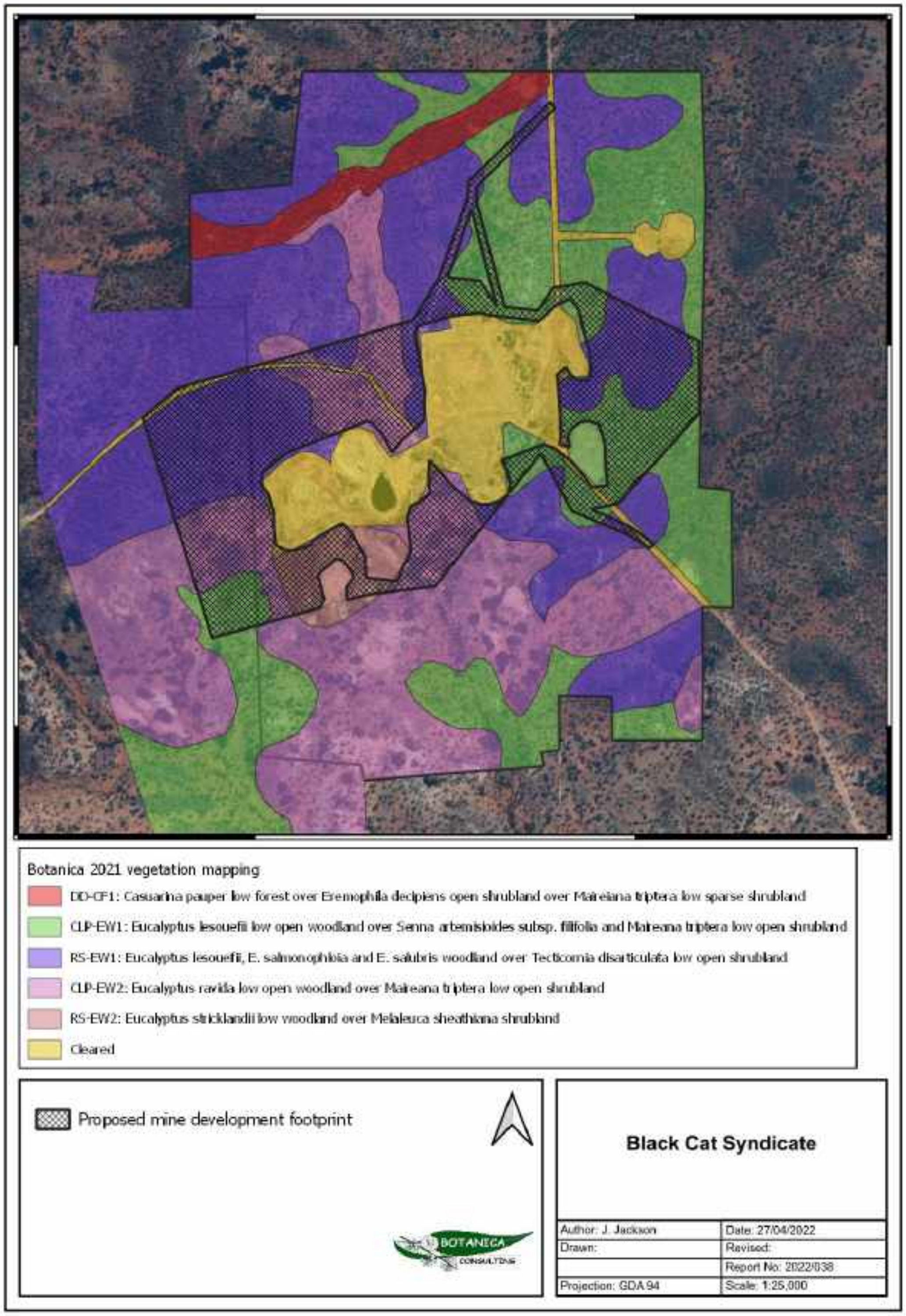

Figure 2: Overlay of proposed mine development footprint over vegetation communities

Summary

The ABAB is not likely to be using the Fingals Project area for breeding, and it is unlikely that the host ant *Camponotus* sp. nr. *terebrans* are present in the area.

The Project area may support approximately 31 ha of a vegetation community where a species of Acacia is present, and the Inland Hairstreak may use this species as a food source, but there is a very low probability of them being present in the Project area. Any proposed clearing for mining would not impact this vegetation community.

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Appendix F: Fingals Hydro-meteorological and Surface Water Management Study

HYDRO-METEOROLOGICAL & SURFACE WATER MANAGEMENT STUDY

FINGALS MINING CENTRE

FEASIBILITY STUDY

Prepared for

Black Cat Syndicate Ltd

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Report J2134R01 Final

29 September 2021

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29 September 2021

EXECUTIVE SUMMARY

Black Cat Syndicate Ltd (Black Cat) proposes to develop their Fingals Mining Centre (FMC) located about 48 km southeast of Kalgoorlie in the Eastern Goldfields Region of Western Australia. The project comprises an enlargement of the existing Fingals Fortune pit void and re-development of the currently backfilled Bagus and Futi Bagus pit voids. Mining will occur over a period of some three years, with ore transported to Black Cat's proposed processing plant at the Majestic Mining Centre located some 8 km to the north. Consequently on-site facilities are likely to be limited to run-of-mine (ROM) stockpiles, two waste rock dumps (WRD), mine services area and related infrastructure.

Black Cat has engaged Groundwater Resource Management Pty Ltd (GRM) to complete the FMC hydrological (surface water) study. This report present the findings from a desktop hydrological (surface water) study and site visit and comprises the results of an assessment of regional and local hydro-meteorological data that can be used in the future design of surface water management measures. 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.
- Regional climatic conditions are arid with mean annual rainfalls of about 250 mm. The rainfall that occurs during the early winter months of May, June and July tends to be more reliable than the less dependable, but more intense, summer rainfalls from January to March.
- Although remnant tropical cyclones and associated depressions may bring heavy rains to the region, they are erratic in nature and occur relatively infrequently. An analysis of cyclone data for the last 49 years shows that, on average, one cyclone will pass within 100 km of the FMC approximately every twelve to thirteen years. Three cyclones (TC's Ingrid 1970, Billy 1986 and Vance 1999) have passed within 50 km of the FMC in the last 49 years.
- The Bureau of Meteorology (BoM) Bulong rainfall station (No. 12013) is located some 28 km north-northwest of the FMC and daily data are available from January 1907 to the present. This record is of very good quality with only minor gaps (99.5% complete) and the 106 complete years of data yield mean and median annual rainfalls of 259 and 240 mm respectively. These values are considered to be representative of conditions at the FMC and their use is recommended for design purposes.
- Locally, maximum and minimum annual rainfalls of 587.7 mm and 43.8 mm have been recorded at Bulong in 1992 and at Cowarna Downs in 1976 respectively. The 1992 maximum rainfall has an annual exceedance probability (AEP) of less than 1% (i.e. greater than 1 in 100) and was largely due to heavy rainfalls associated with remnant Tropical Cyclone Ian which crossed the Goldfields in early March, along with an unusually wet winter that year. The 1976 local minimum rainfall is representative of 1% AEP drought conditions.
- Data for local stations show that, on average, there are some 50 rain days each year, although this may be as low as 13 days and as high as 132 days. The longest period without rain was 149 days and was recorded concurrently at Bulong and Kalgoorlie Airport between 6 Dec 1949 and 4 May 1950.

- Locally the wettest day on record occurred on 22 February 1948, when 177.8 mm was recorded at both Kalgoorlie-Boulder Airport and Kalgoorlie Post Office, some 45 km west-northwest of the FMC. This rainfall was directly associated with TC Unnamed #4 1941/42 and had an AEP of less than 1% (I.e. greater than 1 in 100).
- Short duration rainfall intensities due to remnant cyclones and other tropical depression related events can be significant. Maximum six minute intensities in excess of 150 mm/hr have been recorded regionally and are indicative of cyclonic rainfall intensities that could be experienced at the FMC site.
- A rainfall intensity-frequency-duration relationship was developed for the FMC using the BoM’s recently updated database (2016). In summary, the 1% AEP intensities for 1, 3, 12, 24 and 72 hr duration events are 49.4, 23.6, 10.1, 6.55 and 2.94 mm/hr respectively (yielding equivalent depths of approximately 49, 71, 121, 157 and 212 mm). The 72 hour duration point Probable Maximum Precipitation has been estimated to be in the order of 1,350 mm.
- In the absence of a local evaporation record it is recommended that pan evaporation data for the Kalgoorlie-Boulder Airport be used for design purposes for the FMC. This gives a mean annual pan evaporation of approximately 2,643 mm, some 65-70% of which can be expected to evaporate from shallow freshwater ponds on site.
- The FMC is located on the regional watershed between Lake Raeside-Ponton Catchment (area = 115,965 km^2) to the north and Lake Lefroy Catchment (area = 24,880 km^2) to the north. Both of these catchments form part of the much larger, internally draining Salt Lake Basin (area = 441,000 km^2) which extends across much of central WA.
- The FMC is situated roughly midway between Lake Yindarlgooda to the north and Lake Lefroy to the south. Both lakes are ephemeral, internally draining salt lakes extending over areas in excess of several hundred square kilometres. There are no significant river systems or watercourses in the vicinity of the FMC.
- Inspection of the available topographical data and imagery and field inspection indicates that the local catchment divide passes through the project area and, in effect, has no discernible upstream catchment area. Consequently the proposed surface water management measures will need to be designed for runoff resulting from direct precipitation only i.e. no surface water runoff is expected to report to the project facilities from upstream areas.
- Flood protection measures required at the proposed FMC are therefore minimal and runoff flows around the open pit can be managed by the pit safety bund as the catchments fall away on the northern and southern of the catchment divide.

GLOSSARY OF HYDROLOGICAL TERMS

Annual Exceedance Probability (AEP)	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.
Antecedent Soil Moisture	Water present in the soil prior to a rainfall event.
Average Recurrence Interval (ARI)	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random.
Australian Rainfall and Runoff (ARR)	National guideline document, data and software suite that can be used for the estimation of design flood characteristics in Australia. Currently in its 4th edition it is commonly referred to as ARR2016.
Australian Hydrological Geospatial Fabric (AHGF)	The Australian Hydrological Geospatial Fabric (Geofabric) is a specialised Geographic Information System (GIS). It identifies and registers the spatial relationships between important hydrological features such as watercourses, water bodies, canals, aquifers, monitoring points and catchments
Backwater	Water backed-up or retarded in its course as compared with its normal or natural condition of flow
Baseflow	The component of streamflow supplied by groundwater discharge
Basin	A tract of country, generally larger catchment areas, drained by a river and its tributaries.
Catchment	The land area draining to a point of interest, such as a water storage or monitoring site on a watercourse.
Channel	An artificial or constructed waterway designed to convey water. Often described as open channels to distinguish them from pipes.
Control	Physical properties of a cross-section or a reach of an open channel, either natural or artificial, that govern the relation between stage and discharge at a location in the open channel.
Dead Storage	In a water storage, the volume of water stored below the level of the lowest outlet (the minimum supply level). This water cannot be accessed under normal operating conditions.
Discharge	Volume of liquid flowing through a cross-section in a unit time.
Drainage Division	Representation of the catchments of the 12-major surface water drainage systems across Australia, generally comprising a number of river basins.
Endorheic Basin	A closed surface water drainage basin that retains water and has no outflow to the sea.
Environmental Flow	The streamflow required to maintain appropriate environmental conditions in a waterway or water body.
Ephemeral	Something which only lasts for a short time. Typically used to describe rivers, lakes and wetlands that are intermittently dry.
Evapotranspiration (ET)	The sum of evaporation and plant transpiration from the earth's land surface to the atmosphere.
Evaporation	A process that occurs at a liquid surface, resulting in a change of state from liquid to vapour.
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding
Full Supply Level (FSL)	The normal maximum operating water level of a water storage when not affected by floods. This water level corresponds to 100% capacity.

GLOSSARY OF HYDROLOGICAL TERMS

Generalised Short-Duration Method (GSDM)	Appropriate for estimating probable maximum precipitation for durations up to six hours and for an area of less than 1000 square kilometres.
Generalised Tropical Storm Method – Revised (GTSMR)	Appropriate for estimating probable maximum precipitation in regions of Australia affected by tropical storms.
Intensity-Frequency-Duration (IFD)	Design rainfall intensities (mm/h) or design rainfall depths (mm) corresponding to selected standard probabilities, based on the statistical analysis of historical rainfall.
Minimum Supply Level (MSL)	The lowest water level to which a water storage can be drawn down (0% full) with existing outlet infrastructure; typically, equal to the level of the lowest outlet, the lower limit of accessible storage capacity.
Precipitation	All forms in which water falls on the land surface and open water bodies as rain, sleet, snow, hail, or drizzle.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation (PMP, and coupled with the worst flood producing catchment conditions.
Probable Maximum Precipitation (PMP)	The theoretically greatest depth of precipitation for a given duration under modern meteorological conditions for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
Rainfall	The total liquid product of precipitation or condensation from the atmosphere, as received and measured in a rain gauge
Riparian	An area or zone within or along the banks of a stream or adjacent to a watercourse or wetland; relating to a riverbank and its environment, particularly to the vegetation.
Stage	The water level, typically measured at a water monitoring site
Storage	A pond, lake or basin, whether natural or artificial, for the storage, regulation and control of water.
Surface Runoff	Water from precipitation or other sources that flows over the land surface. Surface runoff is the fraction of precipitation that does not infiltrate at the land surface and may be retained at the surface or result in overland flow toward depressions, streams and other surface water bodies
Sustainable Yield	The level of water extraction from a particular system that would compromise key environmental assets, or ecosystem functions and the productive base of the resource, if it were exceeded.
Total Suspended Solids (TSS)	The sum of all particulate material suspended (i.e. not dissolved) in water. Usually expressed in terms of milligrams per litre (mg/L). It can be measured by filtering and comparing the filter weight before and after filtration.
Transpiration	Evaporative loss of water from the leaves of plants through the stomata; the flow of water through plants from soil to atmosphere.
Watercourse	A river, creek or other natural watercourse (whether modified or not) in which water is contained or flows (whether permanently or from time to time).
Wind Run	The product of the average wind speed and the period over which that average speed was measured

Ref: Australian Water Information Dictionary, Bureau of Meteorology, Commonwealth of Australia 2017 (http://www.bom.gov.au/water/awid/all.shtml)

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1.0 INTRODUCTION

1.1 GENERAL

Black Cat Syndicate Ltd (Black Cat) proposes to develop their Fingals Mining Centre (FMC) located about 48 km southeast of Kalgoorlie in the Eastern Goldfields Region of Western Australia. The project comprises an enlargement of the existing Fingals Fortune pit void and re-development of the currently backfilled Bagus and Futi Bagus pit voids. Mining will occur over a period of some three years, with ore transported to Black Cat's proposed processing plant at the Majestic Mining Centre located some 8 km to the north. Consequently on-site facilities are likely to be limited to run-of-mine (ROM) stockpiles, two waste rock dumps (WRD), mine services area and related infrastructure.

Black Cat has engaged Groundwater Resource Management Pty Ltd (GRM) to complete the FMC hydrological (surface water) study. This report present the findings from a desktop surface water management study and site visit and comprises the results of an assessment of regional and local hydro-meteorological data. This information is then used in the design of the required surface water management measures.

The scope of work comprised the following surface water tasks:

- Hydrological/meteorological desktop study - completed using data obtained from the relevant government bodies and mapping information provided by Black Cat, as presented in this report.
- Site visit – the FMC site and upstream catchment areas were visually inspected on 10 September 2020.
- Floodwater management - hydrologic and hydraulic analyses.
- Surface water and sediment management - philosophy and design criteria.
- FS level design of water management measures - described in the report and presented on preliminary engineering drawings.

The desktop hydro-meteorological study is presented in the following section. The hydrological assessment of the local catchment areas and the design philosophy for floodwater and surface water management measures is presented in Section 3.0 while the FS level engineering designs for those measures are then presented in Section 4.0.

2.0 DESKTOP HYDRO-METEOROLOGICAL STUDY

2.1 DATA SOURCES

No on-site rainfall or streamflow data were available. The hydro-meteorological desktop study therefore made use of local and regional data available from the public domain sources presented in the following sections. The key data used in the study have been analysed and the results discussed in the following sections and summarised in Appendix A.

2.1.1 Bureau of Meteorology (BoM) Data:

The BoM data summarised in Tables 1 and 2 were obtained and used in the completion of the desktop study (refer to Figures 1 and 2 for locations). It should be noted that all stations remain open unless noted otherwise and all distances were measured from a central FMC location at 6,573,500 m N and 395,250 m E (GDA94/MGA51) or -30.9674° Lat and 121.9032° Lon (WGS84).

Table 1: Climate Summaries for Regional BoM Stations

BoM Station Name	Station No.	Data Period[1]	Distance from Site
Norseman Aero	12009	December 1999 - September 2021	139 km S
Coolgardie	12018	January 1893 - September 2021	70 km W
Kalgoorlie-Boulder Airport	12038	March 1939 - September 2021	47 km NW
Kalgoorlie Post Office[closed]	12039	February 1896 - January 1953	48 km NW
Kanowna[closed]	12040	February 1896 - January 1952	50 km NW
Norseman[closed]	12065	March 1898 - September 2012	137 km S

Note 1: Data Period and % Complete varies depending on climate parameter under consideration.

Table 2: Daily Rainfall Records for Local BoM Stations

BoM Station Name	Station No.	Data Period	% Complete[2]	Distance from Site
Bulong	12013	1 Jan 1907[1] - 31 May 2019	99.5%	28 km NW
Kalgoorlie-Boulder Airport	12038	1 Mar 1939 - 31 Sep 2019	99.0%	47 km NW
Kalgoorlie Post Office[closed]	12039	1 Jan 1907[1] - 30 Sep 1953	100.0%	48 km NW
Woolibar	12106	1 Dec 1951[1] - 31 Oct 2015	75.1%	26 km SW
Cowarna Downs	12220	1 Aug 1968 - 30 Apr 2018	96.3%	44 km E

Note 1: Data for Bulong and Kalgoorlie P.O. prior to January 1907 and for Woolibar prior to December 1951 were discarded due to unacceptably high frequency and length of gaps.

Note 2: % Complete = No. of Daily Observations ÷ (End Date of Record - Start Date of Record)

The BoM's swept path data sets for Australian cyclones from 1969/1970 season to 2017/2018 season (http://www.bom.gov.au/cyclone/history/tracks/index.shtml) were also used in the study.

2.1.2 Department of Water & Environmental Regulation (DWER):

A request was made to the DWER for mean and maximum flow monitoring data. However, currently the Department has no flow gauging stations within the Raeside-Ponton catchment of the Salt Lake Basin (Basin No. 024).

2.1.3 Department of Agriculture (DoA):

Data presented in the Department's Evaporation Data for Western Australia, Resource Management Technical Report No. 65, October 1987 were used as part of the hydro-meteorological study.

2.1.4 Mapping Data

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

- LiDAR topographical data captured over FMC site February & June 2021.
- Preliminary pit and mine infrastructure locations provided by Black Cat 22 September 2021.
- Catchment Boundaries - from Bureau of Meteorology Australian Hydrological Geospatial Fabric Dataset (V2.1, Feb 2013).
- Geoscience Australia 1:250,000 scale electronic topographic data for Kurnalpi (SH51-10) map sheet.
- Geoscience Australia 1-second Hydro-Enforced SRTM data set.
- ESRI World Imagery.

2.2 DESKTOP STUDY FINDINGS

2.3 METEOROLOGICAL CONDITIONS

2.3.1 General

The regional climate is arid to semi-arid[1] and can be characterised by its relatively low annual rainfall and large temperature range. The FMC is located within the "Desert: Non-seasonal" bioclimatic zone[2] and as such none of the months of the year are reliably wet, and zero rainfall can be recorded in any month.

The mean annual rainfall is typically about 250 mm, but may vary annually from less than one third to almost three times that amount. The rainfall that occurs during the autumn and early winter months of May to July tends to be more reliable though generally of a lesser total amount than the less dependable, but more intense summer cyclonic rainfall from December to March.

Temperature ranges of over 45°C have been recorded between summer maxima and winter minima. Annual pan evaporation rates typically exceed 2,500 mm/year and surpass rainfall by an order of magnitude.

1 In the temperate zones of Australia the classification of aridity generally refers to areas with a mean annual rainfall of less than 250 mm.

2 *Plant Life of Western Australia*, Beard, J.S., 1990.

2.3.2 Regional Summer Climate

During the warmer months between November and April the region is influenced by anti-cyclonic systems to the southeast. The area is also occasionally influenced by southern extensions of the Inter Tropic Convergence Zone (ITCZ) which may bring thunderstorm activity. Significant summer features include almost stationary heat lows over the region, which occur during fine, hot to very hot days, with little or no cloud, and easterly winds. Evenings typically bring only slight decreases in temperature with an easing in wind velocity and direction change to the south-east.

Occasionally, remnant tropical cyclones, which have crossed the Pilbara coast, pass over the Goldfields region. These proceed in a south-easterly direction weakening as they progress to become rain-bearing troughs or depressions between the usual anti-cyclone patterns. Strong wind gusts can be associated with these depressions that can occasionally cause wind erosion and dust storms.

During March to April, the surface winds become lighter and more variable. Typically by April, the northward movement of the anti-cyclone belt has become very noticeable and the probability of tropical depression rain decreases.

Summer maximum temperatures commonly exceed 40°C. Evaporation levels are very high during the summer months, with Kalgoorlie averaging in excess of 300 mm/month. Humidity levels are low and dews are rare except during and immediately following periods of rain.

2.3.3 Regional Winter Climate

Anti-cyclone systems reach their northern limit over Western Australia during the cooler half of the year, between May and October. Winter in the region is then characterised by a continuous sequence of anti-cyclones moving from west to east, which distribute westerly winds and on occasion, north-westerly winds to the area.

Associated with these sequences of anti-cyclones are depressions bringing rain-bearing frontal systems through the region. Winds are usually moderate but occasionally westerly gales can extend into the area. Winter rains most often occur between late May and early August. When anti-cyclones are centred over the area, winds are frequently light and variable. Minimum temperatures may occasionally fall below freezing point for several successive days.

During September-October the re-establishment of stable anti-cyclonic conditions is characterised by little to no rain in the region. Also during October, because of the southward movement of the ITCZ and the anti-cyclonic belt, the easterlies in the north and the westerlies in the south of the region both weaken, and light variable winds are characteristic.

Winter mean minimum temperatures range from 4.0 to -6.0°C. Evaporation levels are greatly reduced during the winter months with a mean monthly evaporation at Kalgoorlie of less than 100 mm/month. Generally the average rainfall during the wettest months of July to August still does not exceed the evaporation rate. Humidity levels are generally higher in winter than in summer, except during, and immediately following, summer rainfalls.

2.3.4 Local Rainfall

In order to analyse local rainfall conditions daily rainfall data were obtained for five BoM rainfall stations, all of which remain open and are situated within a 50 km radius of the FMC site as shown in Figure 2. The results of the local rainfall data analyses are summarised in the following sections (summary charts and tables are presented in Appendix A).

Annual Rainfall

An analysis of annual rainfall data for the local rainfall stations was completed. Table 3 gives the minimum, maximum, mean and median annual rainfalls for each of the stations, while Table 4 gives the minimum, maximum and mean number of rain days per year and maximum duration without rain.

Table 3: Local Rainfall Stations Annual Rainfall

Station Name	Minimum Annual Rainfall (mm)	Maximum Annual Rainfall (mm)	Mean Annual Rainfall (mm)	Median Annual Rainfall (mm)	No. of Complete Years
Bulong	94.2 (1969)	***587.7 (1992)***	258.5	240.4	106
Kalgoorlie-Boulder Airport	108.7 (1940)	530.8 (1992)	266.9	254.9	70
Kalgoorlie Post Office	129.3 (1950)	458.7 (1942)	240.7	222.5	46
Woolibar	79.0 (2002)	483.8 (1992)	251.4	238.4	39
Cowarna Downs	***43.8 (1976)***	500.8 (2000)	264.8	254.8	42

Note: Annual Rainfall values above calculated using complete years of data only. Maximum and minimum values have been shown in ***bold italics.***

Table 4: Local Rainfall Stations Annual Rain Days and Duration without Rain

Station Name[note]	No. of Rain Days per Year			Periods Without Rain		
	Min.	Max.	Mean	Maximum Duration	From	To
Bulong	25 (1944)	85 (1992)	47.7	***149***	6 Dec 1949	4 May 1950
Kalgoorlie-Boulder Airport	31 (1940)	***132 (1963)***	69.7	***149***	6 Dec 1949	4 May 1950
Kalgoorlie Post Office closed	32 (1944)	69 (1942)	50.9	110	17 Nov 1916	7 Mar 1917
Woolibar	14 (2002)	62 (1992)	37.2	129	8 Dec 2001	16 Apr 2002
Cowarna Downs	***13 (1976)***	94 (1992)	43.3	147	1 Jun 1976	26 Oct 1976

Note: Annual Rainfall values above calculated using complete years of data only. Maximum and minimum values have been shown in ***bold italics.***

The annual rainfall data for all the local stations, demonstrate the right-handed or positive skewness typical of the region (annual skewness values ranged from +0.3 to +0.9). Median annual rainfall was therefore also calculated as it is generally considered to be a more representative reflection of rainfall central tendency for areas with skewed rainfall data than mean annual rainfall. 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 3 shows that mean annual rainfall for the local stations ranges from about 241 mm to 267 mm, while the median value ranged from some 223 mm to 255 mm. For design purposes it is recommended that data for the Bulong station, with mean and median annual rainfall of 259 mm and 240 mm respectively, be utilised given that it remains open, is located only some 28 km northwest of the FMC site and comprises 111 years of high quality daily data (99.5% complete).

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

- Local annual rainfalls are highly variable with typically a one order of magnitude range between maximum and minimum annual rainfalls. Minimum and maximum annual rainfalls of 43.8 mm and 587.7 mm were recorded at Cowarna Downs in 1976 and at Bulong in 1992 respectively. There is no obvious spatial rainfall distribution between the local rainfall stations and extreme rainfall values appear to be more closely related to the length of record.
- Local annual rainfalls are also highly temporally variable and significantly wet and dry years can occur in consecutive years. This temporal variation is reflected in the data for Bulong with annual rainfalls of 455.4 mm in 1975, followed by 113.4 mm in 1976 i.e. greater than a fourfold year-on-year decrease.
- The local annual maximum of 587.7 mm recorded at Bulong in 1992 was due largely to heavy rainfalls associated with remnant Tropical Cyclone Ian which crossed the Goldfields in early March, along with an unusually wet winter that year. It should be noted that 1992 was also the wettest year on record at Kalgoorlie Airport and Woolibar with annual totals of 530.8 mm and 483.8 mm respectively due to the same events. Frequency analyses of the annual rainfall data for Bulong indicates that the 1992 maximum annual rainfall had an annual exceedance probability (AEP) of less than 0.4%.
- The second wettest year recorded at Bulong was 1995 when 531.4 mm was recorded, due largely to the passage of TC Bobby. Frequency analyses indicate that the 1995 total had an AEP of less than 1.33%.
- A significantly wet year also occurred locally in 2000 with several of the local stations recording their highest or second highest annual rainfalls. Rainfalls that year were attributable largely to TC Steve which was active locally between late February and early March that year.
- The local minimum annual rainfall of 43.8 mm which was recorded at the Cowarna Downs station in 1976 was as a result of only 13 days of rainfall that year. It is interesting to note that half of the annual total (22 mm) was recorded on a single day (18 November 1976).

Frequency analyses indicate that the Cowarna Downs 1976 rainfall was approximately equal to the 1% AEP annual drought for the local area.

- The longest continuously dry period was 149 days and was recorded concurrently at Bulong and Kalgoorlie Airport between 6 Dec 1949 and 4 May 1950 inclusive. This drought was due to the absence of remnant cyclones or significant depression related events over the Goldfields that year.
- The average number of rain days per year recorded locally ranges from between 37 and 70 days, with an overall average of some 50 days. However, as many as 132 rain days per year (Kalgoorlie Airport in 1963) and as few as 13 rain days per year (Cowarna Downs in 1976) have been recorded locally.

Monthly Rainfall

Maximum, minimum, mean and median monthly rainfall values were determined for all five local rainfall stations using only complete months of data (refer to Appendix A for results). The monthly values for Bulong using all 1,311 complete months within the data set are shown in Table 5. It should be noted that this is a slightly larger data set than the 106 year data set used for determination of the mean and median annual rainfall as complete months of data were available during incomplete years.

Table 5: Bulong Monthly Rainfall

Month	Maximum Monthly Rainfall & Year (mm)	Minimum Monthly Rainfall (mm)	Mean Monthly Rainfall (mm)	Median Monthly Rainfall (mm)	No. of Complete Months
January	174.0 (2014)[1]	0.0	23.4	7.2	109
February	315.7 (1948)[2]	0.0	28.9	10.0	107
March	222.4 (1999)[3]	0.0	27.1	14.5	110
April	99.3 (1934)	0.0	21.1	13.1	110
May	104.9 (1986)	0.0	24.4	19.6	109
June	118.7 (1968)	0.5	26.2	22.4	110
July	85.0 (1980)	0.0	23.0	19.4	108
August	96.4 (1992)	0.0	22.0	16.2	109
September	101.7 (1955)	0.0	13.5	8.6	111
October	95.7 (1909)	0.0	15.5	9.0	111
November	97.0 (2012)	0.0	16.9	10.7	108
December	99.0 (1988)	0.0	16.6	9.8	109
Total no. of complete months in data set					**1,311**

Note 1: Due to Tropical Low 06U 2013/14.
Note 2: Due to Tropical Cyclone Unnamed #4 1947/48 (prior to 1964 Tropical Cyclones were unnamed and were instead assigned a sequential number by BoM according to the season of their occurrence).
Note 3: Due to Tropical Cyclone Vance.

Table 5 shows that typically the wettest month at Bulong is February with mean and maximum values of 28.9 mm and 315.7 mm respectively, while September is the driest with a mean rainfall of 13.5 mm. The wettest periods of the year based on mean monthly values are between January and

March and between May and July. This bi-modal distribution is caused in late summer by tropical cyclones and associated depressions, while the increase in rainfall in winter tends to be due to low-pressure trough systems acting in conjunction with large southerly frontal systems.

Zero precipitation or dry months have been recorded at Bulong throughout the year, with the exception of June with a minimum recorded rainfall of 0.5 mm (both Woolibar and Cowarna Downs have recorded completely dry months throughout the year). For approximately 10% of the usually wettest month of February no rainfall has been recorded at Bulong.

The maximum monthly rainfalls for each of the local stations are presented in Table 6.

Table 6: Local Rainfall Stations Maximum Monthly Rainfall

Station Name	Maximum Monthly Rainfall (mm)	Month	Event [see note]
Bulong	315.7	February 1948	TC Unnamed #4 1947/48
Kalgoorlie-Boulder Airport	307.8	February 1948	TC Unnamed #4 1947/48
Kalgoorlie Post Office [closed]	314.8	February 1948	TC Unnamed #4 1947/48
Woolibar	227.6	February 1995	TC Bobby
Cowarna Downs	262.6	February 1995	TC Bobby

Note: Prior to 1964 Tropical Cyclones were unnamed and were instead assigned a sequential number by BoM according to the season of their occurrence.

The maximum monthly rainfalls were recorded at all of the local stations either in February 1948 as a result of TC Unnamed #4 1941/2 or in February 1995 following TC Bobby. Both these events were significant and also gave rise to the maximum two, three and seven-day rainfall totals, as described later. TC Bobby was a significant regional event as described later (refer to Cyclone Swept Path section).

A plot of the mean monthly rainfall data for the Bulong station is included in Appendix A, along with those for the other four local BoM rainfall stations.

Daily Rainfall

A frequency analysis was carried out using the Bulong daily data to assess the typical duration of local rainfall events. As only daily data were available, a multiple day duration event was assumed to comprise two or more consecutive days of rainfall, resulting in 40,816 discrete rainfall events during the approximately 112 year span of the Bulong rainfall dataset. The results of the frequency analysis are presented in Table 7.

A review of the results of the rainfall duration frequency analysis shows that by far the greatest amount (about 97%) of rainfall events are discrete, single-day events. Two, three and seven-day duration events represent some 1.95%, 0.60% and 0.21% respectively of all rainfall events.

Table 7: Rainfall Duration Frequency Analysis for Bulong

Event Duration (days)	Frequency (No. of Events)	Frequency (%)
1	39,635	97.107%
2	796	1.951%
3	243	0.595%
4	84	0.206%
5	31	0.076%
6	15	0.037%
7	7	0.017%
8	3	0.007%
10	1	0.002%
15	1	0.002%
Total	**40,816**	**100%**

The longest period of consecutive daily rainfall was found to be 15 days and occurred between 28 March and 11 April 1918. However, this event was not very significant in terms of rainfall depth, with a 15 day total of only 61.2 mm and a maximum daily amount of 23.4 mm.

Maximum two, three and seven-day rainfalls recorded at each of the local rainfall stations are shown in Table 8.

Table 8: Local Stations Maximum Two, Three and Seven-Day Rainfalls

Station Name	Maximum Two-Day Rainfall (mm)	Maximum Three-Day Rainfall (mm)	Maximum Seven-Day Rainfall (mm)
Bulong	297.9 (23 Feb 1948)[1]	297.9 (23 Feb 1948)[1]	297.9 (23 Feb 1948)[1]
Kalgoorlie-Boulder Airport	301.2 (23 Feb 1948)[1]	302.2 (24 Feb 1948)[1]	302.2 (24 Feb 1948)[1]
Kalgoorlie Post Office closed	***303.8*** (23 Feb 1948)[1]	***304.8*** (24 Feb 1948)[1]	***304.8*** (24 Feb 1948)[1]
Woolibar	149.4 (28 Feb 1995)[2]	169.4 (28 Feb 1995)[2]	211.0 (2 Mar 1995)[2]
Cowarna Downs	141.6 (23 Jan 2014)[3]	180.2 (27 Feb 1995)[2]	220.8 (3 Mar 1995)[2]

Notes:
1. Due to Tropical Cyclone Unnamed #4 1947/48.
2. Due to Tropical Cyclone Bobby.
3. Due to Tropical Low 06U 2013/14.

The maximum two, three and seven-day rainfall depths of 303.8 mm, 304.8 mm and 304.8 mm respectively recorded at Kalgoorlie Post Office in February 1942 was as a result of rainfall associated with TC Unnamed #4 1947/48 which was active in the Goldfields region at that time. All three rainfall totals have AEP's of less than 1% (in excess of 100 year ARI).

An analysis of maximum daily rainfall data was completed for all five local BoM stations. The top ten wettest days are shown in Table 9 on the following page along with the recording station, date and tropical cyclone name where related. It should be noted that the highest daily events are more than double minimum annual rainfall and are of a similar order as mean annual rainfall at some of the local stations.

Table 9: Local Rainfall Stations Maximum Daily Rainfall

Station Name	Date	Precipitation to 9 am (mm)	Rank	Event Name note1
Kalgoorlie-Boulder Airport	22 Feb 1948	177.8	1st	TC Unnamed #4 1947/48
Kalgoorlie Post Office	22 Feb 1948	177.8	2nd	TC Unnamed #4 1947/48
Kalgoorlie-Boulder Airport	23 Jan 1967	154.4	3rd	TC Elsie
Bulong	22 Feb 1948	153.9	4th	TC Unnamed #4 1947/48
Bulong	23 Feb 1948	144.0	5th	TC Unnamed #4 1947/48
Bulong	23 Jan 2014	127.6	6th	Tropical Low 06U
Kalgoorlie Post Office	23 Feb 1948	126.0	7th	TC Unnamed #4 1947/48
Kalgoorlie-Boulder Airport	23 Feb 1948	123.4	8th	TC Unnamed #4 1947/48
Cowarna Downs	23 Jan 2014	121.2	9th	Tropical Low 06U
Bulong	22 Jan 1987	116.5	10th	TC Connie

Notes: 1. Prior to 1964 Tropical Cyclones were unnamed and were instead assigned a sequential number by BoM according to the season of their occurrence.

Frequency analyses were carried out on the annual daily maxima for the local BoM rainfall stations. The analyses showed that the 177.8 mm event recorded on 22 February 1948 at both Kalgoorlie-Boulder Airport and Kalgoorlie Post Office had an AEP's of less than 1% (in excess of 100 year ARI).

A listing of the ten wettest days at each of the local stations is provided in Appendix A and is presented by individual station, by total rainfall depth and chronologically.

Sub-Daily Rainfall

Pluviograph data from the three closest regional stations at Leonora (205 km northwest), Kalgoorlie Airport (36 km west) and Cashmere Downs (290 km northwest) were assessed. Table 10 shows the maximum six-minute duration rainfall intensities recorded at each of the pluviograph stations.

Table 10: Regional Stations Maximum Recorded Six & Sixty-Minute Rainfall Intensity

Station Name	Record Length (years approx.)	Max. Six-Minute Intensity (mm/hr)	Date
Leonora	47	141.3	19 Dec 2006
Kalgoorlie Airport	54	152.6	4 Mar 2005
Cashmere Downs	7	167.5	20 Feb 2004

The maximum recorded six-minute intensities shown in Table 10 compare well with the 1% AEP (100 year ARI) six-minute duration Intensity-Frequency-Duration (IFD) intensities shown in the following section. These intensities are considered to be indicative of cyclonic rainfall intensities that could be experienced at the FMC.

Intensity-Frequency-Duration Relationship

Table 11 shows the point rainfall IFD relationship developed for the FMC using the data set updated by BoM in 2016[3].

Table 11: FMC Point Rainfall IFD Relationship

Duration (hours)	50% AEP (mm/hr)	20% AEP (mm/hr)	10% AEP (mm/hr)	5% AEP (mm/hr)	2% AEP (mm/hr)	1% AEP (mm/hr)
0.1 (6 mins)	52.20	80.80	103.00	126.00	160.00	189.00
0.5 (30 mins)	21.80	33.80	42.90	52.70	66.90	79.00
1	13.90	21.40	27.10	33.10	41.90	49.40
2	8.74	13.40	16.90	20.70	26.20	30.80
3	6.65	10.20	12.90	15.80	20.00	23.60
6	4.17	6.44	8.20	10.10	12.90	15.30
12	2.60	4.08	5.25	6.55	8.44	10.10
24	1.60	2.55	3.32	4.20	5.46	6.55
72	0.68	1.11	1.46	1.88	2.45	2.94

The full IFD relationship is presented in Appendix B of this report.

Probable Maximum Precipitation

In order to estimate the probable maximum rainfall (PMP) that might be experienced at the FMC the BoM GSDM and GTSMR Coastal/GSAM Inland methods were applied to the FMC location (refer to Appendix C). The resulting PMP rainfall depths are summarised in Table 12.

Table 12: PMP Rainfall Depth Estimates

Duration (hours)	PMP Depth (mm)	Duration (hours)	PMP Depth (mm)
1	370	12	650
2	470	24	740
3	540	36	910
4	580	48	1,070
5	590	72	1,350
6	600	96	1,510

Cyclone Swept Path Analysis

As discussed earlier, the project site is located within part of the southern Goldfields that is occasionally subject to tropical cyclones, thunderstorms and related events. Of particular note was TC Bobby which crossed the western Pilbara coast near Onslow on 25 February 1995 as a Category 4 event, before continuing southwards across the Gascoyne as a Category 2 event and then the Goldfields as a rain bearing depression. Intense rainfall accompanied Bobby, with Onslow recording more than 400 mm over the duration of the cyclone. Many centres in the Goldfields recorded their

[3] The new IFDs are part of a larger suite of design flood estimation inputs that have recently been revised by BoM, Geoscience Australia and Engineers Australia as part of Australian Rainfall and Runoff 2016.

maximum daily, monthly and annual rainfalls as presented in the preceding sections. Yundamindra and Leonora recorded some 287 mm and 233 mm of rainfall respectively in the four days to 28 February 1995, and a daily rainfall of some 106 mm at Leonora on 27 February. The resulting runoff closed roads and flooded many open pits and underground mines across the region. It was estimated to have caused more than a $50 million loss in gold output alone.

In more recent times, Tropical Low 06U crossed the Northern Territory coast east of Darwin on 14 January 2014 and moved inland causing significant rainfall across vast swathes of inland Australia including the Kimberley, Pilbara, Mid-West and Goldfields regions of Western Australia. Kalgoorlie recorded 103.0 mm during a 24 hour period on 23-24 January and Bulong and Cowarna Downs received some 127 mm and 121 mm respectively to 9 a.m. on 23 January (these amounts are equivalent to approximately the 50 year-24 hour duration rainfall amount). Parts of the arid Nullarbor Plain received more than an entire summer's worth of rain in 24 hours, with Eyre receiving over 106 mm. While this event brought much needed rainfall and alleviated drought conditions over north-west Australia, it also caused widespread flooding and inundation of mines and cattle stations in the Goldfields.

Photograph 1 shows runoff overtopping a public road near Lake Lefroy in the north-eastern Goldfields on 23 January 2014 during Tropical Low 06U.

Photograph 1: Runoff overtopping road on 23 January 2014 during Tropical Low 06U

In order to estimate the frequency that cyclones might be expected in the region, the swept paths of all Australian cyclones from the 1969/70 season to the 2017/18 season were examined and those that passed within a 200 km radius of the FMC site were noted. This radius of influence was arbitrarily chosen as the width within which a cyclone would cause some operational impact to the FMC, even if only minor.

This initial assessment showed that some nine tropical cyclones entered the 200 km radius during the approximately 49-year period of record, or that the long-term regional average is approximately one cyclone within 200 km every five or six years.

A second assessment was carried out to determine the number of cyclones crossing closer to or within 100 km of the FMC site. It was considered that cyclones crossing within this tighter radius would have more significant impacts on the operation, likely leading to lost time and possible asset damage or loss. This assessment showed that six cyclones crossed within a 100 km radius over the approximately 49-year period of record, or one every eight to nine years or so.

A final assessment showed that three cyclones (TC's Ingrid 1970, Billy 1986 and Vance 1999 crossed within a 50 km radius of the FMC site over the approximately 49-year period of record, or one every 16 years or so.

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

2.3.5 Evaporation

The mean monthly Class A bird-guarded pan evaporation measured at Kalgoorlie-Boulder Airport, the closest reliable evaporation gauging site located some 47 km to the northwest, is listed in Table 13.

Table 13: Mean Monthly Pan Evaporation

Month	**Kalgoorlie-Boulder Airport Mean Monthly Pan Evaporation** note 1
January	387.5
February	305.1
March	266.6
April	174.0
May	111.6
June	78.0
July	86.8
August	117.8
September	174.0
October	260.4
November	309.0
December	372.0
Mean Annual Pan Evaporation (mm)	**2,643**

Notes: 1. Kalgoorlie-Boulder Airport values based on BoM's analysis of approx. 50 years of data collected between 1966 and 2016.

The mean annual pan evaporation measured at Kalgoorlie-Boulder Airport is 2,643 mm, which is one order of magnitude greater than the mean annual rainfall for the region. It should also be noted that mean monthly evaporation exceeds mean monthly rainfall throughout the year.

The evaporation data show that evaporation is highest in the summer months from December to February, with January having the highest values.

In the absence of any site based evaporation data, it is recommended that the Kalgoorlie-Boulder Airport dataset be used for FMC purposes.

The Department of Agriculture's (DoA) Technical Report No. 65 referenced earlier states that a 7% coefficient of variation can be applied to mean annual evaporation rates in WA. Applying this coefficient to the project mean annual evaporation of 2,643 mm gives a standard deviation of about 185 mm. Assuming that evaporation data are normally distributed, estimates of annual pan evaporation with 10%, 2% and 1% AEP (10, 50 and 100 year ARI) will be in the order of 2,950 mm, 3,015 mm and 3,200 mm respectively.

The DoA report also states that a "pan to dam" coefficient in the order of 65-70% is appropriate for use for shallow dams and ponds (less than 4 m deep) storing freshwater in the Goldfields. Consequently, mean annual evaporative rates in the order of 1,720 mm to 1,850 mm might be expected from freshwater storage ponds at the project site.

2.3.6 Temperature

Temperature data for the Kalgoorlie-Boulder Airport station, some 47 km northwest of the FMC site, are shown in Table 14.

Table 14: Kalgoorlie-Boulder Airport Monthly Temperature

Month	Mean daily maximum Temp (°C)	Mean daily minimum Temp (°C)	Highest daily Max Temp (°C)	Lowest daily Min Temp (°C)	Mean no. of days where Max Temp ≥ 40.0 °C	Mean no. of days where Max Temp ≤ 2.0 °C
Jan	33.6	18.3	46.5	8.8	3.6	0
Feb	32.1	17.9	44.9	8.5	2.3	0
Mar	29.4	16.1	44.5	5.7	0.6	0
Apr	25.3	12.7	38.9	1.7	0	0
May	20.7	8.7	33.4	-1.8	0	0.7
Jun	17.6	6.3	27.6	-3.0	0	3.8
Jul	16.8	5.1	28.7	-3.4	0	6.3
Aug	18.7	5.7	32.0	-2.4	0	4.6
Sep	22.3	8.0	36.8	-0.6	0	0.8
Oct	25.9	11.2	40.9	-1.0	0.1	0.1
Nov	29.1	14.2	42.9	3.1	0.5	0
Dec	32.0	16.6	45.0	5.5	1.8	0

Note: Kalgoorlie-Boulder Airport daily temperature values based on approximately 77 years of data recorded between 1939 and 2018

The monthly temperature data for Kalgoorlie-Boulder Airport provided the following information regarding temperature:

- Mean daily maximum temperatures range from 33.6°C in January to 16.8°C in July.

- Mean daily minimum temperatures range from 18.3°C in January to 5.1°C in July.
- Highest and lowest daily temperatures of 46.5°C and -3.4°C have been recorded in January (1990) and July (1969) respectively.
- Typically there will be in the order of 9 days each year with daily maximum temperatures in excess of 40°C, practically all of which will occur in December, January and February.
- On average 17 days each year can be expected when minimum temperatures will be 2°C or less and light ground frosts are possible. The bulk of such days will occur in June, July and August.

2.3.7 Wind Speed and Direction

Wind speed and direction data are available for Kalgoorlie-Boulder Airport, some 47 km northwest and Norseman Aero, situated 139 km south of the project site. Both of these stations have the advantage of not only recording wind speed and direction at three-hourly intervals, but also the instantaneous wind gust speed. The 9 am and 3 pm mean monthly wind speeds for both stations and maximum wind gusts for Kalgoorlie Airport are shown in Table 15 and annual wind roses are provided in Appendix A.

Table 15: Mean Monthly 9 am and 3 pm Wind Speed and Maximum Wind Gusts for Kalgoorlie Airport and Norseman Aero Stations

Month and Station Name	Mean 9 am Wind Speed (km/h)		Mean 3 pm Wind Speed (km/h)		Highest Recorded Wind Gust (km/h)	
	Kal. Airport	Norseman Aero	Kal. Airport	Norseman Aero	Kal. Airport	Norseman Aero
Jan	16.6	17.9	15.1	19.1	141	128
Feb	16.4	18.5	15.1	17.7	118	107
Mar	15.7	17.9	14.2	17.3	118	106
Apr	14.4	16.5	13.7	17.9	104	98
May	11.8	13.8	14.1	18.1	122	81
Jun	11.8	13.9	15.7	20.7	102	106
Jul	12.4	14.7	16.6	20.8	97	85
Aug	14.3	16.9	17.2	22.1	108	113
Sep	16.2	20.1	17.8	23.2	109	106
Oct	17.1	20.1	17.6	21.1	117	117
Nov	17.1	19.5	17.2	20.1	139	104
Dec	16.3	18.7	16.0	20.0	122	87

Note: Kalgoorlie Airport mean wind and gust values based on approximately 72 years of data (1939-2010) and 76 years (1939-2016) respectively. Norseman Aero mean wind and gust values based on approximately 11 years of data (1999-2010) and 15 years (2003-2018) respectively.

Mean wind speeds at Norseman Aero are typically 15% fresher than those at Kalgoorlie Airport in the mornings and about 20% fresher in the afternoons. Given that the FMC project site is located roughly midway between both stations, it is likely that it will encounter mean monthly wind speeds similar to those shown above.

The highest instantaneous wind gusts recorded at Kalgoorlie Airport and Norseman Aero were 141 km/h on 14 January 1994 and 128 km/h on 30 January 2011 respectively. Both of these peak gust events occurred when tropical cyclones were active along the WA coastline i.e. TC Pearl in mid-January 1994 and TC Bianca in late January 2011.

Inspection of the 9 a.m. wind roses for the Norseman Aero station show that northerlies in excess of 30 km/h predominate, while at the Kalgoorlie Airport station easterlies of up to 30 km/h are typical. By the afternoon northerlies still predominate at Norseman although their direction changes somewhat to the northwest, while afternoon winds at Kalgoorlie tend to come from the west, although easterlies can still occur.

Norseman Aero experiences calm conditions less frequently than Kalgoorlie with morning calms recorded at Norseman Aero only about 2% of the year and afternoons calms less than 0.5% of the time, compared to 8% and 6% respectively for Kalgoorlie Airport.

2.4 HYDROLOGICAL CONDITIONS

2.4.1 Regional Hydrological Setting

The FMC site is located on DWER's regional watershed with Lake Raeside-Ponton Catchment (area = 115,965 km^2) to the north and Lake Lefroy Catchment (area = 24,880 km^2) to the south, as shown in Figure 3. Both of these catchments form part of the much larger, internally draining Salt Lake Basin (area = 441,000 km^2) which extends across much of central WA.

The Salt Lake Basin comprises several large and broad, sub-parallel, southeast trending salt-lake drainage systems that extend from a regional divide to the west of Wiluna/Sandstone and either drain into Ponton Creek (Raeside and Rebecca system) or terminate at the edge of sand plains (Carey/Minigwal system). These drainages have very low gradients and contain small to very large playa lakes, some with surface areas in excess of 1,000 km^2. Following occasional intense rainfall as a result of tropical cyclones or depression related events the lakes may fill and, following very rare events, some may overflow, link-up and discharge onto the Nullarbor Plain through Ponton Creek, as last occurred following TC Bobby in February 1995.

Currently there are no DWER flow gauging stations within the either the Raeside-Ponton or Lake Lefroy Catchments, or the much larger Salt Lake Basin. It was therefore not possible to review local or regional flow data.

2.4.2 Local Hydrological Setting

There are no significant river systems or watercourses in the vicinity of the FMC, the only noteworthy local hydrological features being Lake Yindarlgooda located some 14 km to the north and Lake Lefroy about 18 km to the south, as shown in Figure 4. Both are large, endorheic salt lakes with surface areas in excess of several hundred square kilometres. The catchment areas that report to Lake Yindarlgooda and Lake Lefroy are approximately 4,125 and 7,698 km^2 respectively. The lakes are normally dry except following periods of significant rainfall-runoff when up to several hundred millimetres of water may be stored in discrete parts of the lake.

Nominal surface elevations in the vicinity of the FMC range between about 390 and 400 mAHD. Natural ground gradients in the vicinity of the FMC are relatively flat with average slopes in the order of 1.0% to 1.5%.

As discussed earlier, DWER's regional watershed divide between Lake Raeside-Ponton and Lake Lefroy Catchments passes through the FMC, as shown on Figure 5 along with existing landforms from previous mining activities. As a result the FMC has no discernible upstream catchment area and proposed surface water management measures need only to be designed for runoff resulting from direct precipitation only i.e. no surface water runoff is expected to report to the proposed project facilities from upstream areas.

Typical existing catchment conditions in the vicinity of the FMC are shown in Photographs 1 to 3.

Photograph No. 1 – Existing Typical Catchment Conditions

Photograph No. 2 – Existing Typical Catchment Conditions

Photograph No. 3 – Existing Typical Catchment Conditions

3.0 SURFACE WATER MANAGEMENT

3.1 SURFACE WATER MANAGEMENT OBJECTIVES

The following three goals define the objectives for surface water management for the FMC:

Reduce Potential Risk of Loss of Life, Health Hazards or Property Damage:

- provide protection for life, livelihood, and property;
- control the incidence of nuisance or damage related to flooding, poor drainage and sedimentation to an acceptable level; and,
- protect project infrastructure.

Preserve the Environment

- minimise the potential project impacts such as changes in the stream-flow regime, alteration of habitat, pollution or increased erosion and sedimentation;
- where feasible, maintain the shape and composition (geomorphology) of the natural watercourse geometry, natural biological indicator conditions and flow conditions;
- employ protection measures to prevent adverse hydrological and water quality impacts for all recognised watercourses within the site limits;
- promote sound development that respects the natural environment; and,
- rehabilitate any watercourses that are impacted as soon as practicable.

Conserve Social and Financial Resources

- treat water as a resource, ensuring that water management facilities are functional and integrate multi-use objectives where possible;
- provide a system of infrastructure that enhances site personnel convenience and safety, and allows development to proceed according to the mine plan;
- sustain future mine development, support orderly and managed development of resources and integration of land uses within the site limits;
- use best management water and sediment practices where feasible; and,
- encourage economic design of drainage systems.

These objectives are intended to ensure a consistent approach to:

- planning and analyses required for surface water management;
- constructing new operational phase surface water management works; and,
- installing future closure phase surface water management works.

The design philosophy and design criteria for floodwater protection and surface water management are presented in the following sections. The FS level design of the various water management facilities is presented in Section 4.0.

3.2 FLOOD RISK

Watercourses in the vicinity of the FMC are ephemeral and are dry for many months and possibly even years at a time. However, flows can occur periodically, particularly during the summer months from January to March, when the potential exposure to high intensity rainfall from remnant tropical cyclones and related depressions is greatest. Such events may cause localised flooding and asset damage or loss if appropriate measures are not in place.

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

- magnitude of the flood event;
- proximity of the facility to the watercourse in flood;
- sensitivity of the facility to flooding; and,
- 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 may lead to flooding that cannot be controlled.

Although significant rainfall-runoff events do not occur cyclically, especially in a climatic region as variable as this, their probability of occurrence within any given period can be estimated. The reciprocal of this probability is typically expressed as an AEP or ARI. Table 16 shows the percentage probability for a range of different AEP flood events that could occur during the currently proposed three year operational life of the FMC.

Table 16: Percentage Probability of Various Flood Events Occurring During Operational Life

Annual Exceedance probability (AEP)	**20%**	**10%**	**5%**	**2%**	**1%**
Probability of Occurrence	48.8%	27.1%	14.3%	5.9%	3.0%

It is recommended that a 1% AEP (1 in 100) design criterion be applied to the pit flood protection measures during Operations, while it has been assumed that a 10% AEP criterion is suitable for the design of all other on-site drainage measures. Typically a range of AEP 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 50% AEP event, while culverts below a main plant access road might be designed for the 10% or 5% AEP event, depending on the consequences of failure.

Good practice suggests that when preparing earthworks pads for mine facilities that they be kept above the 5% AEP flood level as minimum[4]. It should be noted that the probabilities of occurrence of the 5% or 1% events occurring during the envisaged ten year operational life of the project are roughly 40% and 10% respectively.

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

3.3 Pit Flood Protection Design Philosophy

Inspection of the available topographical mapping and aerial photography indicate that the only credible flood risks to the proposed FMC relates to potential flooding of the open pits from direct precipitation. This risk will be ameliorated by the construction of the pit safety bund.

In addition, flood risks to the proposed pits should be minimised by a combination of the following customary measures:

- Grading (cut/fill earthworks) and roadside drains to direct runoff away from the pits;
- "Roll-over" at the top of the pit ramps to minimise surficial inflows to the pits; and,
- Provision of in-pit temporary storage sumps and pumping system;

Ideally only direct precipitation that falls within the pit crests should report to sumps on the floor of the various pits.

3.4 In-Pit Runoff Volume Estimate

Even with the provision of the ex-pit surface water management measures identified above some runoff will report in-pit from direct precipitation and runoff from minor adjacent areas. An estimate of the anticipated rainfall-runoff volume from a range of events is presented in Table 17. The volumes presented in the table are based upon neat pit crest areas with a 10% allowance for adjacent ex-pit areas, an in-pit runoff coefficient of 90% and the 72 hour duration rainfall IFD values shown below (refer to Appendix B):

- 50% AEP = 49 mm;
- 20% AEP = 78 mm;
- 10% AEP = 105 mm;
- 5% AEP = 135 mm
- 2% AEP = 176; and,
- 1% AEP = 212 mm.

Table 17: In-Pit Runoff Volume Estimates

72 hour Duration Rainfall Event	Pit Runoff Volume (m^3)see note		
	Fingals Fortune Pit	Bagus Pit	Futi Bagus Pit
50% AEP	16,700	3,100	2,400
20% AEP	26,500	4,900	3,700
10% AEP	35,700	6,500	5,000
5% AEP	45,900	8,400	6,400
2% AEP	59,800	10,900	8,400
1% AEP	72,100	13,100	10,100

Note: Assumes that pit is empty at start of rainfall event and pit crest areas of 308,800 m^2, 55,950 m^2 and 42,900 m^2 for Fingals Fortune, Bagus and Futi Bagus Pits respectively.

The periodic collection of in-pit runoff within the open pits is likely to only lead to operational delays and it is therefore unlikely that special measures such as a minimum capacity sumps and dedicated, fixed pumps are warranted. When it is necessary to remove runoff that might periodically collect on the floor of the pits, it is envisaged that mobile pumps will be used temporarily, with pumpage delivered to a turkeynest pond on surface or possibly ex-pit subject to DWER approval.

It is critical however that all necessary surface water management measures are installed and carefully maintained in order to minimise runoff from ex-pit areas reporting to the pit voids.

The required storage volumes for sumps should be re-assessed for the final pit shells once they are better defined, particularly if Black Cat intends to develop underground workings from one of the open pits.

3.5 Stormwater and Sediment Management Philosophy

In addition to protecting the proposed pit and mine facilities against flooding from low frequency flood events such as the 1% AEP event discussed above, it will also be necessary to manage runoff from more common rainfall events. Although such events give rise to much lower runoff rates and volumes they should be managed appropriately in order to protect project infrastructure, minimise erosion and reduce the potential loss of sediment laden or other contaminated runoff from the FMC.

For the management of stormwater the various project facilities should therefore be generally segregated as follows:

- Mine Services Area;
- Hazardous Material Storage Areas;
- Disturbed Mine Areas; and,
- Undisturbed Mine Areas.

3.5.1 Mine Services Area

The Mine Services Area will include surface water runoff and wash down water drainage and recovery systems. Rainfall runoff from the Mine Services Area including roads, building roofs, laydown yards etc. will be captured in open drains. The drains will report to Water Management/Sedimentation Pond(s) where water will be temporarily stored prior to reuse.

To aid management of runoff from areas likely to be impacted by hydrocarbons, e.g. fuel storage and dispensing areas, truck wash and workshops, it is proposed to capture runoff from these areas using open drains that report to an oily water separator (OWS) provided upstream of Water Management/Sedimentation Pond(s).

Mine Services Area drains will be sized for the peak of the 10% AEP event as a minimum. Flow velocities along such drains will be limited to minimise erosion and the generation of sediment.

3.5.2 Hazardous Materials Storage Areas

All chemical, oil and other hazardous material storage areas within the Plant or Mine Services/Workshop Area will be enclosed within a bund in accordance with the relevant codes and standards. Water collected within the bunds will be assessed and, if suitable, will be discharged to Water Management/Sedimentation Pond(s).

Water collected within the bunds that is found to be impacted will be disposed of appropriately.

3.5.3 Disturbed Areas

Outside the Plant and Mine Services/Workshops areas the mine facilities will comprise various pits, waste rock dumps, topsoil stockpiles, ROM, TSF and access and haul roads. Source controls will be used to improve the quality of runoff from these facilities. Runoff from these facilities will be directed to Water Management/Sedimentation Pond(s) where possible.

For runoff within the proposed pits, source controls will comprise practices such as mining from upper benches or processing stockpiled material following significant rainfall events. In-pit sumps will be used to settle out sediment from collected runoff prior to pumping to surface for re-use or discharge off-site.

3.5.4 Undisturbed Areas

All practical steps will be taken to divert runoff from undisturbed catchment areas around all proposed mine facilities to minimise potential lowering of water quality. Diversion channels around mining areas will be designed for the 1% AEP event or for the 10% AEP event for diversions around less sensitive facilities. Flow velocities along all diversion channels will be limited to minimise erosion and the generation of sediment.

3.6 Drainage and Sediment Control Design Criteria

The following design criteria will be applied to drainage measures for the project facilities:

3.6.1 Peak Flow Estimation

Peak discharges from catchment areas of less than 10 hectares will be estimated using the Rational Method (i.e. Q = CIA). The average run-off coefficient (C) will be based on the values presented in Table 18 below.

Table 18: Run-off Coefficients

Catchment Type	Run-off Coefficient
Undisturbed areas	0.20
Gravel roads and yard areas	0.50
Asphalt, concrete and roof areas	0.90

Rainfall intensity (I) for the event duration will be interpolated from the rainfall Intensity Duration Frequency (IDF) relationship developed for the FMC provided in Appendix B. The time of concentration of each catchment area will be determined in accordance with the Kirpich Equation as follows:

$T_c = 0.00032 \times L^{0.77} \div S^{0.385}$

Where:

T_c = Time of concentration (hours).

L = Maximum length of water travel (m).

S = Average Slope (m/m).

The minimum time of concentration to be used for design purposes will be 5 minutes. Catchment areas (A) will either be measured directly in the field or calculated using CAD tools and the latest field survey data.

Peak discharge estimates from areas larger than 10 hectares will be obtained by using hydrologic modelling methods such as those presented in ARR16.

3.6.2 Channel Design

Channel design parameters will be determined using Manning's Equation as follows:

$Q = (A\ R^{2/3}\ S^{1/2})/n$

Where:

Q = flow rate (m^3/sec).

A = cross-sectional area of channel (m^2).

n = roughness coefficient, as per values presented below (dimensionless).

R = hydraulic radius, i.e. cross-sectional area, A, divided by wetted perimeter, P (m)

S = channel slope (m/m).

Roughness coefficients will be based on the values presented in Table 19 below:

Table 19: Roughness Coefficients

Channel Type	Roughness Coefficient
Unlined Earth, Clean, recently completed	0.016-0.018
Unlined Earth, With short grass, few weeds	0.022-0.027
Unlined Rock, Smooth and uniform	0.035-0.040
Unlined Rock, Jagged and irregular	0.040-0.045
Lined, Formed concrete	0.017-0.020
Lined, Random stone mortar	0.020-0.023
Lined, Dry rubble (rip-rap)	0.023-0.033

3.6.3 Drainage Design

Open Drain Construction

Open drain construction will be based upon the following criteria:

- Minimum self-cleansing velocity of 0.7 m/sec for a 50% AEP event;
- Maximum velocity of 1.0 m/s for a 10% AEP event for unlined earth channels with no specific erosion protection;
- Minimum 250 mm freeboard on open drains; and,
- Channel erosion control protection in the form of appropriate drop structures, rock check dams, rock-lined channels or concrete lined channels.

Culvert Installation

The minimum culvert diameter will be 450 mm. Culverts will be installed at slopes that will provide self-cleansing minimum velocities of 0.7 m/s for one-third depth of full-flow wherever possible.

Hardstand Area Drainage

Hardstand area drainage will be designed with a minimum surface grade of 0.5% in open yard areas and a minimum grade of 2% for a distance of 25 m away from structures.

Hardstand areas with finished elevations 1 m or greater above natural surface elevations will have a safety bund constructed along their outside edge. Suitably spaced breaks will be placed along the bund to allow runoff to escape. Rock or geomembrane lined slope drains will be constructed at these breaks to minimise erosion of fill material.

3.6.4 Water Management/Sedimentation Pond Design

For preliminary design purposes water management/sedimentation ponds will be designed to store runoff from the 10% AEP 24-hour rainfall event i.e. 80 mm rainfall, without discharge.

The detailed design of sedimentation ponds will be based on removing the settleable fraction down to a selected minimum design particle size based on an analysis of the sediment particle size distribution reporting to the pond. The adopted design particle size will correspond to 25% of the sample passing by weight or an absolute minimum particle size of 20 micron (unless chemical coagulant dosing is used). The required pond surface area will be estimated using the peak inflow rate and design particle settling velocity according to Stokes Law and applying published sedimentation efficiency factors[5].

Sedimentation ponds will have a minimum live settling depth of 1 m and an aspect ratio (length: width) of not less than 3:1 and preferably 5:1. Sufficient provision for dead (sediment) storage and freeboard will also be made.

3.6.5 Oily Water Separator Design

All potentially hydrocarbon impacted water from wash-down and re-fuelling facilities will be directed to a suitable gravity type OWS prior to collection and re-use.

[5] *The Constructed Wetlands Manual (Volumes 1 & 2)*, Department of Land and Water Conservation, New South Wales, 1998.

4.0 FS ENGINEERING DESIGN

The accompanying Drawing No. J2134R01-D01 shows the preliminary project layout relative to the local catchment divide and inferred drainages. This layout has been based on the aerial photography, topographical data set and Black Cat's September 2021 project infrastructure layout.

5.0 CLOSING REMARKS

A desktop study was completed to develop hydro-meteorological information that was then used in the FS level design of surface water management measures at the proposed Fingals Mining Centre.

The fact that the project site straddles the regional catchment divide means that no runoff will report from upstream catchment areas and proposed surface water management measures will only be required for runoff from direct precipitation over the immediate project site. The resulting surface water management measures required for the project are therefore minimal.

We trust that this report satisfies Black Cat Syndicate Ltd's current requirements and we look forward to discussing the future development of the project with you.

Groundwater Resource Management Pty Ltd

[redacted] [redacted]

Doc Ref: J2134R01 Black Cat Fingals Find Final 210929.docx

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 1
FINGALS MINING CENTRE
LOCATION PLAN WITH
BoM REGIONAL SYNOPTIC STATIONS

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Figure scale = 1:1,000,000 @ A3.
2. Coordinates to WGS84/Lat-Lon.

Sources
1. Climate stations Regional from BoM www.bom.gov.au/climate/data/stations/
2. Topo mapping Geoscience Australia https://ecat.ga.gov.au/geonetwork

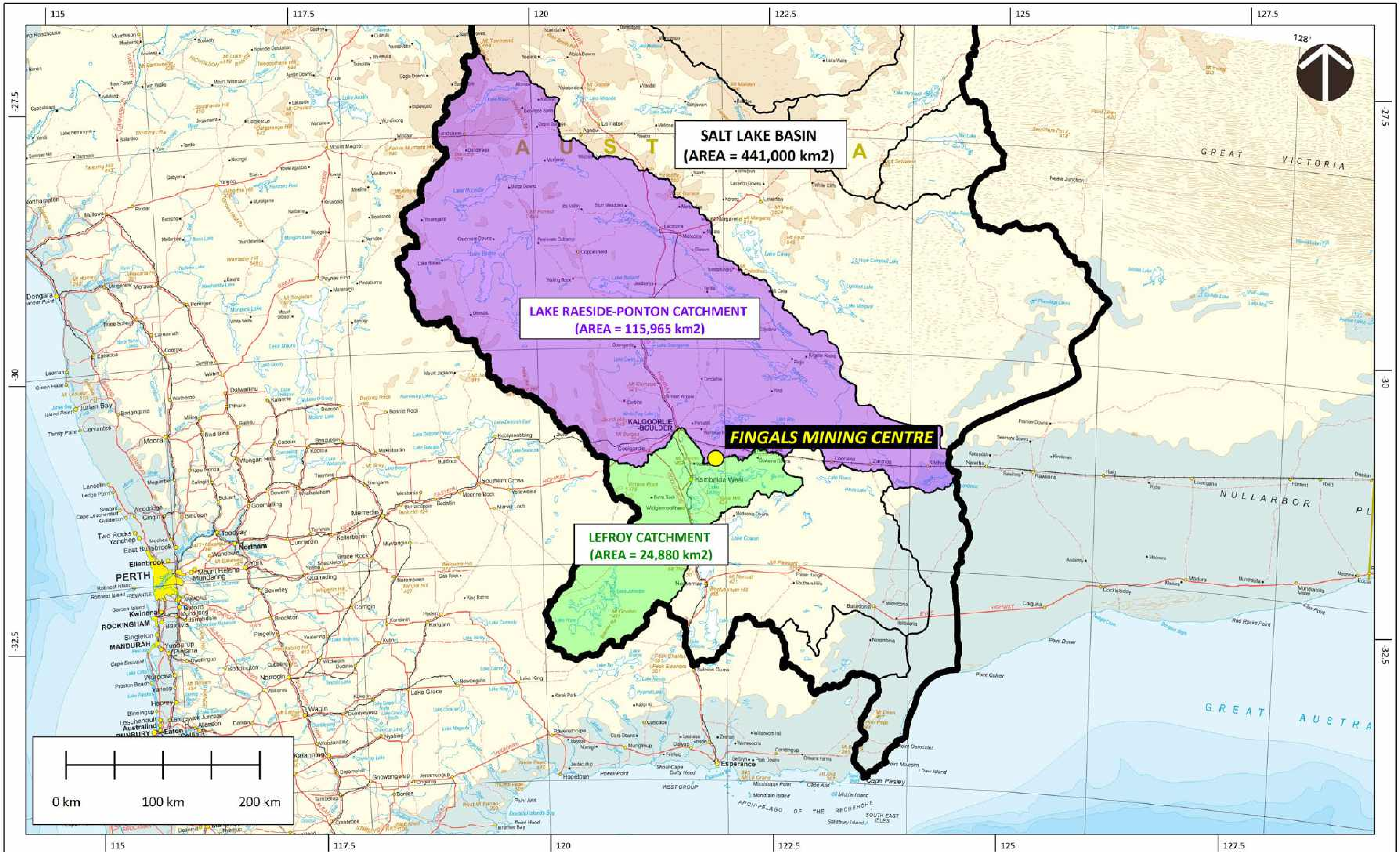
GROUNDWATER
RESOURCE MANAGEMENT

FIGURE 2
FINGALS MINING CENTRE
LOCATION PLAN WITH
BoM LOCAL RAINFALL STATIONS

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Figure scale = 1:275,000 @ A3.
2. Coordinates to WGS84/Lat-Lon.

Sources
1. Climate stations Regional from BoM
www.bom.gov.au/climate/data/stations/
2. Topo mapping Geoscience Australia
https://ecat.ga.gov.au/geonetwork



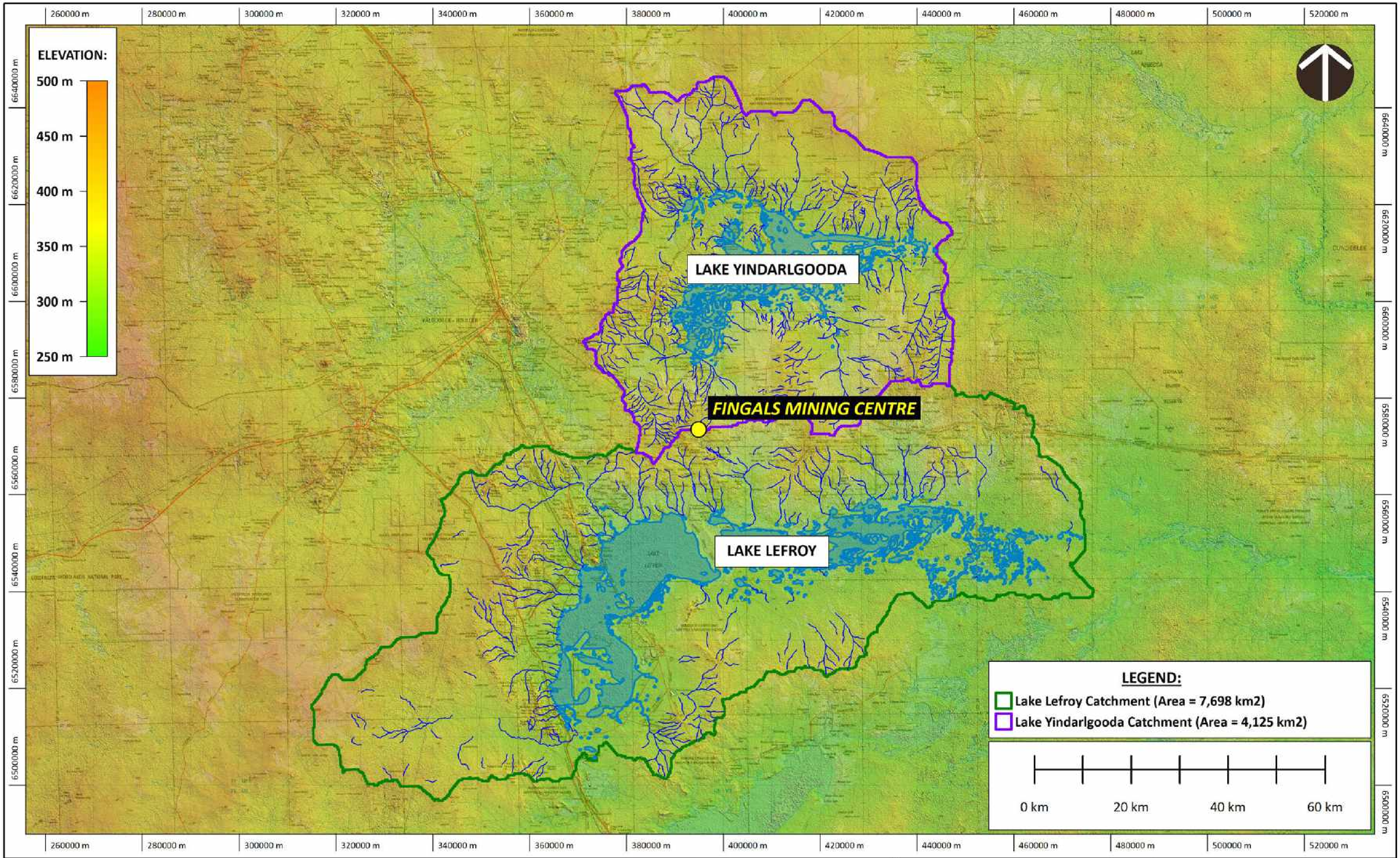
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 3
FINGALS MINING CENTRE
LOCATION PLAN WITH
DWER BASINS AND CATCHMENTS

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Figure scale = 1:3,500,000 @ A3.
2. Coordinates to WGS84/Lat-Lon.

Sources
1. Catchment shapes from DWER
http://www.water.wa.gov.au/
2. Topo mapping Geoscience Australia
https://ecat.ga.gov.au/geonetwork



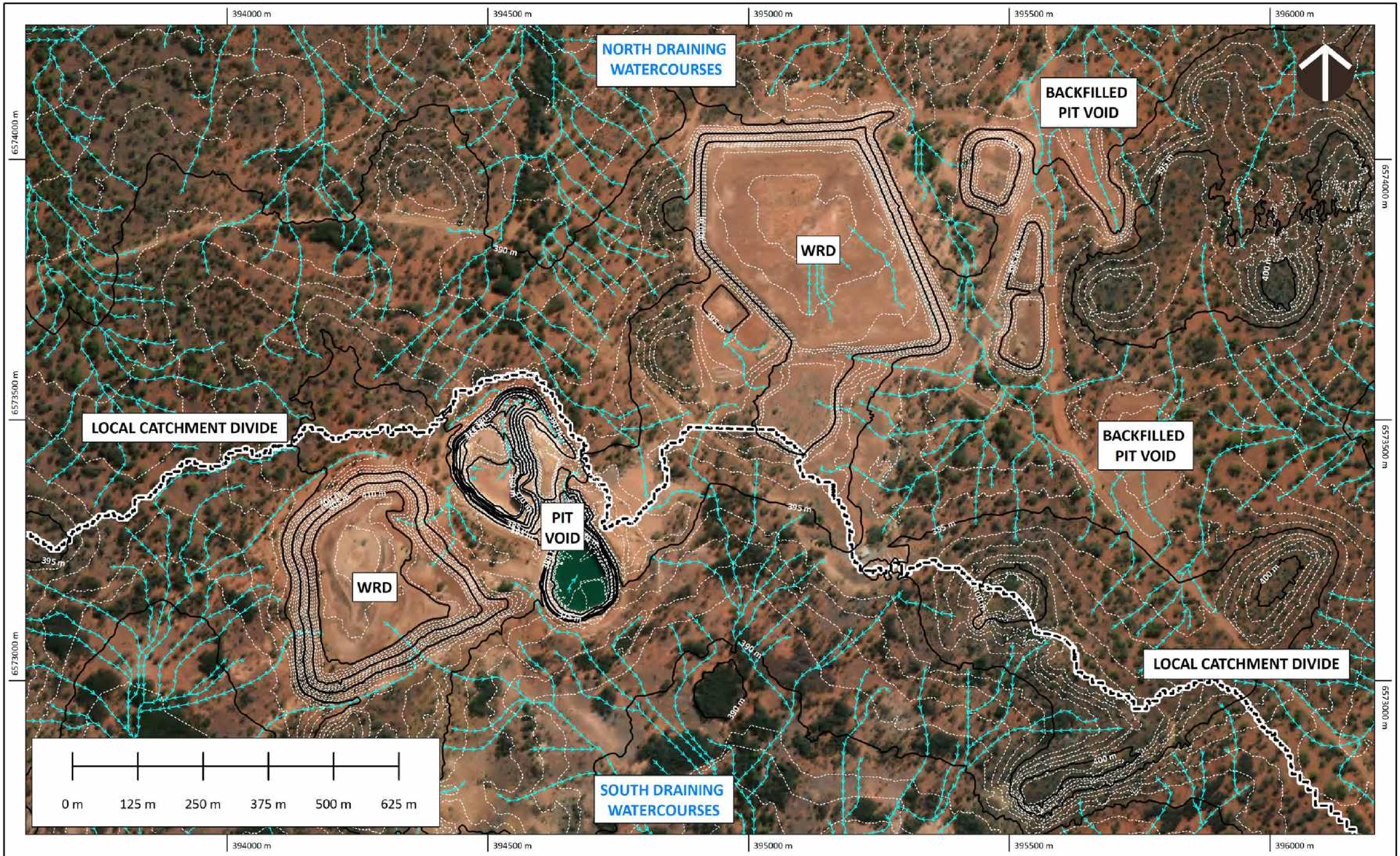
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 4
FINGALS MINING CENTRE LOCATION PLAN WITH LOCAL CATCHMENT DELINEATION

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Figure scale = 1:700,000 @ A3.
2. Coordinates to GDA94/MGA51.
3. DEM from Geoscience Australia's 1-sec SRTM dataset.

Sources
1. Catchment shapes from BoM Australian Hydrological Geospatial Fabric Dataset.
2. Topo mapping Geoscience Australia 250K NATMAP series.



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 5
FINGALS MINING CENTRE
SITE CATCHMENT DELINEATION & EXISTING LANDFORMS

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Figure scale = 1:6,500 @ A3.
2. Coordinates to GDA94/MGA51.
3. Catchment delineation developed using GIS Spatial Analysis tools.
4. Major/minor contour Interval = 5m/1m.

Sources
1. Satellite imagery from ESRI World Imagery.

APPENDIX A

Hydro-Meteorological Data & Analysis Results

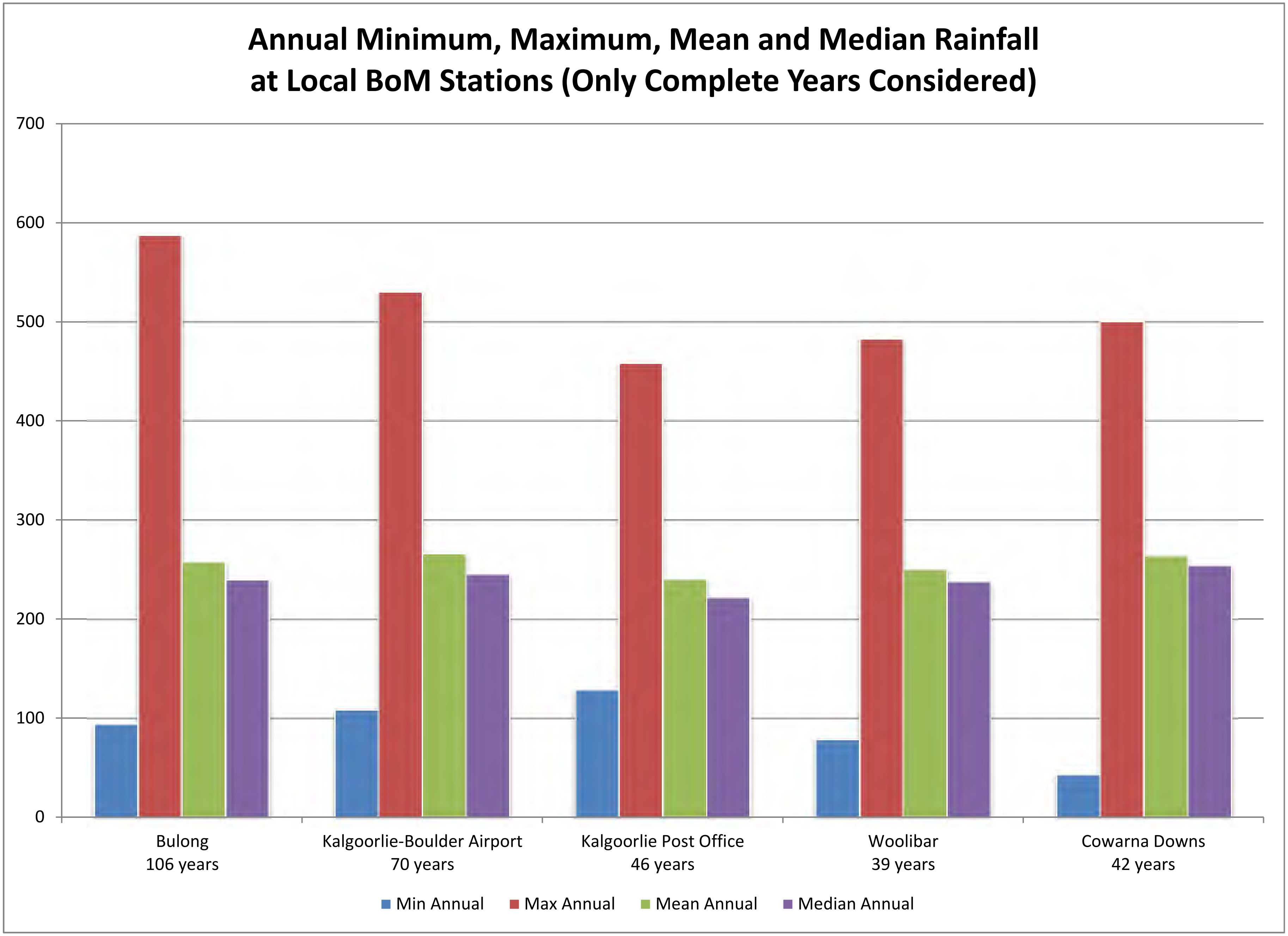
Annual and Monthly Rainfall Values

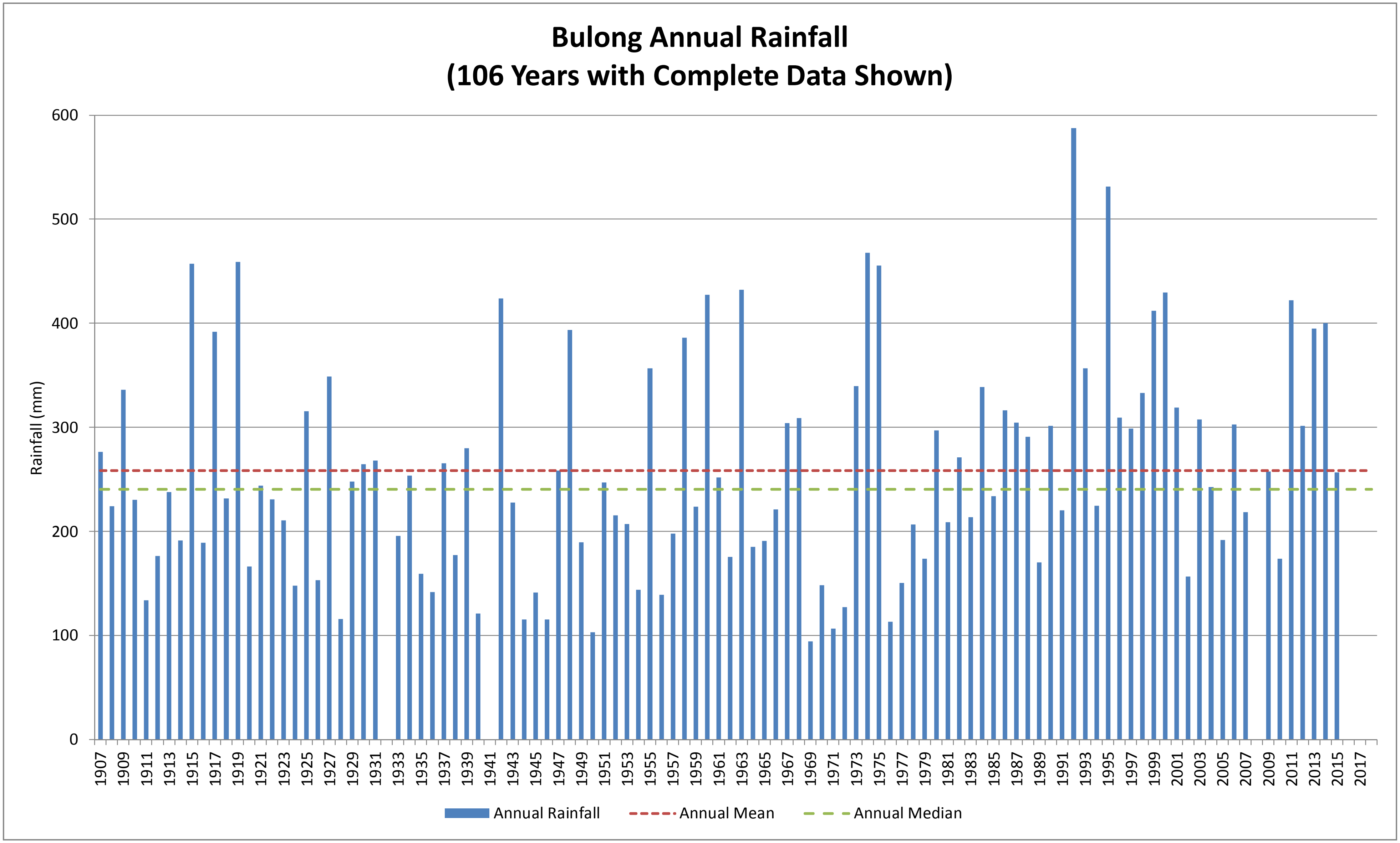
for Local BoM Rainfall stations (all within approximately 50 km of Fingals Mining Centre)

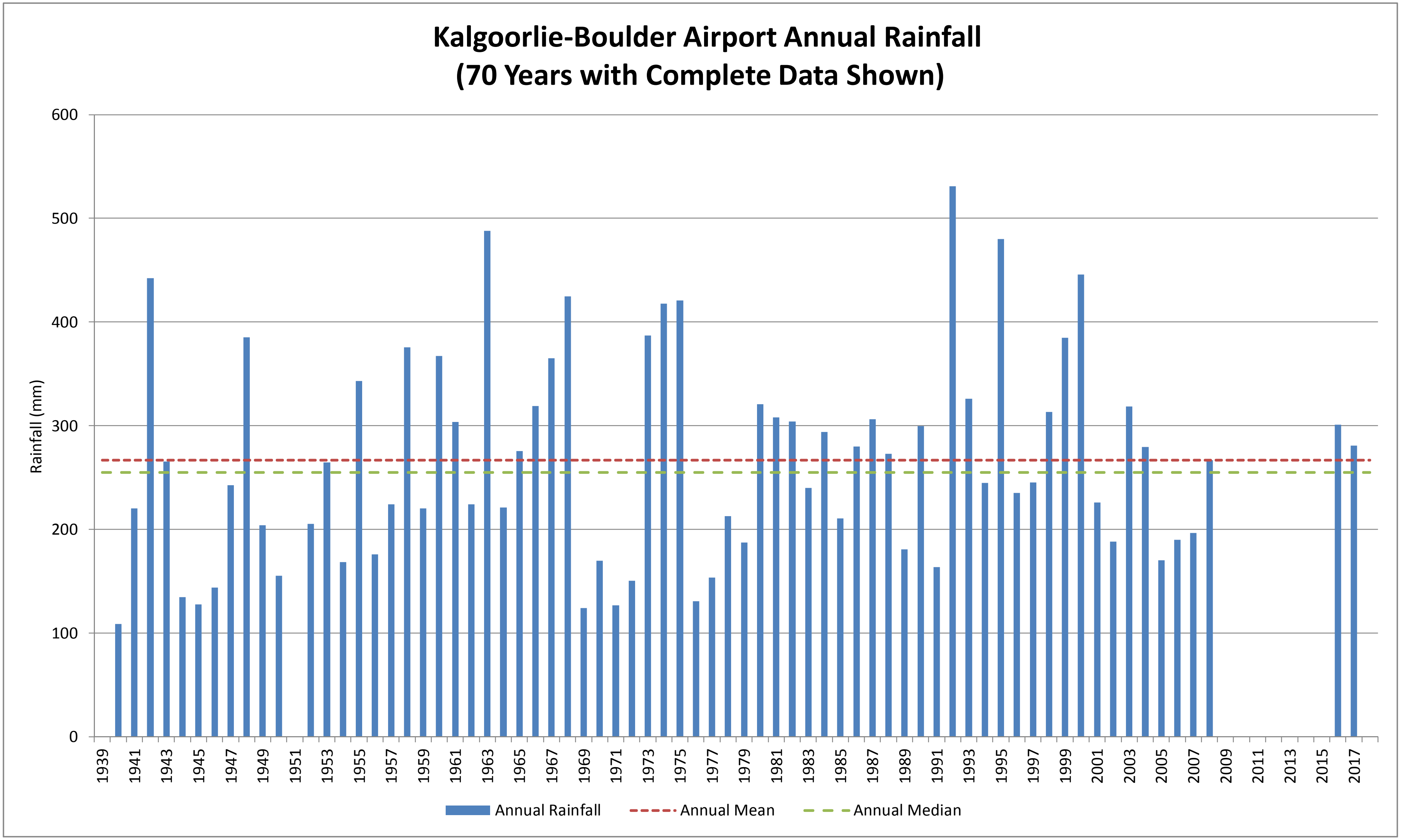
	Bulong				**Kalgoorlie-Boulder Airport**				**Kalgoorlie Post Office**				**Woolibar**				**Cowarna Downs**			
Min Annual	94.2				108.7				129.3				79.0				43.8			
Max Annual	587.7				530.8				458.7				483.8				500.8			
Mean Annual	258.5				266.9				240.7				251.4				266.8			
Median Annual	240.4				254.9				222.5				238.4				259.5			
No. of Complete Years	106				70				46				39				42			
	Mean	Max	Min	Count	Mean	Max	Min	Count	Mean	Max	Min	Count	Mean	Max	Min	Count	Mean	Max	Min	Count
Jan	23.4	174.0	0.0	109	25.1	185.9	0.0	73	17.4	203.6	0.0	47	30.9	164.9	0	47	22.6	194.4	0	47
Feb	28.9	315.7	0.0	107	30.9	307.8	0.0	71	22.2	314.5	0.0	47	35.4	227.6	0	44	35.5	262.6	0	43
Mar	27.1	222.4	0.0	110	24.0	197.0	0.0	71	30.6	166.5	0.0	47	25.4	180.4	0	44	26.0	159.6	0	43
Apr	21.1	99.3	0.0	110	20.9	98.6	0.0	73	23.1	102.6	0.0	47	18.1	114.7	0	45	16.5	60.8	0	45
May	24.4	104.9	0.0	109	26.9	110.2	0.0	72	25.8	86.7	0.0	47	23.9	105.0	0	45	22.4	76.2	0	43
Jun	26.2	118.7	0.5	110	27.7	185.7	1.4	78	24.5	77.2	0.0	47	21.9	74.0	0	44	19.9	73.0	0	42
Jul	23.0	85.0	0.0	108	25.0	82.6	0.6	71	21.8	56.5	2.0	47	23.9	75.2	0	42	22.7	81.5	0	44
Aug	22.0	96.4	0.0	109	21.3	74.0	1.6	70	22.8	80.2	0.0	47	18.5	64.6	0	46	19.1	72.0	0	43
Sep	13.5	101.7	0.0	111	14.2	98.3	0.3	71	9.1	42.7	0.0	47	15.9	101.2	0	42	14.6	77.6	0	47
Oct	15.5	95.7	0.0	111	14.6	84.4	0.0	72	15.8	70.6	0.0	46	13.7	85.2	0	44	18.3	113.4	0	45
Nov	16.9	97.0	0.0	108	17.6	115.4	0.0	71	14.7	70.2	0.0	46	16.9	84.8	0	45	20.4	89.4	0	43
Dec	16.6	99.0	0.0	109	16.5	88.6	0.0	71	14.2	65.3	0.0	46	18.2	69.6	0	47	18.5	60.2	0	46
No. of Complete Months				*1,311*				*864*				*561*				*535*				*531*

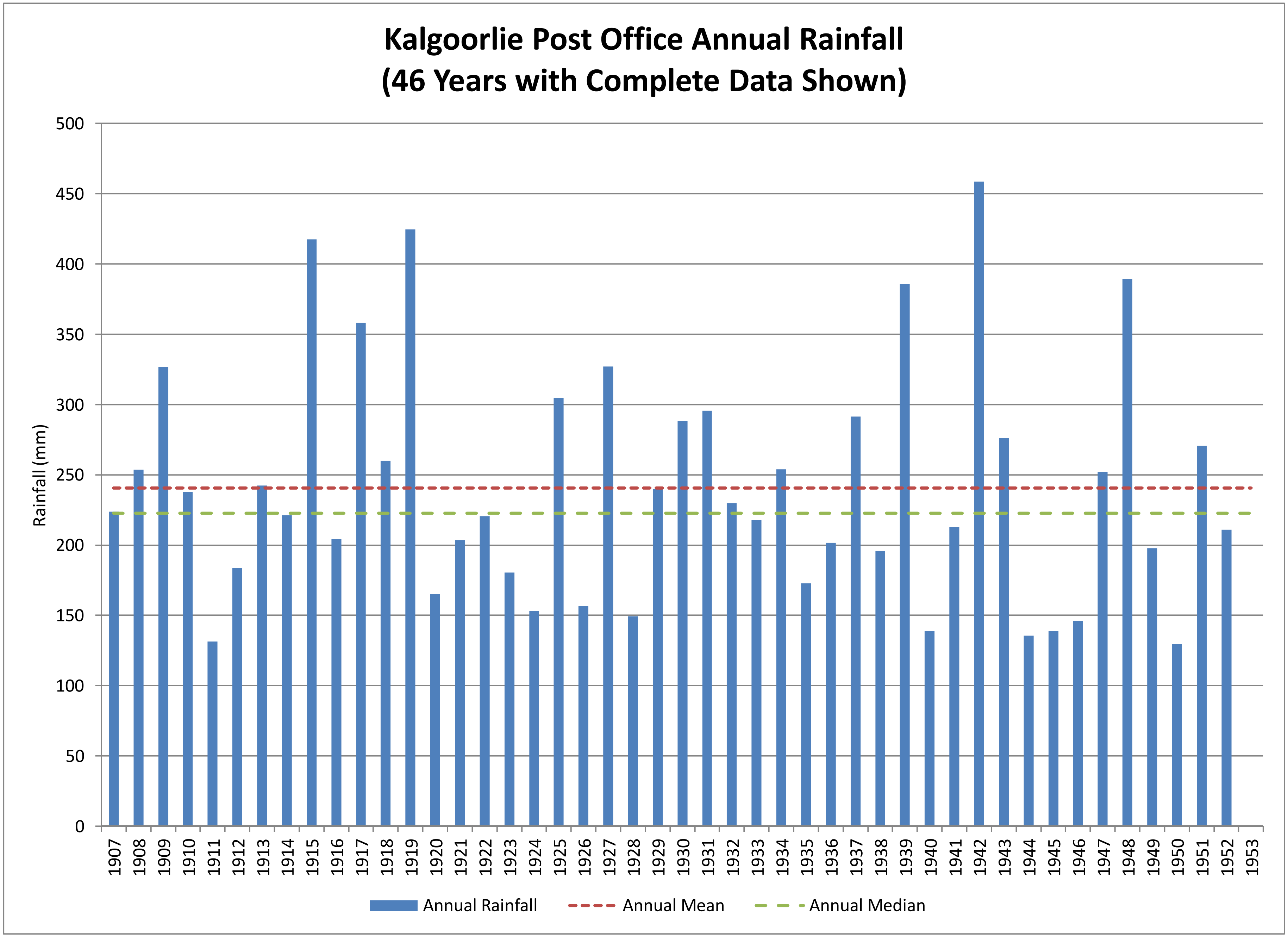
Notes:

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

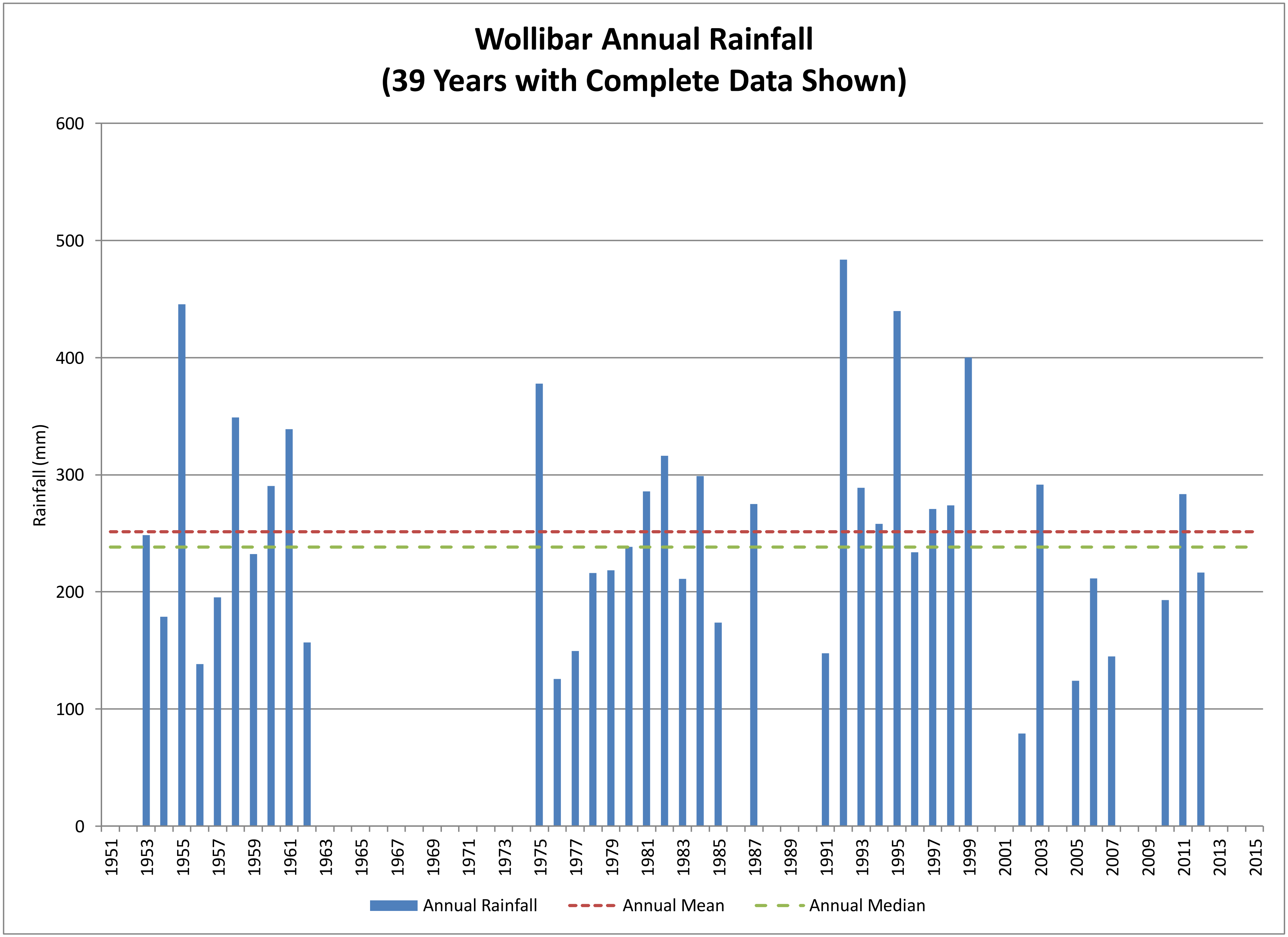

Annual Minimum, Maximum, Mean and Median Rainfall
at Local BoM Stations (Only Complete Years Considered)
700
600
500
400
300
200
100
0
Bulong
106 years
Kalgoorlie-Boulder Airport
70 years
Kalgoorlie Post Office
46 years
Woolibar
39 years
Cowarna Downs
42 years
Min Annual
Max Annual
Mean Annual
Median Annual

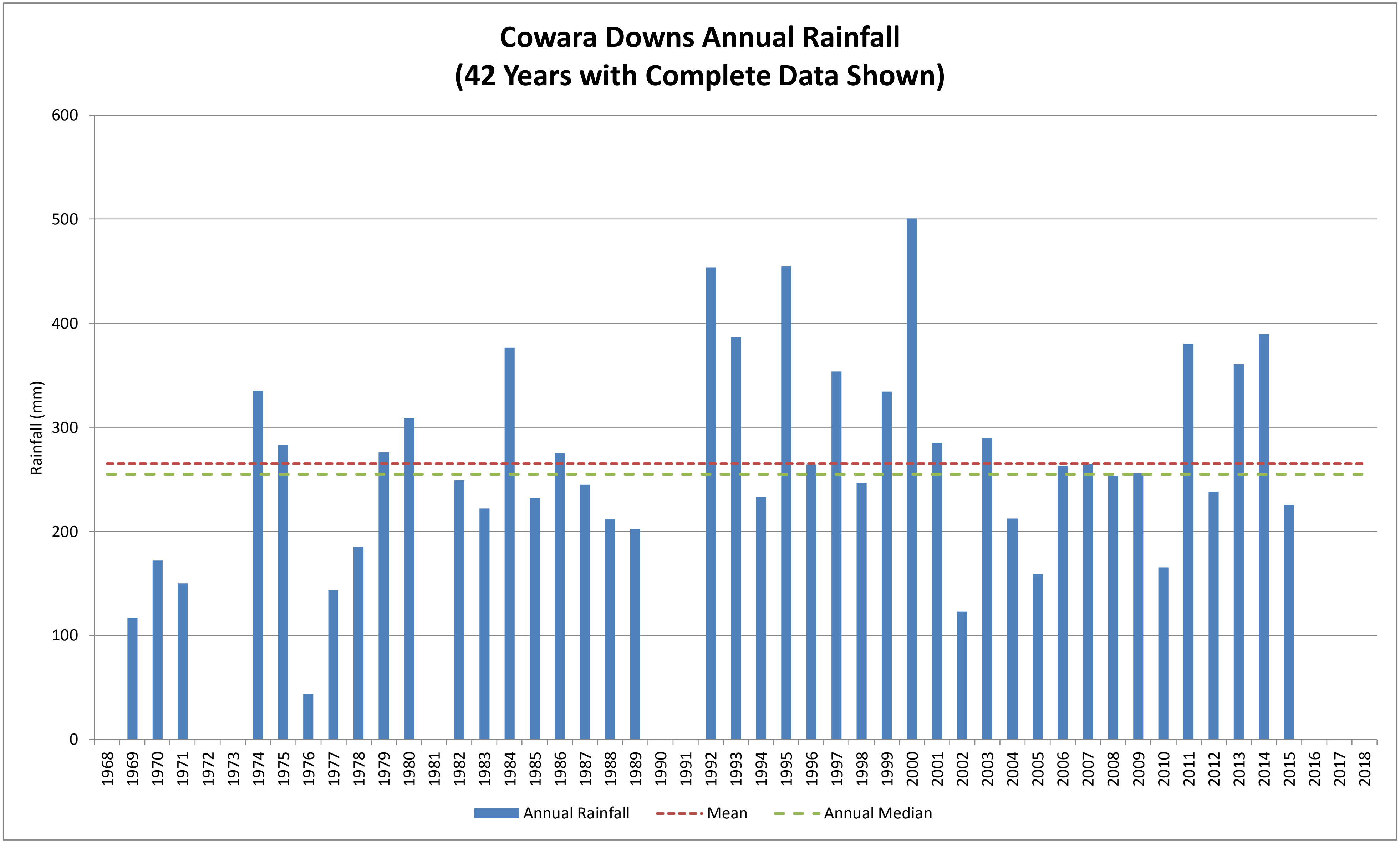

Bulong Annual Rainfall
(106 Years with Complete Data Shown)
600
500
400
300
200
100
0
Rainfall (mm)
1907
1909
1911
1913
1915
1917
1919
1921
1923
1925
1927
1929
1931
1933
1935
1937
1939
1941
1943
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Annual Rainfall
Annual Mean
Annual Median


Kalgoorlie-Boulder Airport Annual Rainfall
(70 Years with Complete Data Shown)
Rainfall (mm)
600
500
400
300
200
100
0
1939
1941
1943
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Annual Rainfall
Annual Mean
Annual Median

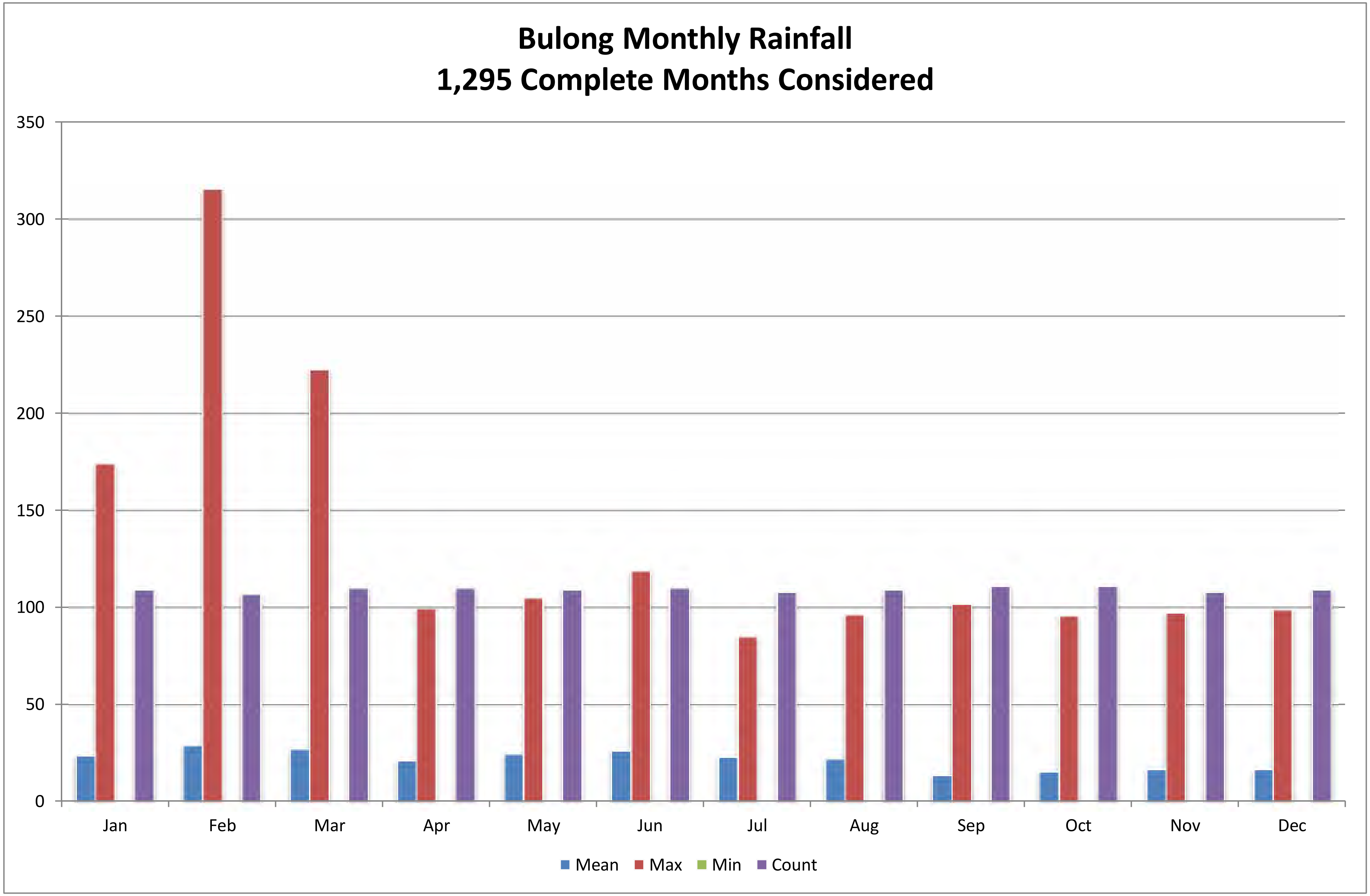


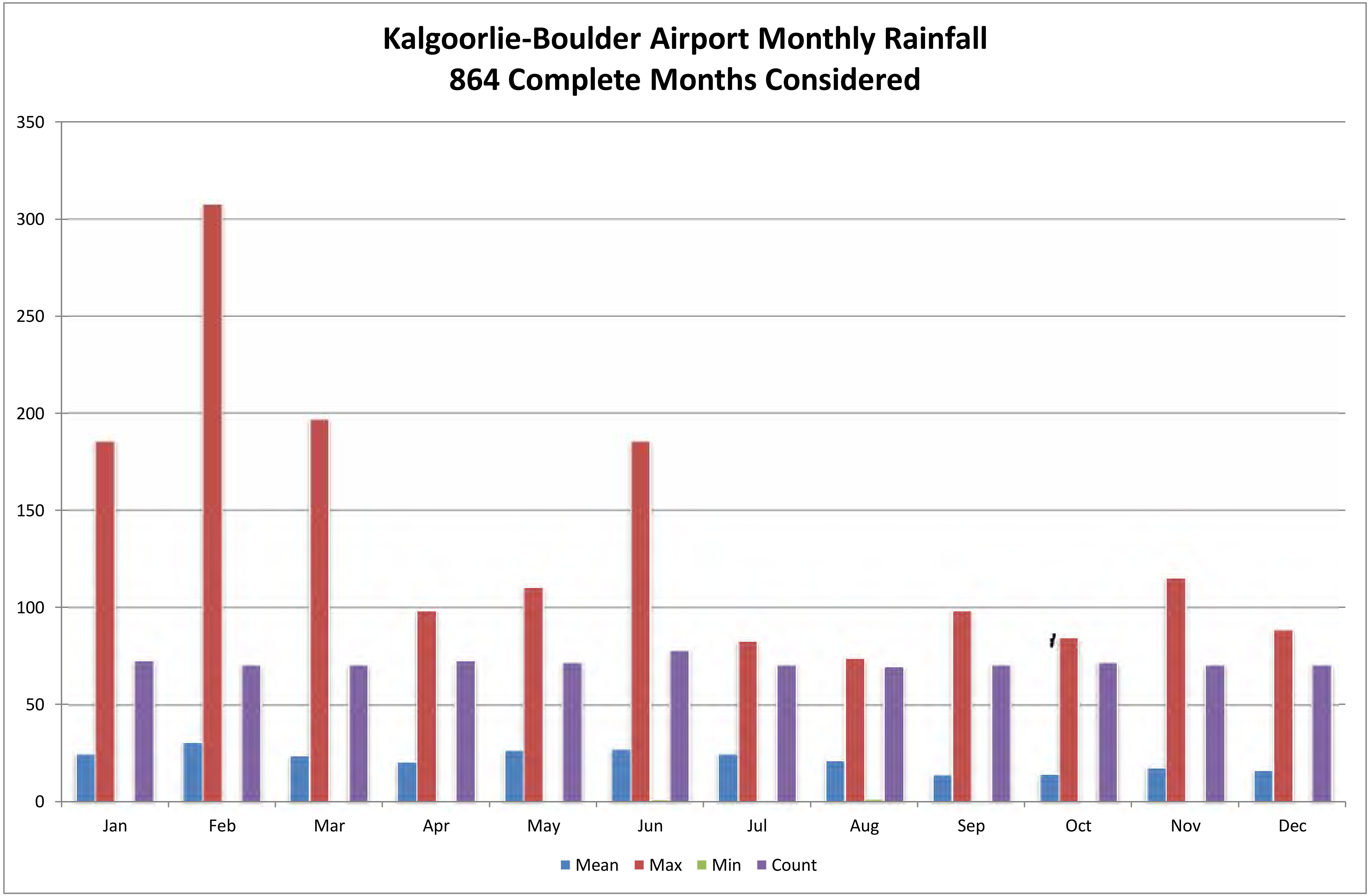
Kalgoorlie Post Office Annual Rainfall
(46 Years with Complete Data Shown)
Rainfall (mm)
500
450
400
350
300
250
200
150
100
50
0
1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953
Annual Rainfall
Annual Mean
Annual Median


Wollibar Annual Rainfall
(39 Years with Complete Data Shown)
Rainfall (mm)
0
100
200
300
400
500
600
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Annual Rainfall
Annual Mean
Annual Median

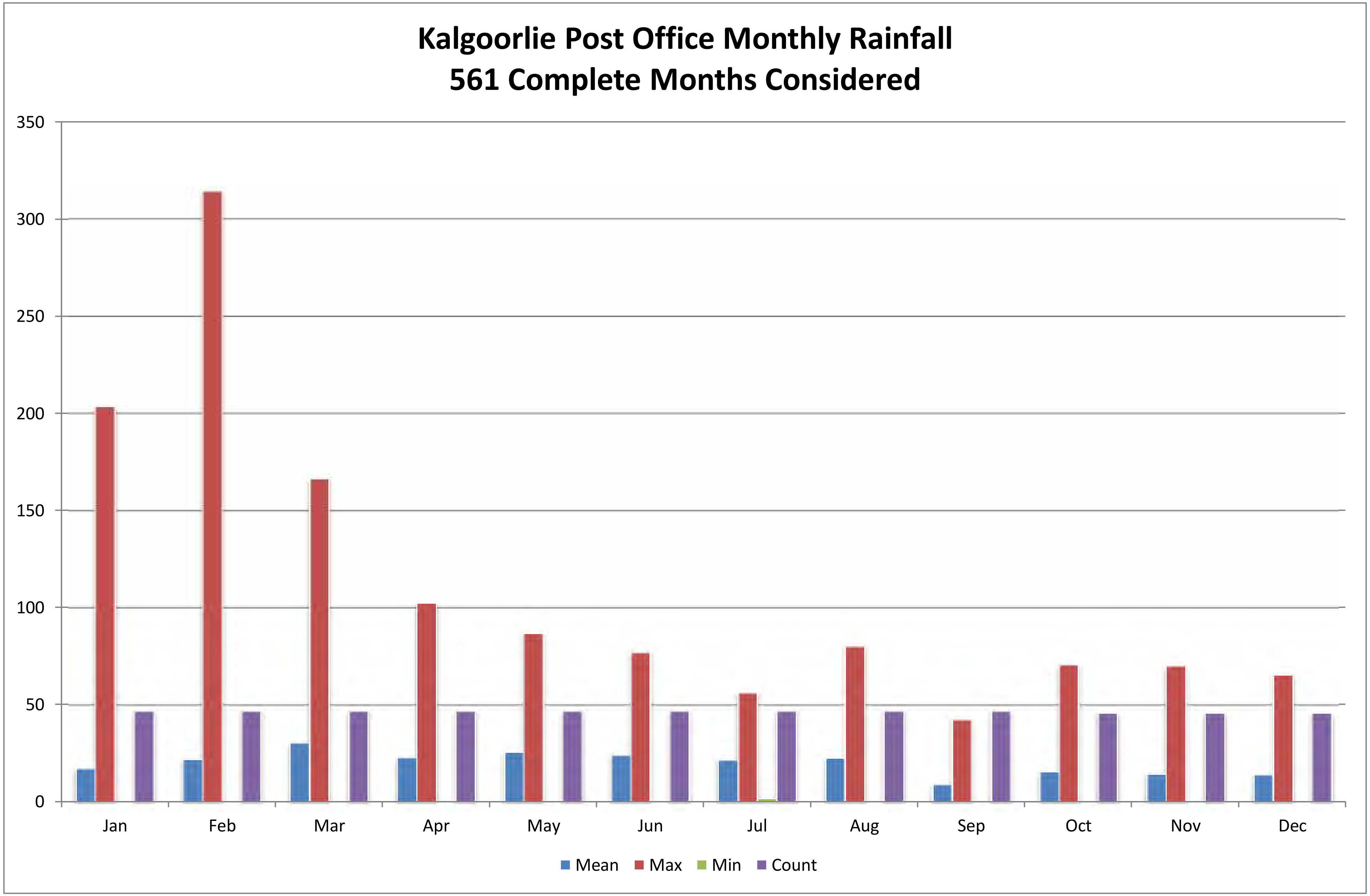


Cowara Downs Annual Rainfall
(42 Years with Complete Data Shown)
Rainfall (mm)
0
100
200
300
400
500
600
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Annual Rainfall
Mean
Annual Median

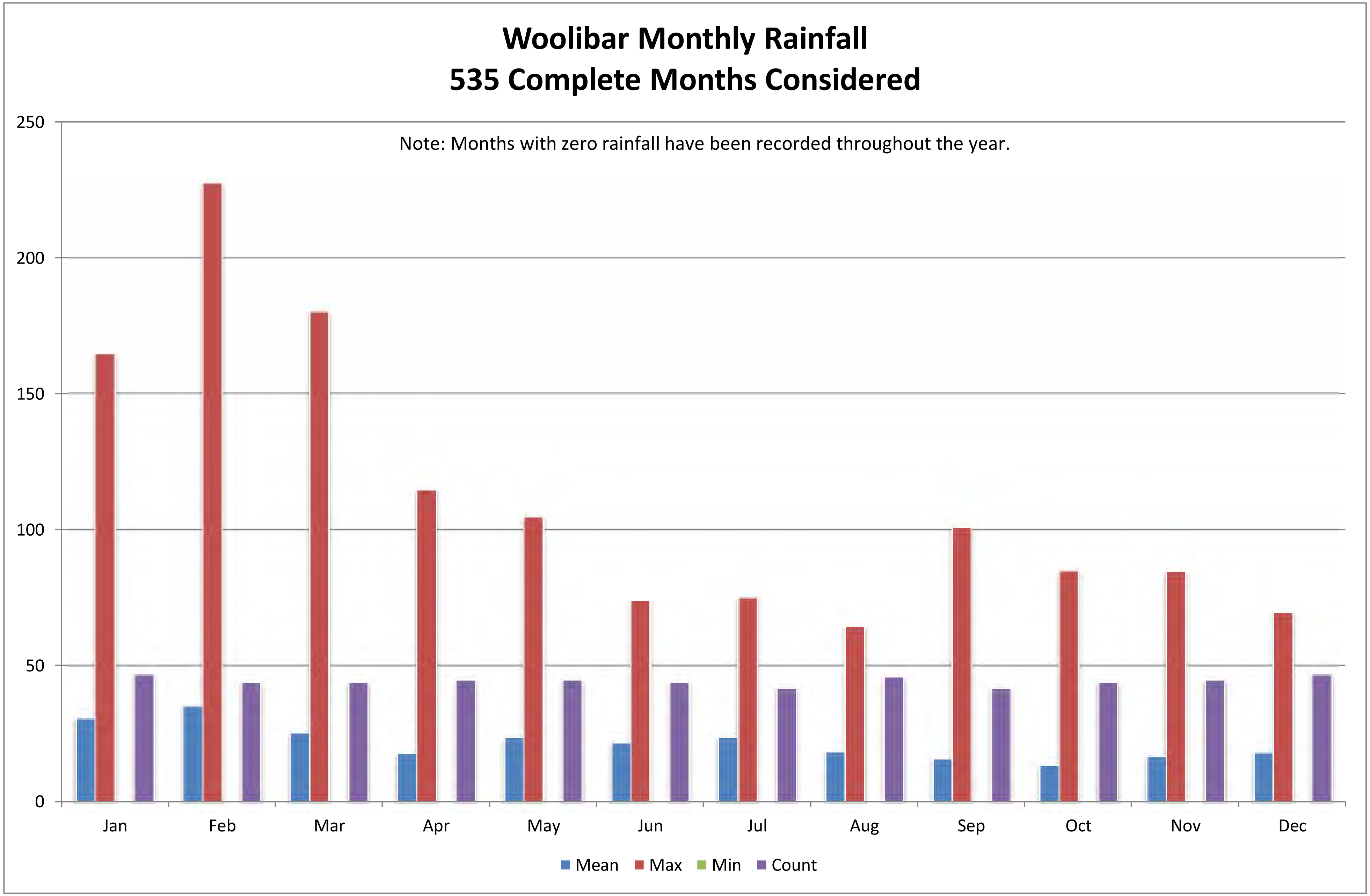

Bulong Monthly Rainfall
1,295 Complete Months Considered
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mean
Max
Min
Count

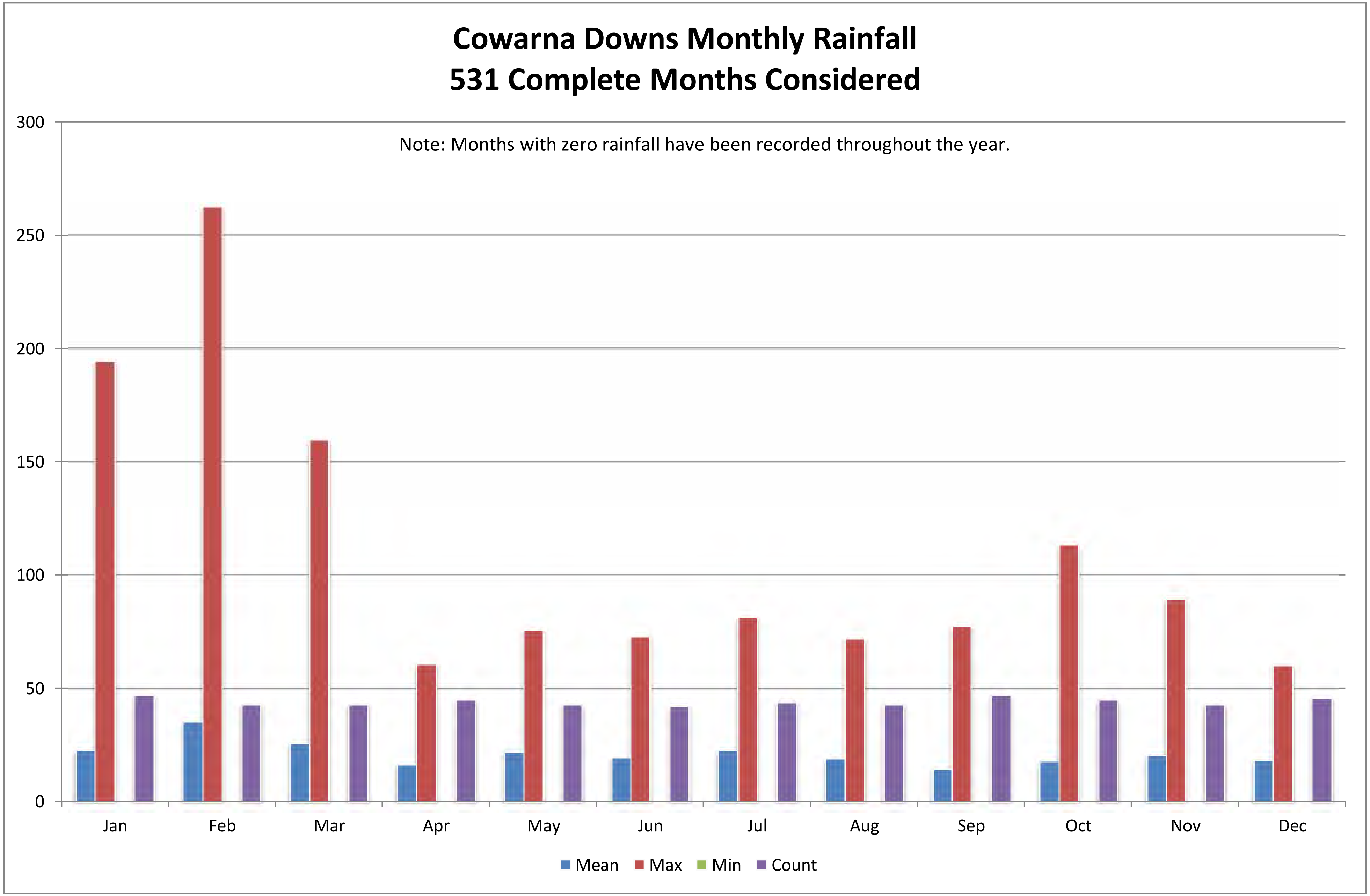


Kalgoorlie-Boulder Airport Monthly Rainfall
864 Complete Months Considered
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mean
Max
Min
Count



Kalgoorlie Post Office Monthly Rainfall
561 Complete Months Considered
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mean
Max
Min
Count


Woolibar Monthly Rainfall
535 Complete Months Considered
Note: Months with zero rainfall have been recorded throughout the year.
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mean
Max
Min
Count

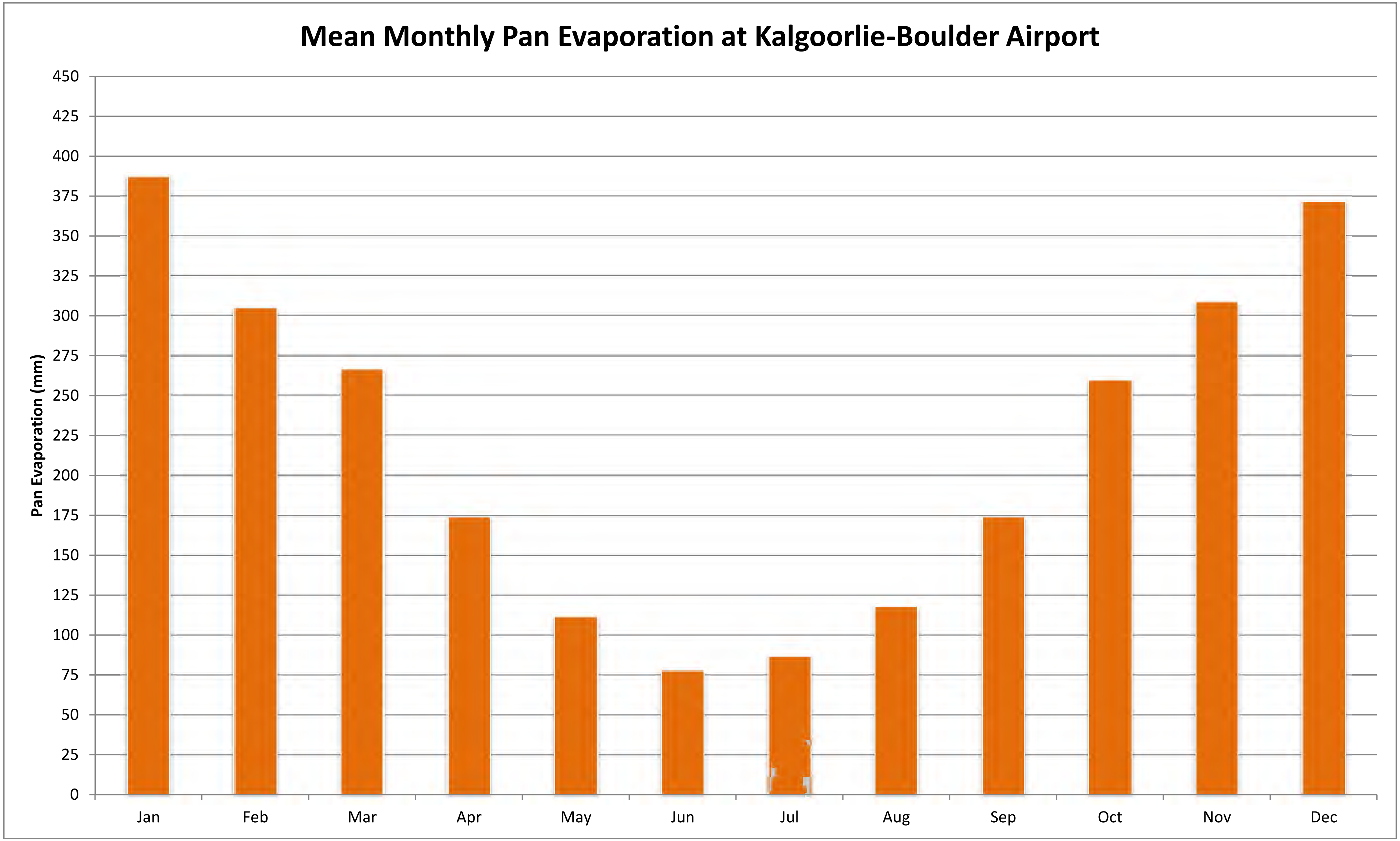

Cowarna Downs Monthly Rainfall
531 Complete Months Considered
Note: Months with zero rainfall have been recorded throughout the year.
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mean
Max
Min
Count

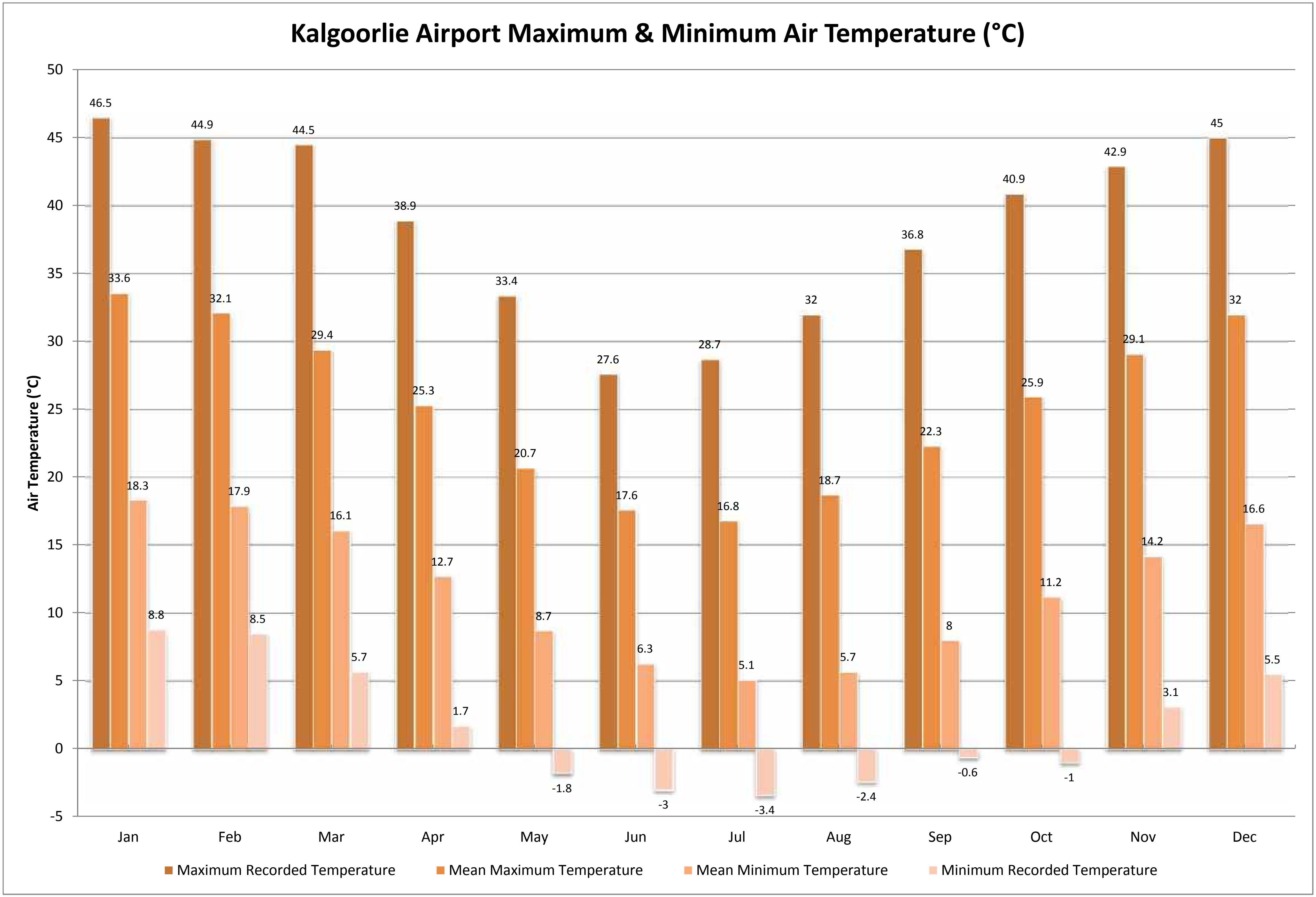
Top 10 Wettest Days at Each Local BoM Station

Station No.	Rainfall Station	Year	Month	Day	Precipitation to 9am (mm)	Rank
12013	Bulong	1948	2	22	153.9	1
12013	Bulong	1948	2	23	144.0	2
12013	Bulong	2014	1	23	127.6	3
12013	Bulong	1987	1	22	116.5	4
12013	Bulong	1995	2	27	113.0	5
12013	Bulong	1967	1	23	107.7	6
12013	Bulong	1974	3	2	91.0	7
12013	Bulong	2000	1	23	90.8	8
12013	Bulong	1961	1	27	90.7	9
12013	Bulong	1909	10	19	85.1	10
12038	Kalgoorlie-Boulder Airport	1948	2	22	177.8	1
12038	Kalgoorlie-Boulder Airport	1967	1	23	154.4	2
12038	Kalgoorlie-Boulder Airport	1948	2	23	123.4	3
12038	Kalgoorlie-Boulder Airport	1995	2	27	104.6	4
12038	Kalgoorlie-Boulder Airport	2014	1	23	94.0	5
12038	Kalgoorlie-Boulder Airport	1987	1	22	88.8	6
12038	Kalgoorlie-Boulder Airport	2000	1	23	86.8	7
12038	Kalgoorlie-Boulder Airport	1961	1	27	86.6	8
12038	Kalgoorlie-Boulder Airport	2016	1	26	83.2	9
12038	Kalgoorlie-Boulder Airport	1981	11	6	77.0	10
12039	Kalgoorlie Post Office	1948	2	22	177.8	1
12039	Kalgoorlie Post Office	1948	2	23	126.0	2
12039	Kalgoorlie Post Office	1939	1	13	96.3	3
12039	Kalgoorlie Post Office	1927	3	20	70.9	4
12039	Kalgoorlie Post Office	1919	4	17	68.6	5
12039	Kalgoorlie Post Office	1909	10	19	62.5	6
12039	Kalgoorlie Post Office	1943	3	8	53.6	7
12039	Kalgoorlie Post Office	1934	4	5	53.3	8
12039	Kalgoorlie Post Office	1915	2	24	51.6	9
12039	Kalgoorlie Post Office	1917	3	19	50.8	10
12106	Woolibar	1961	1	28	111.8	1
12106	Woolibar	2013	3	1	108.0	2
12106	Woolibar	1987	1	22	100.6	3
12106	Woolibar	1995	2	27	97.0	4
12106	Woolibar	2000	1	23	91.0	5
12106	Woolibar	1955	1	16	87.4	6
12106	Woolibar	1975	2	25	80.0	7
12106	Woolibar	1981	11	8	67.2	8
12106	Woolibar	1963	1	12	62.0	9
12106	Woolibar	2014	1	1	59.2	10
12220	Cowarna Downs	2014	1	23	121.2	1
12220	Cowarna Downs	1979	10	16	113.4	2
12220	Cowarna Downs	1995	2	27	102.0	3
12220	Cowarna Downs	1987	1	22	97.6	4
12220	Cowarna Downs	2000	1	23	94.2	5
12220	Cowarna Downs	2007	1	4	82.8	6
12220	Cowarna Downs	2001	2	17	66.6	7
12220	Cowarna Downs	2013	3	2	60.2	8
12220	Cowarna Downs	1993	2	4	55.2	9
12220	Cowarna Downs	2011	2	17	52.0	10

Top 50 Wettest Days at Local BoM Stations						
Station No.	Rainfall Station	Year	Month	Day	Precipitation to 9am (mm)	Rank
12038	Kalgoorlie-Boulder Airport	1948	2	22	177.8	1
12039	Kalgoorlie Post Office	1948	2	22	177.8	2
12038	Kalgoorlie-Boulder Airport	1967	1	23	154.4	3
12013	Bulong	1948	2	22	153.9	4
12013	Bulong	1948	2	23	144.0	5
12013	Bulong	2014	1	23	127.6	6
12039	Kalgoorlie Post Office	1948	2	23	126.0	7
12038	Kalgoorlie-Boulder Airport	1948	2	23	123.4	8
12220	Cowarna Downs	2014	1	23	121.2	9
12013	Bulong	1987	1	22	116.5	10
12220	Cowarna Downs	1979	10	16	113.4	11
12013	Bulong	1995	2	27	113.0	12
12106	Woolibar	1961	1	28	111.8	13
12106	Woolibar	2013	3	1	108.0	14
12013	Bulong	1967	1	23	107.7	15
12038	Kalgoorlie-Boulder Airport	1995	2	27	104.6	16
12220	Cowarna Downs	1995	2	27	102.0	17
12106	Woolibar	1987	1	22	100.6	18
12220	Cowarna Downs	1987	1	22	97.6	19
12106	Woolibar	1995	2	27	97.0	20
12039	Kalgoorlie Post Office	1939	1	13	96.3	21
12220	Cowarna Downs	2000	1	23	94.2	22
12038	Kalgoorlie-Boulder Airport	2014	1	23	94.0	23
12013	Bulong	1974	3	2	91.0	24
12106	Woolibar	2000	1	23	91.0	25
12013	Bulong	2000	1	23	90.8	26
12013	Bulong	1961	1	27	90.7	27
12038	Kalgoorlie-Boulder Airport	1987	1	22	88.8	28
12106	Woolibar	1955	1	16	87.4	29
12038	Kalgoorlie-Boulder Airport	2000	1	23	86.8	30
12038	Kalgoorlie-Boulder Airport	1961	1	27	86.6	31
12013	Bulong	1909	10	19	85.1	32
12038	Kalgoorlie-Boulder Airport	2016	1	26	83.2	33
12220	Cowarna Downs	2007	1	4	82.8	34
12106	Woolibar	1975	2	25	80.0	35
12038	Kalgoorlie-Boulder Airport	1981	11	6	77.0	36
12039	Kalgoorlie Post Office	1927	3	20	70.9	37
12039	Kalgoorlie Post Office	1919	4	17	68.6	38
12106	Woolibar	1981	11	8	67.2	39
12220	Cowarna Downs	2001	2	17	66.6	40
12039	Kalgoorlie Post Office	1909	10	19	62.5	41
12106	Woolibar	1963	1	12	62.0	42
12220	Cowarna Downs	2013	3	2	60.2	43
12106	Woolibar	2014	1	1	59.2	44
12220	Cowarna Downs	1993	2	4	55.2	45
12039	Kalgoorlie Post Office	1943	3	8	53.6	46
12039	Kalgoorlie Post Office	1934	4	5	53.3	47
12220	Cowarna Downs	2011	2	17	52.0	48
12039	Kalgoorlie Post Office	1915	2	24	51.6	49
12039	Kalgoorlie Post Office	1917	3	19	50.8	50

Top 50 Wettest Days at Local BoM Stations in Chronological Order					
Station No.	**Rainfall Station**	**Year**	**Month**	**Day**	**Precipitation to 9am (mm)**
12013	Bulong	1909	10	19	85.1
12039	Kalgoorlie Post Office	1909	10	19	62.5
12039	Kalgoorlie Post Office	1915	2	24	51.6
12039	Kalgoorlie Post Office	1917	3	19	50.8
12039	Kalgoorlie Post Office	1919	4	17	68.6
12039	Kalgoorlie Post Office	1927	3	20	70.9
12039	Kalgoorlie Post Office	1934	4	5	53.3
12039	Kalgoorlie Post Office	1939	1	13	96.3
12039	Kalgoorlie Post Office	1943	3	8	53.6
12038	Kalgoorlie-Boulder Airport	1948	2	22	177.8
12039	Kalgoorlie Post Office	1948	2	22	177.8
12013	Bulong	1948	2	22	153.9
12013	Bulong	1948	2	23	144.0
12039	Kalgoorlie Post Office	1948	2	23	126.0
12038	Kalgoorlie-Boulder Airport	1948	2	23	123.4
12106	Woolibar	1955	1	16	87.4
12013	Bulong	1961	1	27	90.7
12038	Kalgoorlie-Boulder Airport	1961	1	27	86.6
12106	Woolibar	1961	1	28	111.8
12106	Woolibar	1963	1	12	62.0
12038	Kalgoorlie-Boulder Airport	1967	1	23	154.4
12013	Bulong	1967	1	23	107.7
12013	Bulong	1974	3	2	91.0
12106	Woolibar	1975	2	25	80.0
12220	Cowarna Downs	1979	10	16	113.4
12038	Kalgoorlie-Boulder Airport	1981	11	6	77.0
12106	Woolibar	1981	11	8	67.2
12013	Bulong	1987	1	22	116.5
12106	Woolibar	1987	1	22	100.6
12220	Cowarna Downs	1987	1	22	97.6
12038	Kalgoorlie-Boulder Airport	1987	1	22	88.8
12220	Cowarna Downs	1993	2	4	55.2
12013	Bulong	1995	2	27	113.0
12038	Kalgoorlie-Boulder Airport	1995	2	27	104.6
12220	Cowarna Downs	1995	2	27	102.0
12106	Woolibar	1995	2	27	97.0
12220	Cowarna Downs	2000	1	23	94.2
12106	Woolibar	2000	1	23	91.0
12013	Bulong	2000	1	23	90.8
12038	Kalgoorlie-Boulder Airport	2000	1	23	86.8
12220	Cowarna Downs	2001	2	17	66.6
12220	Cowarna Downs	2007	1	4	82.8
12220	Cowarna Downs	2011	2	17	52.0
12106	Woolibar	2013	3	1	108.0
12220	Cowarna Downs	2013	3	2	60.2
12106	Woolibar	2014	1	1	59.2
12013	Bulong	2014	1	23	127.6
12220	Cowarna Downs	2014	1	23	121.2
12038	Kalgoorlie-Boulder Airport	2014	1	23	94.0
12038	Kalgoorlie-Boulder Airport	2016	1	26	83.2


Mean Monthly Pan Evaporation at Kalgoorlie-Boulder Airport
Pan Evaporation (mm)
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Kalgoorlie Airport Maximum & Minimum Air Temperature (°C)
Air Temperature (°C)
50
45
40
35
30
25
20
15
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
46.5
33.6
18.3
8.8
44.9
32.1
17.9
8.5
44.5
29.4
16.1
5.7
38.9
25.3
12.7
1.7
33.4
20.7
8.7
-1.8
27.6
17.6
6.3
-3
28.7
16.8
5.1
-3.4
32
18.7
5.7
-2.4
36.8
22.3
8
-0.6
40.9
25.9
11.2
-1
42.9
29.1
14.2
3.1
45
32
16.6
5.5
Maximum Recorded Temperature
Mean Maximum Temperature
Mean Minimum Temperature
Minimum Recorded Temperature

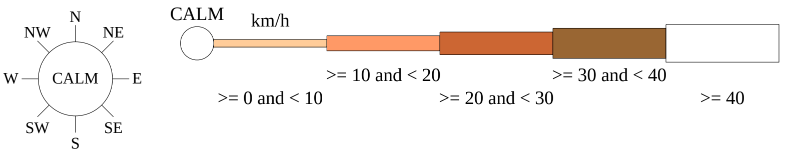
Rose of Wind direction versus Wind speed in km/h (09 Dec 1999 to 10 Aug 2018)

Custom times selected, refer to attached note for details

NORSEMAN AERO

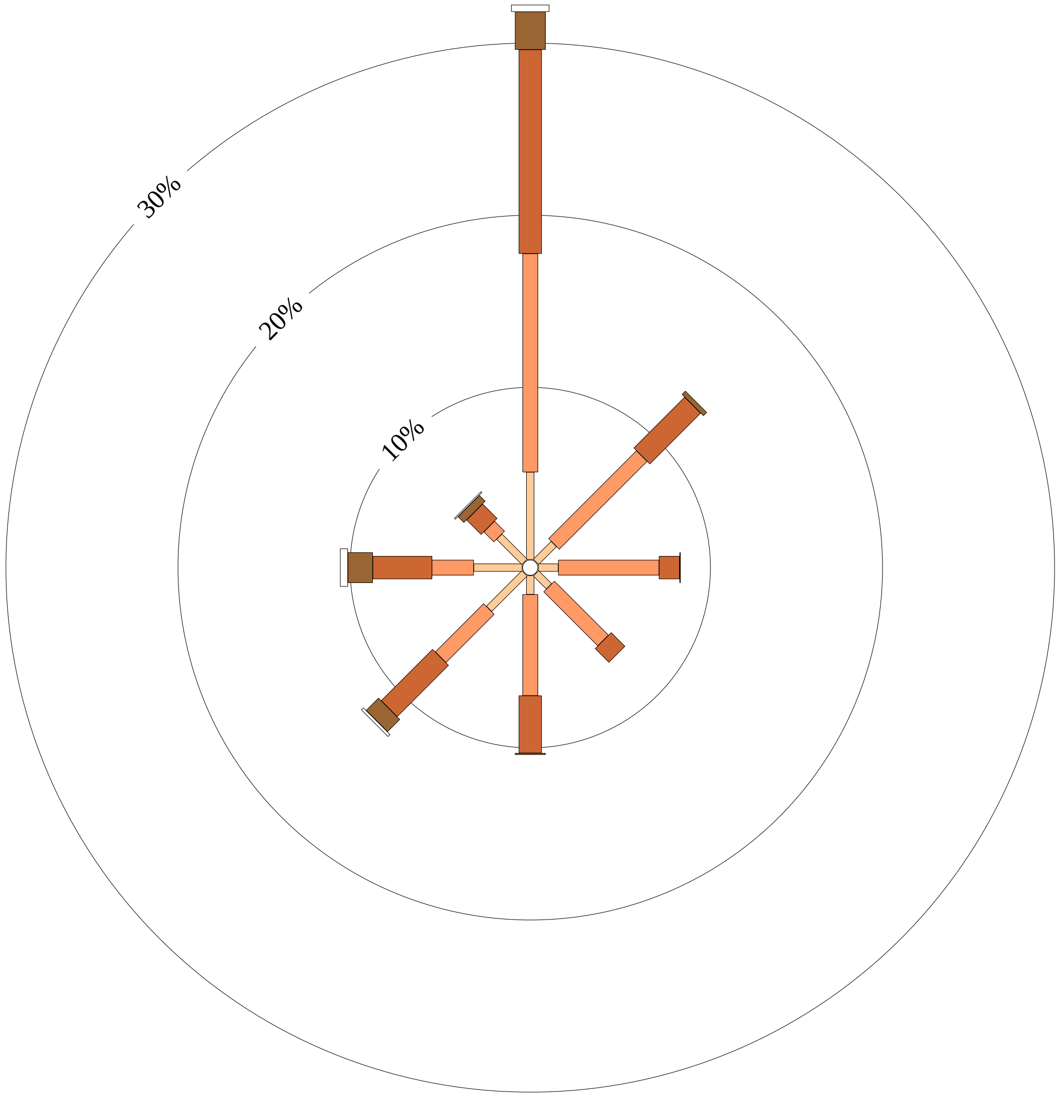
Site No: 012009 • Opened Dec 1999 • Still Open • Latitude: -32.2147° • Longitude: 121.7547° • Elevation 262.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
6768 Total Observations

Calm 2%



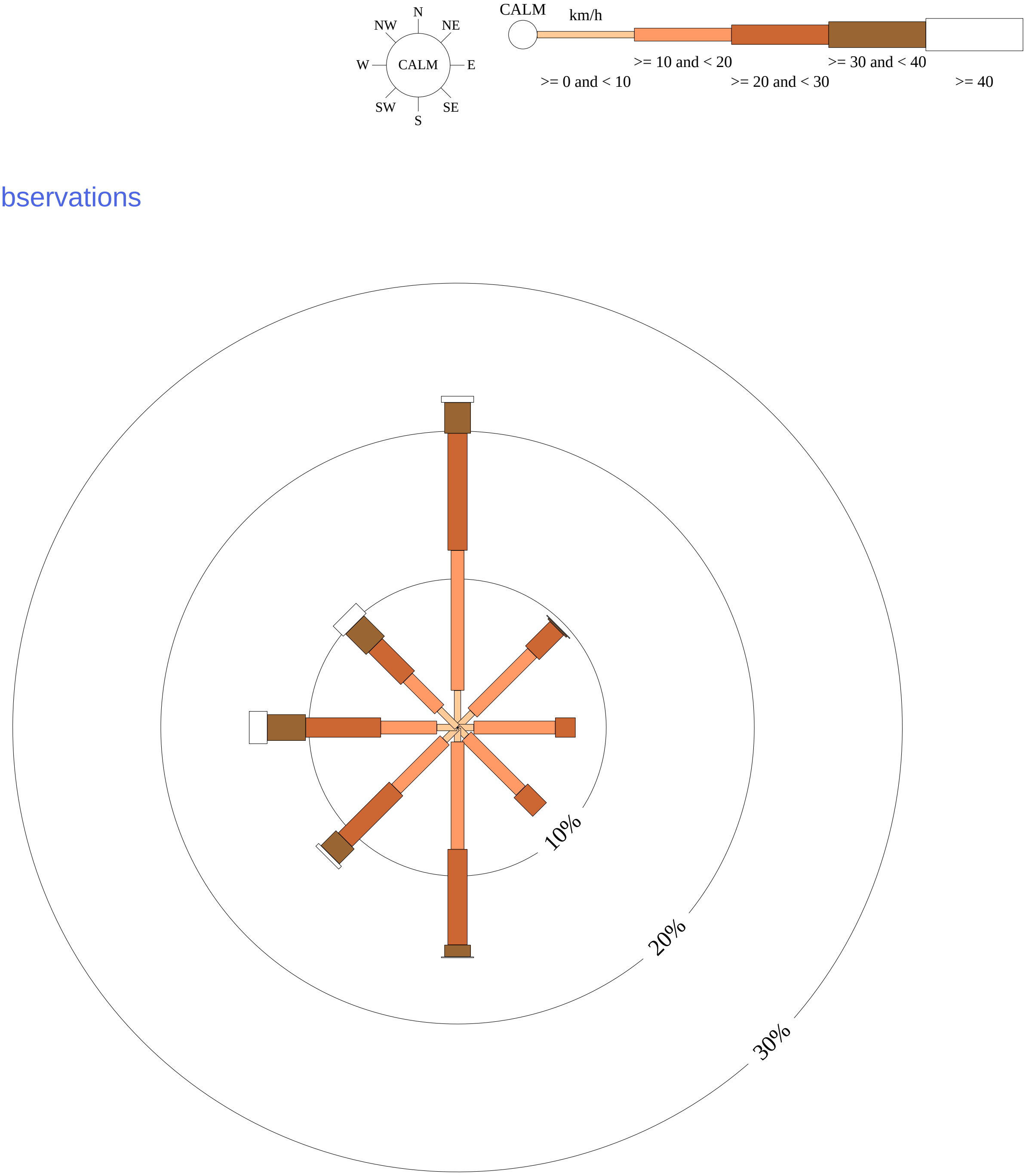
Rose of Wind direction versus Wind speed in km/h (09 Dec 1999 to 10 Aug 2018)

Custom times selected, refer to attached note for details

NORSEMAN AERO

Site No: 012009 • Opened Dec 1999 • Still Open • Latitude: -32.2147° • Longitude: 121.7547° • Elevation 262.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



Contact us by phone on (03) 9669 4082, by fax on (03) 9669 4515, or by email on climatedata@bom.gov.au

Australian Government
Bureau of Meteorology

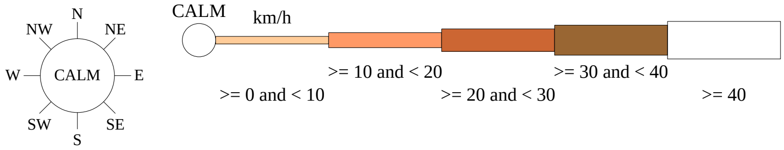
Rose of Wind direction versus Wind speed in km/h (22 Mar 1939 to 10 Aug 2018)

Custom times selected, refer to attached note for details

KALGOORLIE-BOULDER AIRPORT

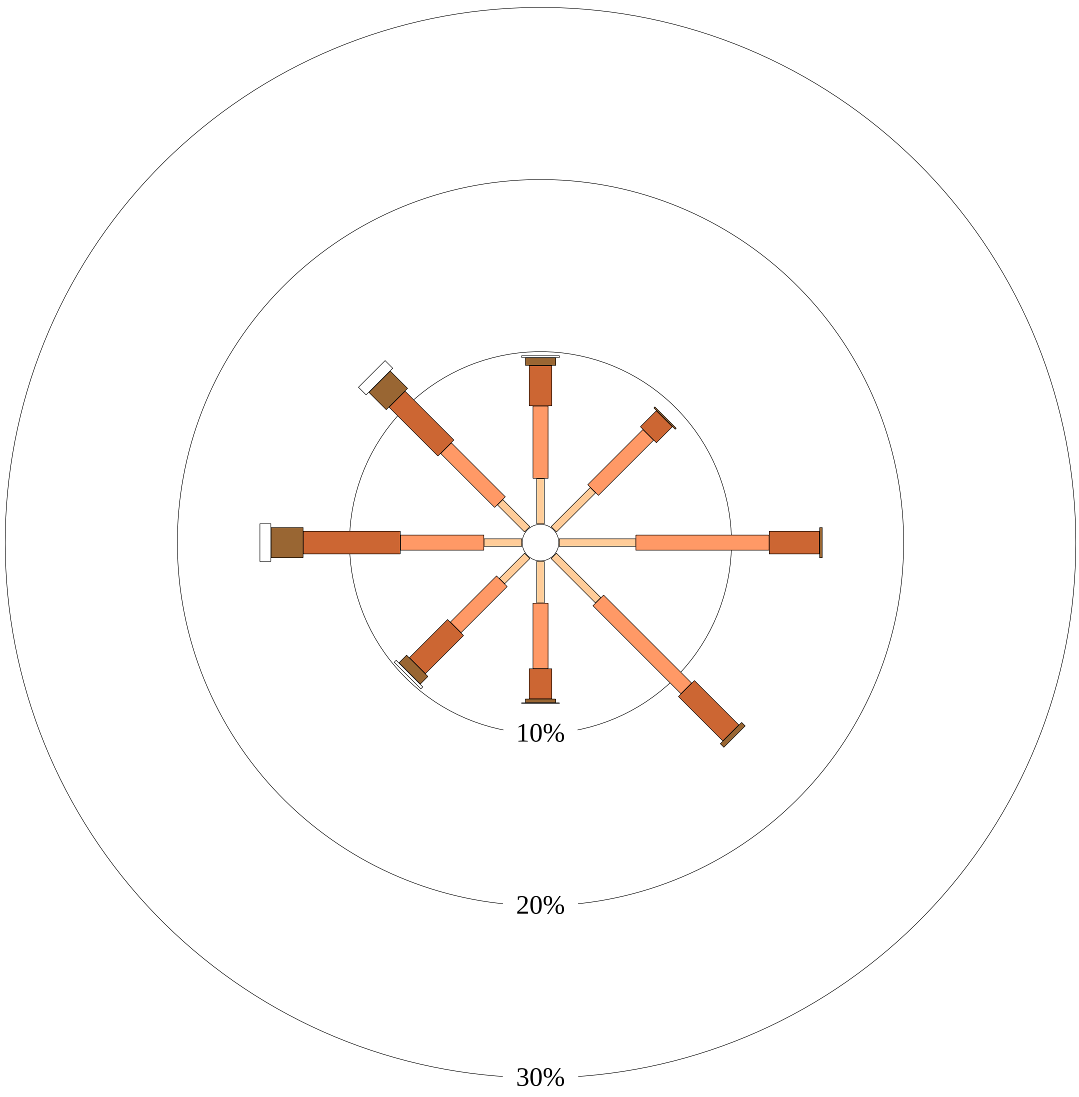
Site No: 012038 • Opened Feb 1939 • Still Open • Latitude: -30.7847° • Longitude: 121.4533° • Elevation 365.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
28853 Total Observations

Calm 5%



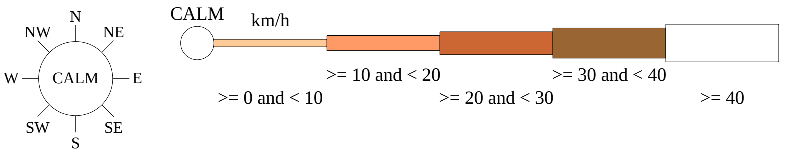
Rose of Wind direction versus Wind speed in km/h (22 Mar 1939 to 10 Aug 2018)

Custom times selected, refer to attached note for details

KALGOORLIE-BOULDER AIRPORT

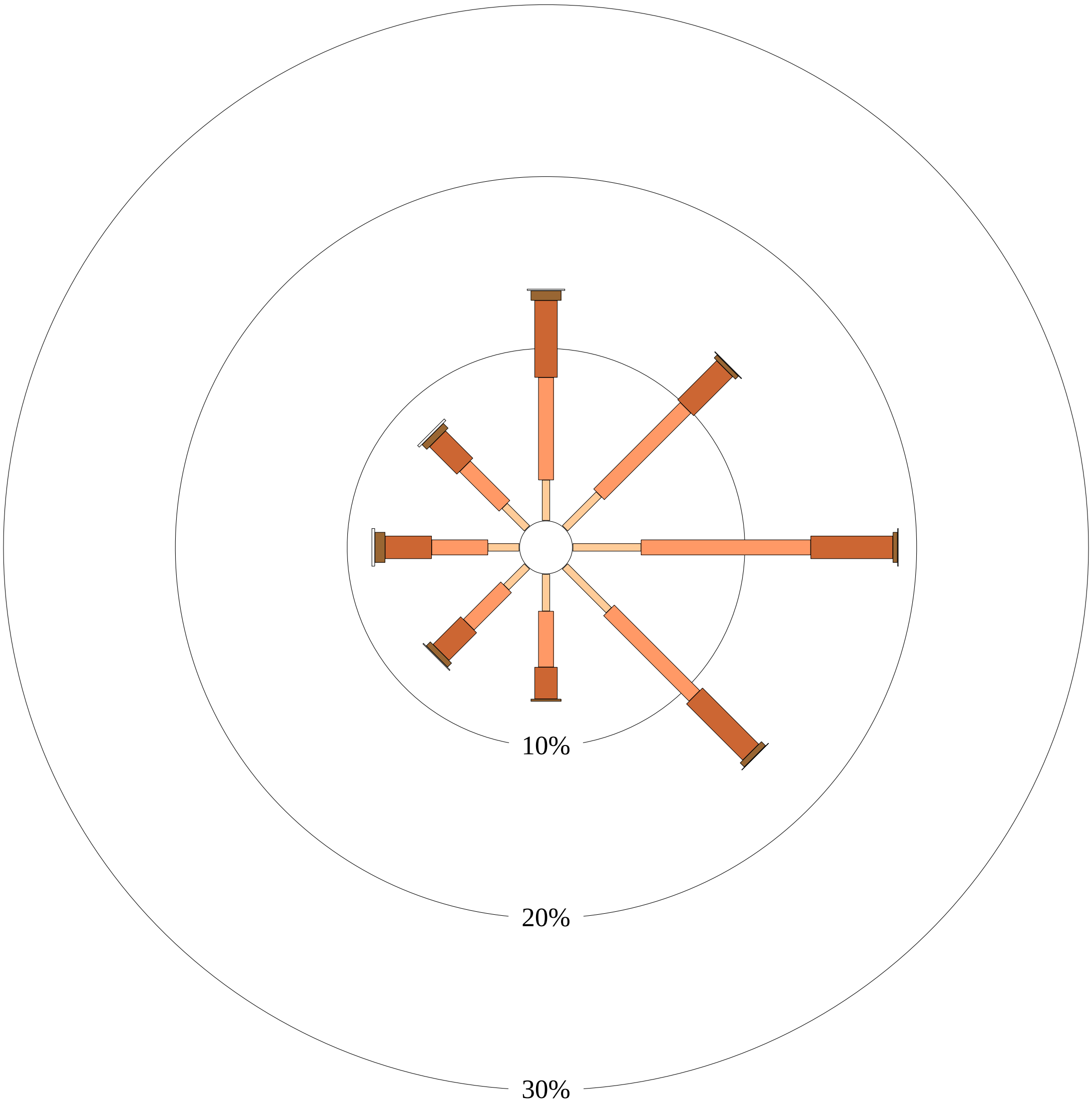
Site No: 012038 • Opened Feb 1939 • Still Open • Latitude: -30.7847° • Longitude: 121.4533° • Elevation 365.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
28912 Total Observations

Calm 8%



Monthly Climate Statistics for 'NORSEMAN AERO' [012009]
Created on [23 Oct 2019 14:57:07 GMT+00:00]

012009 NORSEMAN AERO
Commenced: 1999
Last Record: 2019
Latitude: 32.21 Degrees South
Longitude: 121.75 Degrees East
Elevation: 263 m
State: WA

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) for years 1999 to 2019	32.6	31.6	28.7	25.3	21	18	17.3	19.3	22.5	25.9	28.7	31.1	25.2	20	1999	2019
Highest temperature (Degrees C) for years 1999 to 2019	46.5	44.8	43.5	37.7	32	28.2	25.1	32.9	36	39.6	42.4	45.1	46.5	20	1999	2019
Date of Highest temperature for years 1999 to 2019	13-Jan-19	27-Feb-19	5-Mar-08	12-Apr-05	6-May-02	1-Jun-17	6-Jul-14	30-Aug-06	10-Sep-19	31-Oct-13	29-Nov-07	19-Dec-05	13-Jan-19	N/A	1999	2019
Lowest maximum temperature (Degrees C) for years 1999 to 2019	17.3	16.3	17	15	12.1	10.6	8.9	10.9	11.8	13.8	13.4	15	8.9	20	1999	2019
Date of Lowest maximum temperature for years 1999 to 2019	4-Jan-07	8-Feb-17	27-Mar-00	29-Apr-00	24-May-04	19-Jun-05	9-Jul-16	28-Aug-04	1-Sep-15	31-Oct-08	1-Nov-05	1-Dec-01	9-Jul-16	N/A	1999	2019
Decile 1 maximum temperature (Degrees C) for years 1999 to 2019	25.5	25	22.2	20	16.5	14.7	13.5	14.8	16.8	19.6	21.8	24.7		20	1999	2019
Decile 9 maximum temperature (Degrees C) for years 1999 to 2019	40	39	36.2	31.1	25.5	21.7	21.2	24.5	28	33	36	38.2		20	1999	2019
Mean number of days >= 30 Degrees C for years 1999 to 2019	21.4	16.7	12.3	4.2	0.5	0	0	0.4	2	7.1	12.5	16.9	94	20	1999	2019
Mean number of days >= 35 Degrees C for years 1999 to 2019	10.2	8	3.8	0.6	0	0	0	0	0.3	1.5	3.8	7.7	35.9	20	1999	2019
Mean number of days >= 40 Degrees C for years 1999 to 2019	3.3	1.8	0.6	0	0	0	0	0	0	0	0.5	1.9	8.1	20	1999	2019
Mean minimum temperature (Degrees C) for years 1999 to 2019	15.9	16.1	14.1	11	6.9	4.7	4	4.4	6.3	9.5	12.2	13.9	9.9	20	1999	2019
Lowest temperature (Degrees C) for years 1999 to 2019	5.7	5.9	1.7	0.8	-2.1	-6	-4.4	-3.7	-4.3	-1.9	0.9	3	-6	20	1999	2019
Date of Lowest temperature for years 1999 to 2019	20-Jan-07	1-Feb-06	29-Mar-07	20-Apr-19	31-May-16	27-Jun-10	7-Jul-05	18-Aug-18	11-Sep-04	21-Oct-16	3-Nov-07	4-Dec-02	27-Jun-10	N/A	1999	2019
Highest minimum temperature (Degrees C) for years 1999 to 2019	27	26.1	23.3	22.3	19	14.4	14	14.6	17.7	21.6	23.8	26.8	27	20	1999	2019
Date of Highest minimum temperature for years 1999 to 2019	13-Jan-14	16-Feb-08	7-Mar-17	6-Apr-07	6-May-02	8-Jun-04	3-Jul-18	8-Aug-13	14-Sep-19	28-Oct-09	25-Nov-07	30-Dec-09	13-Jan-14	N/A	1999	2019
Decile 1 minimum temperature (Degrees C) for years 1999 to 2019	11.2	11.3	8	5.3	1.4	-0.1	-1.2	-0.9	0.8	4	6.8	8.9		20	1999	2019
Decile 9 minimum temperature (Degrees C) for years 1999 to 2019	20.4	20.2	18.4	16	12.9	10.4	9.3	10	11.5	14.7	17.2	18.7		20	1999	2019
Mean number of days <= 2 Degrees C for years 1999 to 2019	0	0	0.1	0.5	4.4	9	11	10	5.2	1.6	0.3	0	42.1	20	1999	2019
Mean number of days <= 0 Degrees C for years 1999 to 2019	0	0	0	0	1.1	4.2	5.9	5.5	2.3	0.3	0	0	19.3	20	1999	2019
Mean daily ground minimum temperature Degrees C for years null to null																
Lowest ground temperature Degrees C for years null to null																
Date of Lowest ground temperature for years null to null														N/A		
Mean number of days ground min. temp. <= -1 Degrees C for years null to null																
Mean rainfall (mm) for years 1999 to 2019	36.5	26.7	30.8	24.5	18.9	17.5	21.5	23.7	20.3	24.4	29.1	20.7	298	19	1999	2019
Highest rainfall (mm) for years 1999 to 2019	93.6	136.8	149.8	71	47.6	54.8	55.2	48	71.8	82.8	92.2	79.8	454.2	20	1999	2019
Date of Highest rainfall for years 1999 to 2019	2000	2001	2000	2003	2013	2016	2013	2005	2008	2018	2012	2002	2013	N/A	1999	2019
Lowest rainfall (mm) for years 1999 to 2019	0	0	0	0	1.2	1.4	5.8	7.4	0.4	1	0.6	0.8	183.4	20	1999	2019
Date of Lowest rainfall for years 1999 to 2019	2015	2019	2001	2012	2000	2008	2019	2006	2018	2012	2007	2005	2010	N/A	1999	2019
Decile 1 monthly rainfall (mm) for years 1999 to 2019	1.1	3.6	1.3	2.2	2.4	6.2	6.2	11.9	3.7	6.4	4	2.4	240.5	20	1999	2019
Decile 5 (median) monthly rainfall (mm) for years 1999 to 2019	34.2	14.2	15.2	24.8	13.1	13.8	15.5	20.5	12.2	14.6	17.2	13.8	265.2	20	1999	2019
Decile 9 monthly rainfall (mm) for years 1999 to 2019	76.6	57.7	70.4	47.8	43.4	31.9	40	43.1	43.8	69	73.8	43.2	415.4	20	1999	2019
Highest daily rainfall (mm) for years 1999 to 2019	53	50	76	39	30.4	17	21	23	55	43.8	42	71	76	20	1999	2019
Date of Highest daily rainfall for years 1999 to 2019	21-Jan-01	24-Feb-01	11-Mar-00	1-Apr-03	18-May-11	15-Jun-16	31-Jul-01	1-Aug-15	27-Sep-08	19-Oct-14	27-Nov-13	28-Dec-02	11-Mar-00	N/A	1999	2019
Mean number of days of rain for years 1999 to 2019	5.8	5.3	5.8	6.6	7.2	8.7	10.6	10.5	7.6	6.6	6.9	4.5	86.1	20	1999	2019
Mean number of days of rain >= 1 mm for years 1999 to 2019	3.7	3.2	3.4	3.6	3.5	4.7	5.1	5.5	3.8	4.1	3.8	2.5	46.9	20	1999	2019
Mean number of days of rain >= 10 mm for years 1999 to 2019	1.1	0.8	0.6	0.6	0.4	0.2	0.5	0.6	0.5	0.6	0.8	0.5	7.2	20	1999	2019
Mean number of days of rain >= 25 mm for years 1999 to 2019	0.5	0.3	0.3	0.2	0.1	0	0	0	0.1	0.2	0.3	0.2	2.2	20	1999	2019
Mean daily wind run (km) for years 2003 to 2019	357	339	306	272	260	263	284	312	344	347	361	355	317	16	2003	2019
Maximum wind gust speed (km/h) for years 2003 to 2019	128	107	106	98	81	106	85	113	106	117	104	87	128	16	2003	2019
Date of Maximum wind gust speed for years 2003 to 2019	30-Jan-11	12-Feb-04	25-Mar-13	25-Apr-11	21-May-16	13-Jun-12	17-Jul-13	6-Aug-07	12-Sep-07	16-Oct-14	17-Nov-15	7-Dec-06	30-Jan-11	N/A	2003	2019
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2019	27	23.7	19.5	14.8	11	9.6	10.2	13.6	17.8	22.2	25.4	27.5	18.5	30	1990	2019
Mean number of clear days for years null to null																
Mean number of cloudy days for years null to null																
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years 1999 to 2010	21.8	21.4	19.6	17.3	13.5	10.4	9.9	11.3	14.2	17.2	19.8	20.9	16.4	11	1999	2010
Mean 9am wet bulb temperature (Degrees C) for years 1999 to 2010														8	1999	2010
Mean 9am dew point temperature (Degrees C) for years 1999 to 2010	11.4	12.3	11.2	10.5	8.3	6.3	5.8	5.5	6.4	6.5	8.3	9.3	8.5	11	1999	2010
Mean 9am relative humidity (%) for years 1999 to 2010	55	58	61	66	73	77	77	70	61	52	50	50	63	11	1999	2010
Mean 9am cloud cover (okas) for years null to null																
Mean 9am wind speed (km/h) for years 1999 to 2010	17.9	18.5	17.9	16.5	13.8	13.9	14.7	16.9	20.1	20.1	19.5	18.7	17.4	11	1999	2010
Mean 3pm temperature (Degrees C) for years 1999 to 2010	30.6	29.8	27.6	24	20.3	17	16.2	18	20.8	24	26.9	29.4	23.7	11	1999	2010
Mean 3pm wet bulb temperature (Degrees C) for years 1999 to 2010														8	1999	2010
Mean 3pm dew point temperature (Degrees C) for years 1999 to 2010	9	10.6	8.9	8.3	6.5	5.3	4.8	3.3	3.6	4.1	5.7	6.5	6.4	11	1999	2010
Mean 3pm relative humidity (%) for years 1999 to 2010	31	34	35	40	44	48	49	41	35	31	30	27	37	11	1999	2010
Mean 3pm cloud cover (oktas) for years null to null																
Mean 3pm wind speed (km/h) for years 1999 to 2010	19.1	17.7	17.3	17.9	18.1	20.7	20.8	22.1	23.2	21.1	20.1	20	19.8	11	1999	2010

Monthly Climate Statistics for 'COOLGARDIE' [012018]
Created on [23 Oct 2019 14:17:34 GMT+00:00]

012018 COOLGARDIE
Commenced: 1893
Last Record: 2019
Latitude: 30.96 Degrees South
Longitude: 121.17 Degrees East
Elevation: 427 m
State: WA

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) for years 1897 to 1953	33.3	32.3	29.4	24.9	20.3	16.9	16.1	18.1	22	25.1	29.3	32.3	25	57	1897	1953
Highest temperature (Degrees C) for years null to null																
Date of Highest temperature for years null to null														N/A		
Lowest maximum temperature (Degrees C) for years null to null																
Date of Lowest maximum temperature for years null to null														N/A		
Decile 1 maximum temperature (Degrees C) for years null to null																
Decile 9 maximum temperature (Degrees C) for years null to null																
Mean number of days >= 30 Degrees C for years null to null																
Mean number of days >= 35 Degrees C for years null to null																
Mean number of days >= 40 Degrees C for years null to null																
Mean minimum temperature (Degrees C) for years 1897 to 1953	17	16.8	15.1	12	8.6	6.5	5.2	5.9	7.9	10.2	13.4	15.8	11.2	57	1897	1953
Lowest temperature (Degrees C) for years null to null																
Date of Lowest temperature for years null to null														N/A		
Highest minimum temperature (Degrees C) for years null to null																
Date of Highest minimum temperature for years null to null														N/A		
Decile 1 minimum temperature (Degrees C) for years null to null																
Decile 9 minimum temperature (Degrees C) for years null to null																
Mean number of days <= 2 Degrees C for years null to null																
Mean number of days <= 0 Degrees C for years null to null																
Mean daily ground minimum temperature Degrees C for years 1934 to 1944														6	1934	1944
Lowest ground temperature Degrees C for years null to null																
Date of Lowest ground temperature for years null to null														N/A		
Mean number of days ground min. temp. <= -1 Degrees C for years null to null																
Mean rainfall (mm) for years 1893 to 2019	23.2	27.2	25.3	21.8	28	28.8	23.8	23.6	13.7	16	16.5	17	270.7	117	1893	2019
Highest rainfall (mm) for years 1893 to 2019	194.4	237	219.4	105.5	115.4	165	75.3	93.8	92.6	90	77.8	101.2	633.2	123	1893	2019
Date of Highest rainfall for years 1893 to 2019	2000	1948	1999	1919	1963	1968	1960	1992	1955	1982	1914	1988	1992	N/A	1893	2019
Lowest rainfall (mm) for years 1893 to 2019	0	0	0	0	0	0	0	0	0	0	0	0	83.7	123	1893	2019
Date of Lowest rainfall for years 1893 to 2019	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	1969	N/A	1893	2019
Decile 1 monthly rainfall (mm) for years 1893 to 2019	0	0	0	0	3	5.7	5.6	4.6	1.3	0	0	0	168.2	110	1893	2019
Decile 5 (median) monthly rainfall (mm) for years 1893 to 2019	8.2	13.1	13.8	13.6	22.6	24.4	21.2	17	9.7	9.4	10.5	11	264	110	1893	2019
Decile 9 monthly rainfall (mm) for years 1893 to 2019	58.2	76.1	66.3	64.9	57.2	57.4	48.8	49.3	29.5	43.6	42	37.7	373.9	110	1893	2019
Highest daily rainfall (mm) for years 1893 to 2019	181.4	135.4	81.8	51.6	42.4	49	29.6	53	43.9	65.8	56.1	48.3	181.4	109	1893	2019
Date of Highest daily rainfall for years 1893 to 2019	23-Jan-67	22-Feb-48	11-Mar-00	17-Apr-19	14-May-21	6-Jun-57	26-Jul-85	11-Aug-94	13-Sep-54	19-Oct-09	27-Nov-58	13-Dec-30	23-Jan-67	N/A	1893	2019
Mean number of days of rain for years 1893 to 2019	2.6	2.9	3.4	3.6	5.3	6.6	6.7	5.5	3.5	3.1	2.9	2.6	48.7	110	1893	2019
Mean number of days of rain >= 1 mm for years 1893 to 2019	2	2.1	2.5	2.7	3.7	4.3	4.5	3.7	2.4	2.3	2.1	1.9	34.2	109	1893	2019
Mean number of days of rain >= 10 mm for years 1893 to 2019	0.5	0.7	0.7	0.6	0.7	0.7	0.5	0.5	0.2	0.4	0.5	0.5	6.5	109	1893	2019
Mean number of days of rain >= 25 mm for years 1893 to 2019	0.2	0.2	0.2	0.2	0.1	0.1	0	0.1	0	0.1	0	0.1	1.3	109	1893	2019
Mean daily wind run (km) for years null to null																
Maximum wind gust speed (km/h) for years null to null																
Date of Maximum wind gust speed for years null to null														N/A		
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2019	27.5	24	20.4	15.8	11.9	10.2	11.1	14.6	18.9	23.7	26.6	28.3	19.4	30	1990	2019
Mean number of clear days for years null to null																
Mean number of cloudy days for years null to null																
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years 1897 to 1953	23.7	23.1	20.8	17.6	13.7	10.8	9.7	11.5	14.8	17.7	21.2	23.4	17.3	57	1897	1953
Mean 9am wet bulb temperature (Degrees C) for years 1897 to 1953	16.5	16.3	15.3	13.2	10.5	8.5	7.5	8.4	10.1	11.8	14.1	15.8	12.3	57	1897	1953
Mean 9am dew point temperature (Degrees C) for years null to null																
Mean 9am relative humidity (%) for years 1938 to 1953	44	47	53	59	66	73	74	64	51	45	42	40	55	16	1938	1953
Mean 9am cloud cover (okas) for years 1898 to 1953	2	2.5	2.9	3.1	3.3	3.7	3.3	3	2.5	2.6	2.3	1.9	2.8	56	1898	1953
Mean 9am wind speed (km/h) for years null to null																
Mean 3pm temperature (Degrees C) for years 1897 to 1953	32.2	31.3	28.5	24.1	19.4	16.1	15.4	17.3	21.2	24.2	28.2	31.1	24.1	57	1897	1953
Mean 3pm wet bulb temperature (Degrees C) for years 1898 to 1953	19.3	19.1	18	15.6	12.9	11.1	10.2	10.9	12.6	14.1	16.5	18.4	14.9	56	1898	1953
Mean 3pm dew point temperature (Degrees C) for years null to null																
Mean 3pm relative humidity (%) for years 1938 to 1953	23	25	29	37	42	48	47	39	28	24	23	21	32	16	1938	1953
Mean 3pm cloud cover (oktas) for years 1897 to 1953	2.3	2.5	2.6	3	3.5	3.9	3.6	3.1	2.4	2.5	2.5	2.3	2.8	57	1897	1953
Mean 3pm wind speed (km/h) for years null to null																

Monthly Climate Statistics for 'KALGOORLIE-BOULDER AIRPORT' [012038]
Created on [23 Oct 2019 14:57:07 GMT+00:00]

012038 KALGOORLIE-BOULDER AIRPORT
Commenced: 1939
Last Record: 2019
Latitude: 30.78 Degrees South
Longitude: 121.45 Degrees East
Elevation: 365 m
State: WA

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) for years 1939 to 2019	33.7	32.1	29.5	25.3	20.7	17.6	16.8	18.7	22.4	25.9	29.1	32	25.3	78	1939	2019
Highest temperature (Degrees C) for years 1939 to 2019	46.5	45.3	44.5	40.1	33.4	27.6	28.7	32	36.8	40.9	42.9	45	46.5	78	1939	2019
Date of Highest temperature for years 1939 to 2019	22-Jan-90	28-Feb-19	10-Mar-73	11-Apr-19	2-May-02	15-Jun-47	30-Jul-01	30-Aug-06	28-Sep-80	16-Oct-95	26-Nov-00	31-Dec-72	22-Jan-90	N/A	1939	2019
Lowest maximum temperature (Degrees C) for years 1939 to 2019	14.4	15	14.1	12.8	10.5	9.6	7.2	8.9	10.2	11.6	13.9	14.3	7.2	78	1939	2019
Date of Lowest maximum temperature for years 1939 to 2019	22-Jan-67	19-Feb-08	19-Mar-84	21-Apr-66	25-May-77	19-Jun-68	19-Jul-61	1-Aug-45	13-Sep-55	9-Oct-43	1-Nov-39	12-Dec-68	19-Jul-61	N/A	1939	2019
Decile 1 maximum temperature (Degrees C) for years 1939 to 2019	27.2	25.2	22.8	19.5	16	13.8	13	14.3	16.9	19.6	22.7	25.7		78	1939	2019
Decile 9 maximum temperature (Degrees C) for years 1939 to 2019	40.4	39.4	36.5	31.7	26	21.7	21	24	28.3	32.8	35.9	38.6		78	1939	2019
Mean number of days >= 30 Degrees C for years 1939 to 2019	23.3	17.9	13.8	5.2	0.4	0	0	0.1	1.7	7	12.7	20.4	102.5	78	1939	2019
Mean number of days >= 35 Degrees C for years 1939 to 2019	12.5	8.9	5	0.5	0	0	0	0	0.1	1.4	4.3	8.6	41.3	78	1939	2019
Mean number of days >= 40 Degrees C for years 1939 to 2019	3.6	2.3	0.6	0	0	0	0	0	0	0.1	0.4	1.8	8.8	78	1939	2019
Mean minimum temperature (Degrees C) for years 1939 to 2019	18.3	17.9	16.1	12.7	8.7	6.3	5.1	5.7	8.1	11.2	14.2	16.6	11.7	78	1939	2019
Lowest temperature (Degrees C) for years 1939 to 2019	8.8	8.5	5.7	1.7	-1.8	-3	-3.4	-2.4	-0.6	-1	3.1	5.5	-3.4	78	1939	2019
Date of Lowest temperature for years 1939 to 2019	31-Jan-90	16-Feb-90	24-Mar-01	26-Apr-60	31-May-64	23-Jun-81	12-Jul-69	9-Aug-68	2-Sep-56	4-Oct-42	9-Nov-92	2-Dec-73	12-Jul-69	N/A	1939	2019
Highest minimum temperature (Degrees C) for years 1939 to 2019	30.4	30.8	27.6	24.7	22.8	16.3	15.8	17.4	22	25.7	26.6	29.1	30.8	78	1939	2019
Date of Highest minimum temperature for years 1939 to 2019	24-Jan-94	24-Feb-91	6-Mar-90	1-Apr-89	3-May-47	5-Jun-57	30-Jul-16	28-Aug-50	28-Sep-44	28-Oct-09	27-Nov-17	19-Dec-05	24-Feb-91	N/A	1939	2019
Decile 1 minimum temperature (Degrees C) for years 1939 to 2019	14.1	13.8	11.8	7.9	4	1.7	0.7	1.4	3.7	6.4	9.8	12.3		78	1939	2019
Decile 9 minimum temperature (Degrees C) for years 1939 to 2019	23	22.5	20.4	17.2	13.5	10.8	9.4	10.3	12.6	15.8	18.9	21.6		78	1939	2019
Mean number of days <= 2 Degrees C for years 1939 to 2019	0	0	0	0	0.8	3.8	6.2	4.5	0.8	0.1	0	0	16.2	78	1939	2019
Mean number of days <= 0 Degrees C for years 1939 to 2019	0	0	0	0	0.1	0.7	1.8	1.1	0.1	0	0	0	3.8	78	1939	2019
Mean daily ground minimum temperature Degrees C for years 1965 to 2016	17	16.8	14.6	11	6.8	4	2.9	3.2	5.8	9.4	12.8	15.4	10	50	1965	2016
Lowest ground temperature Degrees C for years 1965 to 2016	7.7	4.6	2.3	-0.5	-3.7	-5.9	-8.3	-6.6	-4.9	-2.9	-0.9	2.8	-8.3	50	1965	2016
Date of Lowest ground temperature for years 1965 to 2016	31-Jan-90	23-Feb-67	26-Mar-72	30-Apr-00	28-May-72	19-Jun-66	13-Jul-69	7-Aug-66	4-Sep-70	2-Oct-66	1-Nov-68	2-Dec-73	13-Jul-69	N/A	1965	2016
Mean number of days ground min. temp. <= -1 Degrees C for years 1965 to 2016	0	0	0	0	0.5	2.4	5.2	4	0.8	0.1	0	0	13	50	1965	2016
Mean rainfall (mm) for years 1939 to 2019	27.5	31.2	25.2	20.5	24.9	27.3	24.2	21.3	13.7	16	18.9	16.5	267.7	78	1939	2019
Highest rainfall (mm) for years 1939 to 2019	185.9	307.8	197	98.6	110.2	185.7	82.6	74	98.3	84.4	115.4	88.6	530.8	81	1939	2019
Date of Highest rainfall for years 1939 to 2019	1967	1948	1999	1961	1963	1968	1960	1992	1955	1982	1981	1988	1992	N/A	1939	2019
Lowest rainfall (mm) for years 1939 to 2019	0	0	0	0	0	1.4	0.6	1.6	0.3	0	0	0	108.7	81	1939	2019
Date of Lowest rainfall for years 1939 to 2019	1977	1998	2019	2001	1948	2008	1994	1989	1972	1979	1994	1964	1940	N/A	1939	2019
Decile 1 monthly rainfall (mm) for years 1939 to 2019	0.6	1.2	0.6	1.6	2.4	5.2	5.4	4.1	1.5	1.1	0.5	1.3	152.6	81	1939	2019
Decile 5 (median) monthly rainfall (mm) for years 1939 to 2019	10.9	14.2	10.2	12.8	18.8	18.8	20	16.2	10.7	10.5	15.4	11.8	254.1	81	1939	2019
Decile 9 monthly rainfall (mm) for years 1939 to 2019	83.6	79.3	69.2	54.8	47.4	54.8	49	44	29.5	34.6	40.4	40.1	397.9	81	1939	2019
Highest daily rainfall (mm) for years 1939 to 2019	154.4	177.8	70	49.8	45.2	57.2	28.6	49.6	44.2	45.6	77	50.6	177.8	80	1939	2019
Date of Highest daily rainfall for years 1939 to 2019	23-Jan-67	22-Feb-48	2-Mar-74	16-Apr-61	24-May-80	6-Jun-57	26-Jul-85	11-Aug-94	13-Sep-54	4-Oct-82	6-Nov-81	13-Dec-16	22-Feb-48	N/A	1939	2019
Mean number of days of rain for years 1939 to 2019	4	4.6	4.4	5.3	6.9	8.5	9	7.7	5.4	4.4	4.2	3.9	68.3	81	1939	2019
Mean number of days of rain >= 1 mm for years 1939 to 2019	2.5	3	2.7	3.3	3.9	4.8	4.8	4	2.9	2.8	2.7	2.5	39.9	80	1939	2019
Mean number of days of rain >= 10 mm for years 1939 to 2019	0.7	0.9	0.7	0.6	0.7	0.7	0.6	0.5	0.3	0.4	0.5	0.6	7.2	80	1939	2019
Mean number of days of rain >= 25 mm for years 1939 to 2019	0.3	0.3	0.3	0.1	0.1	0.1	0	0.1	0	0.1	0.1	0.1	1.6	80	1939	2019
Mean daily wind run (km) for years 1994 to 2019	421	403	361	292	261	269	282	297	341	374	395	409	342	24	1994	2019
Maximum wind gust speed (km/h) for years 1939 to 2019	141	118	118	104	122	102	97	108	109	117	139	122	141	78	1939	2019
Date of Maximum wind gust speed for years 1939 to 2019	14-Jan-94	16-Feb-70	28-Mar-71	24-Apr-73	5-May-75	4-Jun-74	30-Jul-48	12-Aug-64	13-Sep-65	3-Oct-50	7-Nov-79	10-Dec-46	14-Jan-94	N/A	1939	2019
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2019	27.5	24	20.3	15.9	12.1	10.4	11.3	14.7	19.1	23.7	26.6	28.4	19.5	30	1990	2019
Mean number of clear days for years 1939 to 2010	15.7	13.1	13.4	10.2	10.3	9.1	10.1	12.8	14.1	13.9	12.9	15.5	151.1	72	1939	2010
Mean number of cloudy days for years 1939 to 2010	5.6	6.3	6.9	9.2	10.2	10.4	9.7	7	6.2	5.9	6.5	5.3	89.2	72	1939	2010
Mean daily evaporation (mm) for years 1966 to 2016	12.5	10.8	8.6	5.8	3.6	2.6	2.8	3.8	5.8	8.4	10.3	12	7.2	50	1966	2016
Mean 9am temperature (Degrees C) for years 1939 to 2010	23.8	22.8	21	17.9	13.9	11	9.9	11.6	14.8	17.9	20.6	22.7	17.3	72	1939	2010
Mean 9am wet bulb temperature (Degrees C) for years 1939 to 2010	16.4	16.4	15.4	13.4	10.8	8.7	7.7	8.6	10.3	12	13.8	15.4	12.4	71	1939	2010
Mean 9am dew point temperature (Degrees C) for years 1939 to 2010	10	11.2	10.4	9.2	7.4	6	4.9	4.6	4.9	5.5	6.9	8.6	7.5	65	1939	2010
Mean 9am relative humidity (%) for years 1939 to 2010	45	51	54	60	67	74	73	65	54	47	45	43	57	65	1939	2010
Mean 9am cloud cover (okas) for years 1939 to 2010	2.8	3.2	3.4	3.8	3.8	3.8	3.7	3.1	2.9	3	3.1	2.7	3.3	72	1939	2010
Mean 9am wind speed (km/h) for years 1939 to 2010	16.6	16.4	15.7	14.4	11.8	11.8	12.4	14.3	16.2	17.1	17.1	16.3	15	72	1939	2010
Mean 3pm temperature (Degrees C) for years 1939 to 2010	32.3	30.9	28.6	24.3	19.9	16.8	16	17.8	21.3	24.7	27.8	30.7	24.3	72	1939	2010
Mean 3pm wet bulb temperature (Degrees C) for years 1939 to 2010	18.8	18.9	17.8	15.6	13.1	11.2	10.4	10.9	12.5	14.1	15.9	17.7	14.7	71	1939	2010
Mean 3pm dew point temperature (Degrees C) for years 1939 to 2010	7.2	9	8.4	7.5	6	4.9	3.5	2.4	2	2.3	3.8	5.8	5.2	65	1939	2010
Mean 3pm relative humidity (%) for years 1939 to 2010	24	30	32	38	44	48	46	39	31	27	25	24	34	65	1939	2010
Mean 3pm cloud cover (oktas) for years 1939 to 2010	2.8	3	3.1	3.8	4	4.3	4.1	3.5	3	3.1	3.3	2.8	3.4	72	1939	2010
Mean 3pm wind speed (km/h) for years 1939 to 2010	15.1	15.1	14.2	13.7	14.1	15.7	16.6	17.2	17.8	17.6	17.2	16	15.9	72	1939	2010

Monthly Climate Statistics for 'KALGOORLIE POST OFFICE' [012039]
Created on [25 Oct 2019 14:48:28 GMT+00:00]

012039 KALGOORLIE POST OFFICE
Commenced: 1896
Last Record: 1953
Latitude: 30.75 Degrees South
Longitude: 121.47 Degrees East
Elevation: 361 m
State: WA

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) for years 1897 to 1953	33.8	32.9	29.9	25.5	20.7	17.4	16.7	18.7	22.7	25.7	30	32.8	25.6	57	1897	1953
Highest temperature (Degrees C) for years 1907 to 1953	45.8	46	43.9	39.2	33.3	27.7	27.2	30.6	35.6	39.7	43.7	45	46	47	1907	1953
Date of Highest temperature for years 1907 to 1953	30-Jan-44	11-Feb-33	5-Mar-34	9-Apr-38	1-May-14	15-Jun-47	21-Jul-19	29-Aug-07	30-Sep-18	31-Oct-51	24-Nov-23	29-Dec-08	11-Feb-33	N/A	1907	1953
Lowest maximum temperature (Degrees C) for years 1907 to 1953	15.4	16.9	14	13.3	10.4	7.9	8	8.9	12.9	9.9	14.4	15.4	7.9	47	1907	1953
Date of Lowest maximum temperature for years 1907 to 1953	21-Jan-09	23-Feb-27	19-Mar-27	29-Apr-25	18-May-44	19-Jun-38	2-Jul-20	7-Aug-32	22-Sep-26	11-Oct-13	15-Nov-33	14-Dec-43	19-Jun-38	N/A	1907	1953
Decile 1 maximum temperature (Degrees C) for years 1907 to 1953	27	26.2	23.2	19.6	16	13.5	13.2	14.3	17.7	19.4	23.1	26.3		47	1907	1953
Decile 9 maximum temperature (Degrees C) for years 1907 to 1953	40.6	40	36.9	32.2	26.6	21.4	20.6	23.9	28.9	32.2	36.7	39.3		47	1907	1953
Mean number of days >= 30 Degrees C for years 1907 to 1953	23.4	20.1	15.5	5.5	0.5	0	0	0	1.9	6.3	14.9	22.1	110.2	47	1907	1953
Mean number of days >= 35 Degrees C for years 1907 to 1953	12.9	10.9	6	0.7	0	0	0	0	0	1.3	5.5	10.3	47.6	47	1907	1953
Mean number of days >= 40 Degrees C for years 1907 to 1953	3.8	2.9	0.7	0	0	0	0	0	0	0	0.6	2.4	10.4	47	1907	1953
Mean minimum temperature (Degrees C) for years 1897 to 1953	17.9	17.7	16.1	12.9	9.3	7.2	5.9	6.7	8.9	11.3	14.4	16.8	12.1	57	1897	1953
Lowest temperature (Degrees C) for years 1907 to 1953	9.2	8.9	5.3	2.8	1.4	-0.6	-1.1	-1.7	-0.2	0.8	3.3	7.8	-1.7	47	1907	1953
Date of Lowest temperature for years 1907 to 1953	12-Jan-17	28-Feb-40	28-Mar-33	20-Apr-14	30-May-39	18-Jun-31	27-Jul-31	20-Aug-51	13-Sep-32	4-Oct-42	3-Nov-07	16-Dec-43	20-Aug-51	N/A	1907	1953
Highest minimum temperature (Degrees C) for years 1907 to 1953	30	28.6	28.8	24.2	21.7	15.7	15.3	17.8	22.2	23.1	26.9	29.4	30	47	1907	1953
Date of Highest minimum temperature for years 1907 to 1953	5-Jan-32	12-Feb-51	6-Mar-34	2-Apr-45	3-May-47	15-Jun-47	13-Jul-34	28-Aug-50	28-Sep-44	31-Oct-51	23-Nov-23	19-Dec-46	5-Jan-32	N/A	1907	1953
Decile 1 minimum temperature (Degrees C) for years 1907 to 1953	13.3	13.1	11.8	8.8	5	3.1	2.2	2.8	4.6	7	9.9	12.5		47	1907	1953
Decile 9 minimum temperature (Degrees C) for years 1907 to 1953	23.1	23.1	20.8	17	13.9	11.2	10	10.8	13.5	15.8	19.4	21.7		47	1907	1953
Mean number of days <= 2 Degrees C for years 1907 to 1953	0	0	0	0	0.2	1.2	2.7	1.8	0.3	0	0	0	6.2	47	1907	1953
Mean number of days <= 0 Degrees C for years 1907 to 1953	0	0	0	0	0	0.1	0.3	0.2	0	0	0	0	0.6	47	1907	1953
Mean daily ground minimum temperature Degrees C for years null to null																
Lowest ground temperature Degrees C for years null to null																
Date of Lowest ground temperature for years null to null														N/A		
Mean number of days ground min. temp. <= -1 Degrees C for years null to null																
Mean rainfall (mm) for years 1896 to 1953	15.9	21.1	27.8	21.4	26.9	26.1	21.9	23.6	10.9	16.5	13.8	15.7	240.7	57	1896	1953
Highest rainfall (mm) for years 1896 to 1953	203.6	314.5	166.5	102.6	86.7	77.2	56.5	80.8	83.6	79.8	70.2	65.3	458.7	58	1896	1953
Date of Highest rainfall for years 1896 to 1953	1939	1948	1937	1934	1929	1951	1938	1906	1904	1899	1914	1930	1942	N/A	1896	1953
Lowest rainfall (mm) for years 1896 to 1953	0	0	0	0	0	0	2	0	0	0	0	0	120.6	58	1896	1953
Date of Lowest rainfall for years 1896 to 1953	1953	1950	1950	1949	1948	1912	1937	1912	1944	1946	1952	1947	1897	N/A	1896	1953
Decile 1 monthly rainfall (mm) for years 1896 to 1953	0	0	0	0	2.6	6.5	6.7	5.8	0.6	0	0.3	0.2	143.2	48	1896	1953
Decile 5 (median) monthly rainfall (mm) for years 1896 to 1953	4.4	9	13.8	9.4	21.6	21.1	20.6	16.2	8.1	11.6	6.9	8.9	229.7	48	1896	1953
Decile 9 monthly rainfall (mm) for years 1896 to 1953	44.9	55.4	88.7	59.7	62	52.8	38.8	49.7	23.4	36.4	33.6	50.1	344.5	48	1896	1953
Highest daily rainfall (mm) for years 1896 to 1953	96.3	177.8	70.9	68.6	38.6	38.4	26.2	31	17.3	62.5	44.2	32.3	177.8	48	1896	1953
Date of Highest daily rainfall for years 1896 to 1953	13-Jan-39	22-Feb-48	20-Mar-27	17-Apr-19	10-May-29	8-Jun-51	16-Jul-38	20-Aug-19	19-Sep-27	19-Oct-09	12-Nov-09	10-Dec-19	22-Feb-48	N/A	1896	1953
Mean number of days of rain for years 1896 to 1953	2.6	2.7	3.8	3.9	5.2	6.3	6.9	6	3.5	3.5	3	2.6	50	48	1896	1953
Mean number of days of rain >= 1 mm for years 1896 to 1953	1.5	1.7	2.7	2.6	3.2	3.5	4	3.5	2	2.2	1.7	1.7	30.3	48	1896	1953
Mean number of days of rain >= 10 mm for years 1896 to 1953	0.3	0.4	0.7	0.5	0.7	0.5	0.3	0.4	0.1	0.3	0.4	0.4	5	48	1896	1953
Mean number of days of rain >= 25 mm for years 1896 to 1953	0.2	0.1	0.2	0.1	0.1	0	0	0	0	0	0	0.1	0.8	48	1896	1953
Mean daily wind run (km) for years null to null																
Maximum wind gust speed (km/h) for years null to null																
Date of Maximum wind gust speed for years null to null														N/A		
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2018	27.5	23.9	20.4	16	12.1	10.4	11.3	14.7	19.2	23.8	26.5	28.4	19.5	29	1990	2018
Mean number of clear days for years 1907 to 1953	14.7	13.6	11.8	12.2	10.6	8.9	9.6	11.2	12.2	11.2	10.7	12	138.7	45	1907	1953
Mean number of cloudy days for years 1907 to 1953	4	4.1	5.4	6.9	7.4	8.7	7.6	6	3.3	4.5	4.5	3.8	66.2	45	1907	1953
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years 1897 to 1953	24.4	23.6	21.2	18.2	14.2	11	9.9	11.8	15.3	18.2	21.7	24	17.8	56	1897	1953
Mean 9am wet bulb temperature (Degrees C) for years 1897 to 1953	17.1	17	15.7	13.7	10.9	8.7	7.7	8.8	10.5	12.4	14.7	16.4	12.8	56	1897	1953
Mean 9am dew point temperature (Degrees C) for years 1907 to 1953	11.8	12.3	11.7	9.9	7.7	6	5.3	5.3	5.4	6.7	8.8	10.5	8.5	46	1907	1953
Mean 9am relative humidity (%) for years 1907 to 1953	48	52	58	61	67	73	74	66	54	50	46	46	58	46	1907	1953
Mean 9am cloud cover (okas) for years 1897 to 1953	2.5	2.7	3.1	3.3	3.6	4	3.7	3.3	2.9	3	2.9	2.7	3.1	55	1897	1953
Mean 9am wind speed (km/h) for years 1907 to 1952	11.6	12.1	12.1	11.4	10.6	10.6	10.3	12	13.1	13	12.8	12	11.8	46	1907	1952
Mean 3pm temperature (Degrees C) for years 1897 to 1953	32.9	32.1	29	24.7	19.9	16.6	15.9	17.9	21.9	24.9	29	31.8	24.7	56	1897	1953
Mean 3pm wet bulb temperature (Degrees C) for years 1897 to 1953	20	20.1	18.6	16.2	13.5	11.5	10.7	11.6	13.2	14.9	17.3	19.1	15.6	56	1897	1953
Mean 3pm dew point temperature (Degrees C) for years 1907 to 1953	11	11.9	11.2	9.5	7.5	6	5.1	4.7	4.2	5.4	7.6	9.5	7.8	46	1907	1953
Mean 3pm relative humidity (%) for years 1907 to 1953	29	32	37	42	47	51	51	44	33	31	29	28	38	46	1907	1953
Mean 3pm cloud cover (oktas) for years 1897 to 1953	2.6	2.8	2.9	3.2	3.7	4	3.7	3.4	2.8	3.1	3.2	3	3.2	55	1897	1953
Mean 3pm wind speed (km/h) for years 1907 to 1952	10.8	11.1	10.7	10.6	11.5	11.8	12.3	14.2	14.4	14.3	13.1	12.3	12.3	45	1907	1952

Monthly Climate Statistics for 'KANOWNA' [012040]
Created on [25 Oct 2019 14:49:19 GMT+00:00]

012040 KANOWNA
Commenced: 1896
Last Record: 1952
Latitude: 30.60 Degrees South
Longitude: 121.60 Degrees East
Elevation: 374 m
State: WA

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) for years 1903 to 1930	33.4	32.7	29.1	25.1	20.1	16.9	16.2	18.2	22	25.2	29.5	32.4	25.1	27	1903	1930
Highest temperature (Degrees C) for years null to null																
Date of Highest temperature for years null to null														N/A		
Lowest maximum temperature (Degrees C) for years null to null																
Date of Lowest maximum temperature for years null to null														N/A		
Decile 1 maximum temperature (Degrees C) for years null to null																
Decile 9 maximum temperature (Degrees C) for years null to null																
Mean number of days >= 30 Degrees C for years null to null																
Mean number of days >= 35 Degrees C for years null to null																
Mean number of days >= 40 Degrees C for years null to null																
Mean minimum temperature (Degrees C) for years 1903 to 1930	17.4	17.4	15.5	12.2	8.4	6.1	4.7	5.5	7.8	10.4	14.2	16.5	11.3	27	1903	1930
Lowest temperature (Degrees C) for years null to null																
Date of Lowest temperature for years null to null														N/A		
Highest minimum temperature (Degrees C) for years null to null																
Date of Highest minimum temperature for years null to null														N/A		
Decile 1 minimum temperature (Degrees C) for years null to null																
Decile 9 minimum temperature (Degrees C) for years null to null																
Mean number of days <= 2 Degrees C for years null to null																
Mean number of days <= 0 Degrees C for years null to null																
Mean daily ground minimum temperature Degrees C for years null to null																
Lowest ground temperature Degrees C for years null to null																
Date of Lowest ground temperature for years null to null														N/A		
Mean number of days ground min. temp. <= -1 Degrees C for years null to null																
Mean rainfall (mm) for years 1896 to 1952	16.7	19.4	27	18.6	25.8	25.1	20.3	22.3	10.3	16.1	14	16.8	232	56	1896	1952
Highest rainfall (mm) for years 1896 to 1952	93.2	236.5	189.5	89	93.2	89.1	46.3	81	84.3	130.8	83.4	167.7	485.5	57	1896	1952
Date of Highest rainfall for years 1896 to 1952	1952	1948	1896	1934	1903	1915	1938	1906	1904	1935	1919	1930	1915	N/A	1896	1952
Lowest rainfall (mm) for years 1896 to 1952	0	0	0	0	0	0.5	0.5	0	0	0	0	0	82.4	57	1896	1952
Date of Lowest rainfall for years 1896 to 1952	1949	1950	1950	1952	1952	1952	1937	1923	1944	1946	1951	1950	1950	N/A	1896	1952
Decile 1 monthly rainfall (mm) for years 1896 to 1952	0	0	0.2	0	2.5	5.3	8.3	5.5	0.4	0.8	0	0	134.9	47	1896	1952
Decile 5 (median) monthly rainfall (mm) for years 1896 to 1952	4.3	9.1	13.5	9.4	20.8	19.8	18.5	15.5	6.7	11.6	9	10	224.8	47	1896	1952
Decile 9 monthly rainfall (mm) for years 1896 to 1952	48.2	38.7	88.7	57.4	61.4	52.8	33.5	51.5	23.1	29.7	32.9	37.5	335.8	47	1896	1952
Highest daily rainfall (mm) for years 1896 to 1952	50.8	63.5	53.6	55.4	38.4	33.5	21.6	35.1	17.3	63.2	35.1	112.3	112.3	47	1896	1952
Date of Highest daily rainfall for years 1896 to 1952	3-Jan-29	24-Feb-15	10-Mar-52	5-Apr-34	22-May-33	8-Jun-51	16-Jul-38	29-Aug-14	19-Sep-17	19-Oct-09	12-Nov-09	13-Dec-30	13-Dec-30	N/A	1896	1952
Mean number of days of rain for years 1896 to 1952	2.5	2.5	3.5	3.2	4.7	5.8	6.3	5.2	3	3.2	2.6	2.6	45.1	47	1896	1952
Mean number of days of rain >= 1 mm for years 1896 to 1952	1.7	1.6	2.4	2.2	3.1	3.5	3.6	3.5	1.6	2.1	1.6	1.7	28.6	47	1896	1952
Mean number of days of rain >= 10 mm for years 1896 to 1952	0.5	0.3	0.7	0.5	0.5	0.6	0.3	0.4	0.1	0.3	0.4	0.4	5	47	1896	1952
Mean number of days of rain >= 25 mm for years 1896 to 1952	0.1	0.1	0.2	0.1	0.1	0.1	0	0	0	0.1	0.1	0.1	1	47	1896	1952
Mean daily wind run (km) for years null to null																
Maximum wind gust speed (km/h) for years null to null																
Date of Maximum wind gust speed for years null to null														N/A		
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2018	27.6	24	20.5	15.9	12.2	10.4	11.4	14.9	19.3	23.9	26.6	28.4	19.6	29	1990	2018
Mean number of clear days for years null to null																
Mean number of cloudy days for years null to null																
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years null to null																
Mean 9am wet bulb temperature (Degrees C) for years null to null																
Mean 9am dew point temperature (Degrees C) for years null to null																
Mean 9am relative humidity (%) for years null to null																
Mean 9am cloud cover (okas) for years 1908 to 1930	1.9	2.4	3.1	2.9	2.9	3.3	3.1	2.4	2.1	2.1	1.9	1.5	2.5	23	1908	1930
Mean 9am wind speed (km/h) for years null to null																
Mean 3pm temperature (Degrees C) for years null to null																
Mean 3pm wet bulb temperature (Degrees C) for years null to null																
Mean 3pm dew point temperature (Degrees C) for years null to null																
Mean 3pm relative humidity (%) for years null to null																
Mean 3pm cloud cover (oktas) for years null to null																
Mean 3pm wind speed (km/h) for years null to null																

Monthly Climate Statistics for 'NORSEMAN' [012065]
Created on [25 Oct 2019 15:33:51 GMT+00:00]

012065 NORSEMAN
Commenced: 1897
Last Record: 2012
Latitude: 32.20 Degrees South
Longitude: 121.78 Degrees East
Elevation: 277 m
State: WA

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) for years 1951 to 2012	32.6	31.3	28.8	24.6	20.4	17.5	16.8	18.5	21.6	25	28.1	30.7	24.7	61	1951	2012
Highest temperature (Degrees C) for years 1957 to 2012	46	44.9	43.8	37	33.3	27.8	27.7	32.5	35.6	40	41.1	44.9	46	56	1957	2012
Date of Highest temperature for years 1957 to 2012	22-Jan-90	24-Feb-91	10-Mar-73	12-Apr-05	6-May-59	4-Jun-57	31-Jul-69	30-Aug-06	28-Sep-80	31-Oct-88	21-Nov-66	31-Dec-72	22-Jan-90	N/A	1957	2012
Lowest maximum temperature (Degrees C) for years 1957 to 2012	16.4	15.2	16	11.9	10.4	9.3	8.3	9.8	11.2	10.6	13.4	13.8	8.3	56	1957	2012
Date of Lowest maximum temperature for years 1957 to 2012	23-Jan-67	8-Feb-63	15-Mar-92	17-Apr-70	24-May-79	21-Jun-81	19-Jul-61	19-Aug-68	3-Sep-77	7-Oct-92	20-Nov-92	1-Dec-83	19-Jul-61	N/A	1957	2012
Decile 1 maximum temperature (Degrees C) for years 1957 to 2012	26.3	24.4	22.6	19.3	16.1	14.1	13.5	14.5	16.6	18.9	21.5	24.3		54	1957	2012
Decile 9 maximum temperature (Degrees C) for years 1957 to 2012	39.1	38.1	35.5	31	25.3	21.1	20.6	23.1	27.2	32	34.9	37.2		54	1957	2012
Mean number of days >= 30 Degrees C for years 1957 to 2012	20.9	16.4	11.3	3.8	0.3	0	0	0.1	1	5.1	10.4	16.5	85.8	56	1957	2012
Mean number of days >= 35 Degrees C for years 1957 to 2012	9.6	6.5	3.5	0.3	0	0	0	0	0	0.8	2.8	5.9	29.4	56	1957	2012
Mean number of days >= 40 Degrees C for years 1957 to 2012	2.1	1.2	0.5	0	0	0	0	0	0	0	0.2	0.8	4.8	56	1957	2012
Mean minimum temperature (Degrees C) for years 1951 to 2012	15.8	15.9	14.5	11.6	8.5	6.3	5.1	5.4	7.3	9.7	12.3	14.1	10.5	61	1951	2012
Lowest temperature (Degrees C) for years 1957 to 2012	6	6.3	3.3	0.6	-2.3	-4.6	-3.1	-2.2	-3	-0.7	2.2	3.6	-4.6	56	1957	2012
Date of Lowest temperature for years 1957 to 2012	31-Jan-90	15-Feb-94	29-Mar-07	30-Apr-60	31-May-64	27-Jun-10	21-Jul-88	18-Aug-97	11-Sep-04	4-Oct-94	2-Nov-64	2-Dec-73	27-Jun-10	N/A	1957	2012
Highest minimum temperature (Degrees C) for years 1957 to 2012	27.3	29.1	25.9	24.2	21.1	16.4	15.8	16.8	19.6	24.6	25.4	26.6	29.1	56	1957	2012
Date of Highest minimum temperature for years 1957 to 2012	31-Jan-93	24-Feb-91	3-Mar-92	1-Apr-89	6-May-02	23-Jun-91	30-Jul-01	19-Aug-82	30-Sep-90	24-Oct-90	24-Nov-78	16-Dec-70	24-Feb-91	N/A	1957	2012
Decile 1 minimum temperature (Degrees C) for years 1957 to 2012	11.6	11.6	9.9	6.7	3.9	1.8	0.6	1.1	2.8	4.6	7.5	9.8		54	1957	2012
Decile 9 minimum temperature (Degrees C) for years 1957 to 2012	20.5	20.4	18.6	16.4	13.3	10.8	9.5	10	11.9	14.4	17	18.9		54	1957	2012
Mean number of days <= 2 Degrees C for years 1957 to 2012	0	0	0	0	0.9	3.6	5.8	5.2	1.8	0.5	0	0	17.8	56	1957	2012
Mean number of days <= 0 Degrees C for years 1957 to 2012	0	0	0	0	0.1	1	2.1	1.2	0.3	0	0	0	4.7	56	1957	2012
Mean daily ground minimum temperature Degrees C for years null to null																
Lowest ground temperature Degrees C for years null to null																
Date of Lowest ground temperature for years null to null														N/A		
Mean number of days ground min. temp. <= -1 Degrees C for years null to null																
Mean rainfall (mm) for years 1897 to 2012	19.9	24.9	24.4	23.4	30.5	30.1	26.8	24.8	21.4	20.3	20.4	21.4	288.9	112	1897	2012
Highest rainfall (mm) for years 1897 to 2012	116.4	202.6	188.7	111.8	136.6	104.4	80	94.9	75.2	87.2	86.9	150.8	623.6	115	1897	2012
Date of Highest rainfall for years 1897 to 2012	2000	1948	1992	1918	1950	1968	1964	1931	2008	1924	1993	1983	1992	N/A	1897	2012
Lowest rainfall (mm) for years 1897 to 2012	0	0	0	0	0	2.2	2.5	0.8	0.4	0	0	0	137.9	115	1897	2012
Date of Lowest rainfall for years 1897 to 2012	1997	1998	2001	1994	1959	2008	1971	1956	1980	1922	1961	1996	1911	N/A	1897	2012
Decile 1 monthly rainfall (mm) for years 1897 to 2012	0.8	0	0.9	1.5	6.2	7.8	9.2	8.1	4.2	5	2	1.5	200.3	106	1897	2012
Decile 5 (median) monthly rainfall (mm) for years 1897 to 2012	10.6	11.6	12.4	16.5	24.5	26	24.1	21.8	18.2	15	14.5	13.2	276.6	106	1897	2012
Decile 9 monthly rainfall (mm) for years 1897 to 2012	56	56.3	61.8	50.8	60.8	55.8	46.4	47.2	44	48.1	46.2	50.2	387.5	106	1897	2012
Highest daily rainfall (mm) for years 1898 to 2012	67.4	163.6	86	66.3	42.4	43.8	32.8	38.6	58.8	45	48.3	54.1	163.6	106	1898	2012
Date of Highest daily rainfall for years 1898 to 2012	6-Jan-99	23-Feb-48	11-Mar-00	11-Apr-13	5-May-65	14-Jun-89	20-Jul-84	12-Aug-31	27-Sep-08	4-Oct-82	12-Nov-09	15-Dec-43	23-Feb-48	N/A	1898	2012
Mean number of days of rain for years 1897 to 2012	3.5	3.7	4.5	5.3	7.3	8.7	9.4	8.5	7	5.3	4.6	3.9	71.7	106	1897	2012
Mean number of days of rain >= 1 mm for years 1898 to 2012	2.3	2.4	3	3.2	4.8	5.6	5.8	5.1	4.3	3.4	3.1	2.6	45.6	106	1898	2012
Mean number of days of rain >= 10 mm for years 1898 to 2012	0.5	0.7	0.7	0.6	0.7	0.6	0.5	0.4	0.4	0.3	0.6	0.6	6.6	106	1898	2012
Mean number of days of rain >= 25 mm for years 1898 to 2012	0.1	0.2	0.1	0.1	0.1	0.1	0	0	0	0.1	0.1	0.1	1	106	1898	2012
Mean daily wind run (km) for years null to null																
Maximum wind gust speed (km/h) for years null to null																
Date of Maximum wind gust speed for years null to null														N/A		
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2018	27	23.6	19.5	14.8	10.9	9.6	10.2	13.5	17.7	22.3	25.4	27.7	18.5	29	1990	2018
Mean number of clear days for years 1957 to 2012	15.9	12	12.2	9.6	8.7	8.6	9	10	10.6	11.4	11.4	14	133.4	54	1957	2012
Mean number of cloudy days for years 1957 to 2012	5	5.9	7.1	8.7	10.1	9.6	9	7.9	6.9	6.5	6.4	5.6	88.7	54	1957	2012
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years 1951 to 2012	22.5	21.8	20.1	17.1	13.5	10.8	9.9	11.4	14.3	17.2	19.7	21.4	16.6	60	1951	2012
Mean 9am wet bulb temperature (Degrees C) for years 1951 to 2012	16.7	16.6	15.6	13.7	11.1	9	8.1	9	10.7	12.3	14.1	15.4	12.7	54	1951	2012
Mean 9am dew point temperature (Degrees C) for years 1957 to 2012	12.5	12.9	12	10.7	8.7	7.1	6.1	6.2	6.9	7.6	9.3	10.8	9.2	48	1957	2012
Mean 9am relative humidity (%) for years 1951 to 2012	55	60	62	68	74	79	78	71	63	55	52	53	64	54	1951	2012
Mean 9am cloud cover (okas) for years 1957 to 2012	2.8	3.5	3.5	3.8	4	3.9	3.5	3.3	3.3	3.2	3.4	2.8	3.4	54	1957	2012
Mean 9am wind speed (km/h) for years 1957 to 2012	12.2	12.4	11.7	10.8	10	10.3	10.6	11.3	12.2	12.4	12.7	12.5	11.6	52	1957	2012
Mean 3pm temperature (Degrees C) for years 1951 to 2012	31.4	30.2	27.9	23.7	19.5	16.6	15.9	17.5	20.6	23.8	26.9	29.6	23.6	60	1951	2012
Mean 3pm wet bulb temperature (Degrees C) for years 1951 to 2012	19.4	19.3	18.2	16	13.6	11.8	11	11.5	13	14.6	16.5	18	15.2	54	1951	2012
Mean 3pm dew point temperature (Degrees C) for years 1957 to 2012	10.8	11.6	11	9.6	8	6.9	5.7	5.2	5.3	5.9	7.6	9.1	8.1	48	1957	2012
Mean 3pm relative humidity (%) for years 1951 to 2012	31	35	37	43	49	55	53	46	39	34	32	30	40	54	1951	2012
Mean 3pm cloud cover (oktas) for years 1957 to 2012	2.4	2.9	3	3.9	4.2	4.4	4.2	3.8	3.5	3.3	3.4	2.8	3.5	54	1957	2012
Mean 3pm wind speed (km/h) for years 1957 to 2012	12.9	12.5	11.7	11.6	12.4	13.4	14.2	14.4	14.5	13.3	13.3	12.8	13.1	51	1957	2012

APPENDIX B

Fingals Mining Centre Rainfall Intensity-Frequency-Duration Relationship

Label: FINGALS MINING CENTRE

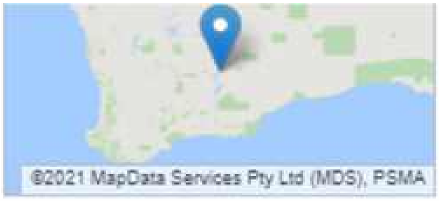
Easting: 395250

Northing: 6573500

Zone: 51

Latitude: Nearest grid cell: 30.9625 (S)

Longitude: Nearest grid cell: 121.9125 (E)



IFD Design Rainfall Intensity (mm/h)

Issued: 23 September 2021

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	72.3	85.9	133	169	208	264	312
2 min	63.1	74.9	115	144	175	221	259
3 min	56.5	67.1	103	130	159	200	235
4 min	51.4	61.1	94.2	119	146	184	217
5 min	47.3	56.2	86.9	110	135	171	202
6 min	43.9	52.2	80.8	103	126	160	189
10 min	34.6	41.1	63.9	81.3	100.0	127	151
15 min	27.8	33.1	51.4	65.4	80.5	103	121
20 min	23.6	28.0	43.4	55.3	68.0	86.6	102
25 min	20.6	24.5	37.9	48.2	59.2	75.3	89.0
30 min	18.4	21.8	33.8	42.9	52.7	66.9	79.0
45 min	14.2	16.8	25.9	32.9	40.2	51.0	60.2
1 hour	11.7	13.9	21.4	27.1	33.1	41.9	49.4
1.5 hour	8.96	10.6	16.3	20.6	25.1	31.8	37.4
2 hour	7.38	8.74	13.4	16.9	20.7	26.2	30.8
3 hour	5.62	6.65	10.2	12.9	15.8	20.0	23.6
4.5 hour	4.27	5.06	7.79	9.88	12.1	15.4	18.3
6 hour	3.52	4.17	6.44	8.20	10.1	12.9	15.3
9 hour	2.67	3.17	4.93	6.32	7.83	10.1	12.0
12 hour	2.19	2.60	4.08	5.25	6.55	8.44	10.1
18 hour	1.65	1.96	3.11	4.03	5.07	6.56	7.87
24 hour	1.34	1.60	2.55	3.32	4.20	5.46	6.55
30 hour	1.14	1.36	2.17	2.85	3.61	4.70	5.65
36 hour	0.989	1.18	1.90	2.50	3.18	4.15	4.99
48 hour	0.791	0.948	1.53	2.02	2.58	3.37	4.05
72 hour	0.569	0.683	1.11	1.46	1.88	2.45	2.94
96 hour	0.446	0.534	0.867	1.15	1.47	1.92	2.30
120 hour	0.366	0.439	0.711	0.940	1.20	1.57	1.89
144 hour	0.311	0.372	0.602	0.794	1.02	1.32	1.59
168 hour	0.270	0.323	0.520	0.685	0.874	1.14	1.37

Location

Label: FINGALS MINING CENTRE

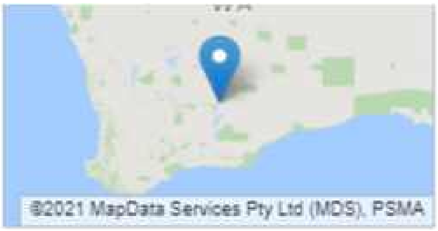
Easting: 395250

Northing: 6573500

Zone: 51

Latitude: Nearest grid cell: 30.9625 (S)

Longitude: Nearest grid cell: 121.9125 (E)



IFD Design Rainfall Intensity (mm/h)

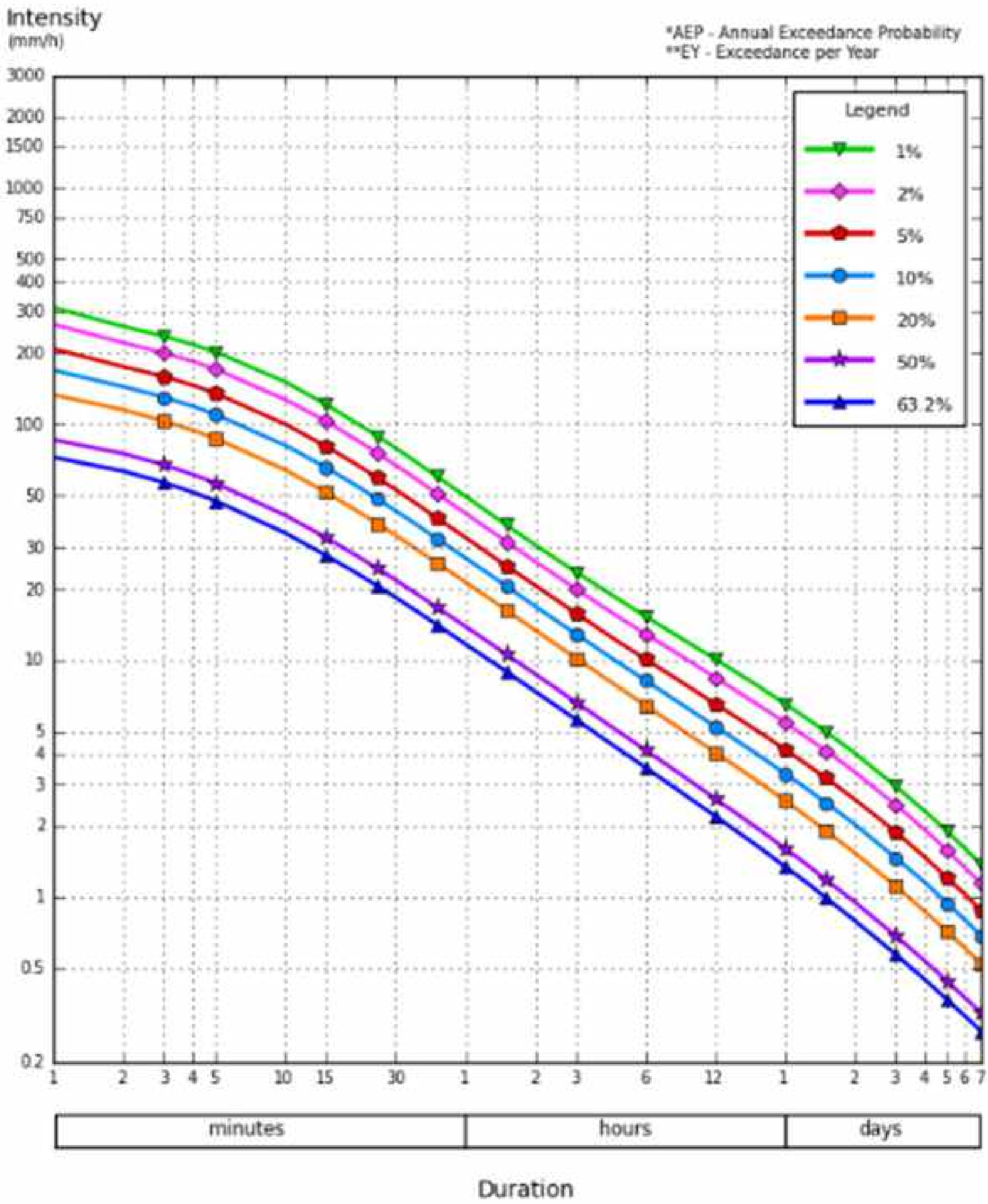
Issued: 23 September 2021

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).

FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h

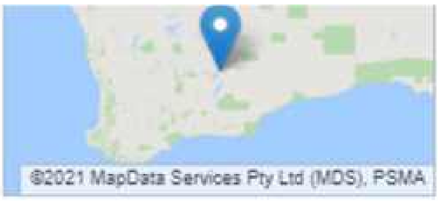


GROUNDWATER RESOURCE MANAGEMENT

APPENDIX B2
FINGALS MINING CENTRE
POINT RAINFALL INTENSITY
FREQUENCY DURATION CHART

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2135R01

Label: FINGALS MINING CENTRE
Easting: 395250
Northing: 6573500
Zone: 51
Latitude: Nearest grid cell: 30.9625 (S)
Longitude: Nearest grid cell: 121.9125 (E)



IFD Design Rainfall Depth (mm)

Issued: 23 September 2021

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	1.20	1.43	2.22	2.82	3.46	4.40	5.20
2 min	2.10	2.50	3.82	4.81	5.85	7.37	8.62
3 min	2.83	3.36	5.16	6.51	7.93	10.0	11.7
4 min	3.43	4.07	6.28	7.94	9.70	12.3	14.4
5 min	3.94	4.69	7.24	9.18	11.2	14.3	16.8
6 min	4.39	5.22	8.08	10.3	12.6	16.0	18.9
10 min	5.76	6.85	10.6	13.5	16.7	21.2	25.1
15 min	6.95	8.27	12.8	16.4	20.1	25.6	30.4
20 min	7.85	9.34	14.5	18.4	22.7	28.9	34.1
25 min	8.58	10.2	15.8	20.1	24.7	31.4	37.1
30 min	9.19	10.9	16.9	21.4	26.3	33.5	39.5
45 min	10.6	12.6	19.5	24.6	30.2	38.3	45.1
1 hour	11.7	13.9	21.4	27.1	33.1	41.9	49.4
1.5 hour	13.4	15.9	24.4	30.8	37.7	47.7	56.1
2 hour	14.8	17.5	26.8	33.8	41.3	52.4	61.6
3 hour	16.8	20.0	30.6	38.7	47.3	60.1	70.8
4.5 hour	19.2	22.8	35.1	44.5	54.6	69.5	82.2
6 hour	21.1	25.0	38.7	49.2	60.6	77.4	91.8
9 hour	24.0	28.5	44.4	56.9	70.5	90.5	108
12 hour	26.3	31.2	48.9	63.0	78.6	101	121
18 hour	29.6	35.3	55.9	72.5	91.2	118	142
24 hour	32.1	38.4	61.1	79.7	101	131	157
30 hour	34.1	40.7	65.2	85.4	108	141	170
36 hour	35.6	42.6	68.5	90.0	115	149	180
48 hour	38.0	45.5	73.5	96.9	124	162	194
72 hour	41.0	49.2	79.7	105	135	176	212
96 hour	42.8	51.3	83.3	110	141	184	221
120 hour	43.9	52.7	85.4	113	145	188	226
144 hour	44.7	53.6	86.6	114	146	190	229
168 hour	45.3	54.2	87.4	115	147	191	231

GROUNDWATER RESOURCE MANAGEMENT

APPENDIX B3
FINGALS MINING CENTRE
POINT RAINFALL DEPTH
FREQUENCY DURATION TABLE

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2135R01

Location

Label: FINGALS MINING CENTRE

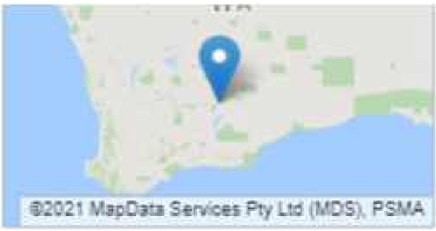
Easting: 395250

Northing: 6573500

Zone: 51

Latitude: Nearest grid cell: 30.9625 (S)

Longitude: Nearest grid cell: 121.9125 (E)



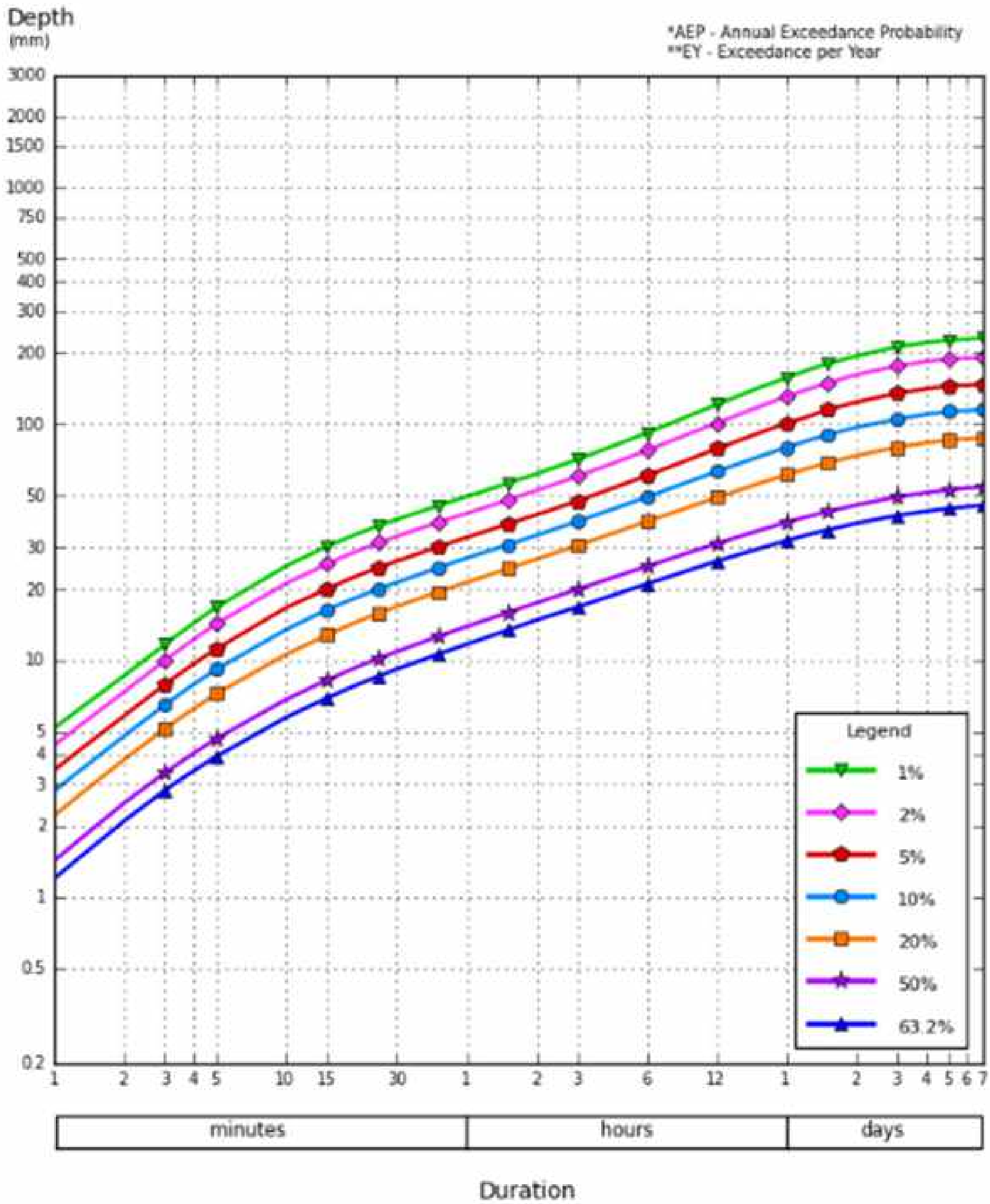
IFD Design Rainfall Depth (mm)

Issued: 23 September 2021

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm



Label: FINGALS MINING CENTRE
Easting: 395250
Northing: 6573500
Zone: 51
Latitude: Nearest grid cell: 30.9625 (S)
Longitude: Nearest grid cell: 121.9125 (E)

Rare Design Rainfall Intensity (mm/h)

Issued: 23 September 2021

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h

	Annual Exceedance Probability (1 in x)				
Duration	**1 in 100**	**1 in 200**	**1 in 500**	**1 in 1000**	**1 in 2000**
1 min	312	366	453	529	616
2 min	259	305	378	442	515
3 min	235	277	343	401	467
4 min	217	255	316	369	430
5 min	202	237	294	343	399
6 min	189	222	274	321	373
10 min	151	177	219	256	297
15 min	121	142	176	206	239
20 min	102	120	149	174	202
25 min	89.0	104	129	151	175
30 min	79.0	92.7	115	134	156
45 min	60.2	70.6	87.5	102	119
1 hour	49.4	58.0	71.9	84.0	97.7
1.5 hour	37.4	44.0	54.5	63.6	74.0
2 hour	30.8	36.2	44.9	52.4	61.0
3 hour	23.6	27.7	34.4	40.1	46.7
4.5 hour	18.3	21.4	26.6	31.0	36.1
6 hour	15.3	17.9	22.2	26.0	30.2
9 hour	12.0	14.0	17.4	20.3	23.6
12 hour	10.1	11.8	14.6	17.1	19.8
18 hour	7.87	9.22	11.4	13.3	15.5
24 hour	6.55	7.69	9.53	11.1	12.9
30 hour	5.65	6.60	8.14	9.47	11.0
36 hour	4.99	5.81	7.16	8.33	9.65
48 hour	4.05	4.74	5.85	6.82	7.91
72 hour	2.94	3.50	4.35	5.10	5.95
96 hour	2.30	2.77	3.46	4.07	4.77
120 hour	1.89	2.28	2.86	3.37	3.96
144 hour	1.59	1.92	2.42	2.86	3.35
168 hour	1.37	1.65	2.08	2.45	2.88

Label: FINGALS MINING CENTRE

Easting: 395250

Northing: 6573500

Zone: 51

Latitude: Nearest grid cell: 30.9625 (S)

Longitude: Nearest grid cell: 121.9125 (E)

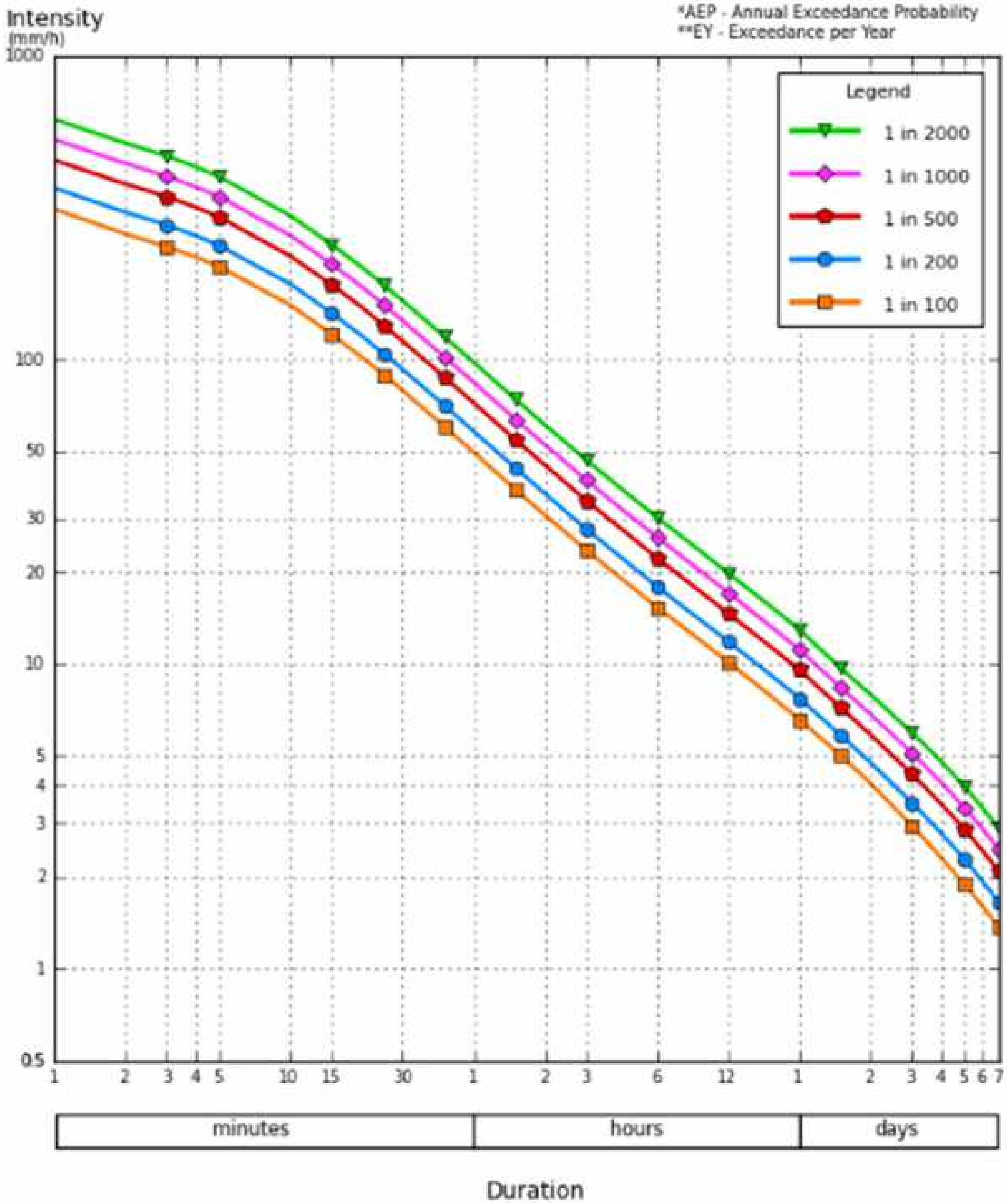
Rare Design Rainfall Intensity (mm/h)

Issued: 23 September 2021

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm/h



Label: FINGALS MINING CENTRE
Easting: 395250
Northing: 6573500
Zone: 51
Latitude: Nearest grid cell: 30.9625 (S)
Longitude: Nearest grid cell: 121.9125 (E)

Rare Design Rainfall Depth (mm)

Issued: 23 September 2021

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

Unit: mm

	Annual Exceedance Probability (1 in x)				
Duration	**1 in 100**	**1 in 200**	**1 in 500**	**1 in 1000**	**1 in 2000**
1 min	5.20	6.10	7.55	8.82	10.3
2 min	8.62	10.2	12.6	14.7	17.2
3 min	11.7	13.8	17.1	20.0	23.3
4 min	14.4	17.0	21.1	24.6	28.6
5 min	16.8	19.7	24.5	28.6	33.3
6 min	18.9	22.2	27.4	32.1	37.3
10 min	25.1	29.5	36.5	42.6	49.5
15 min	30.4	35.6	44.1	51.4	59.8
20 min	34.1	40.0	49.5	57.8	67.3
25 min	37.1	43.5	53.8	62.9	73.1
30 min	39.5	46.4	57.4	67.0	78.0
45 min	45.1	53.0	65.6	76.7	89.2
1 hour	49.4	58.0	71.9	84.0	97.7
1.5 hour	56.1	65.9	81.7	95.5	111
2 hour	61.6	72.4	89.7	105	122
3 hour	70.8	83.2	103	120	140
4.5 hour	82.2	96.4	119	140	162
6 hour	91.8	108	133	156	181
9 hour	108	126	156	183	212
12 hour	121	142	175	205	238
18 hour	142	166	206	240	279
24 hour	157	185	229	267	311
30 hour	170	198	244	284	329
36 hour	180	209	258	300	347
48 hour	194	227	281	327	380
72 hour	212	252	313	367	428
96 hour	221	266	332	391	458
120 hour	226	273	343	405	475
144 hour	229	277	349	411	483
168 hour	231	278	350	412	484

Label: FINGALS MINING CENTRE

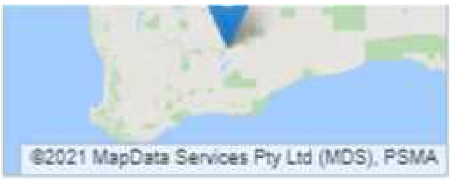
Easting: 395250

Northing: 6573500

Zone: 51

Latitude: Nearest grid cell: 30.9625 (S)

Longitude: Nearest grid cell: 121.9125 (E)



Rare Design Rainfall Depth (mm)

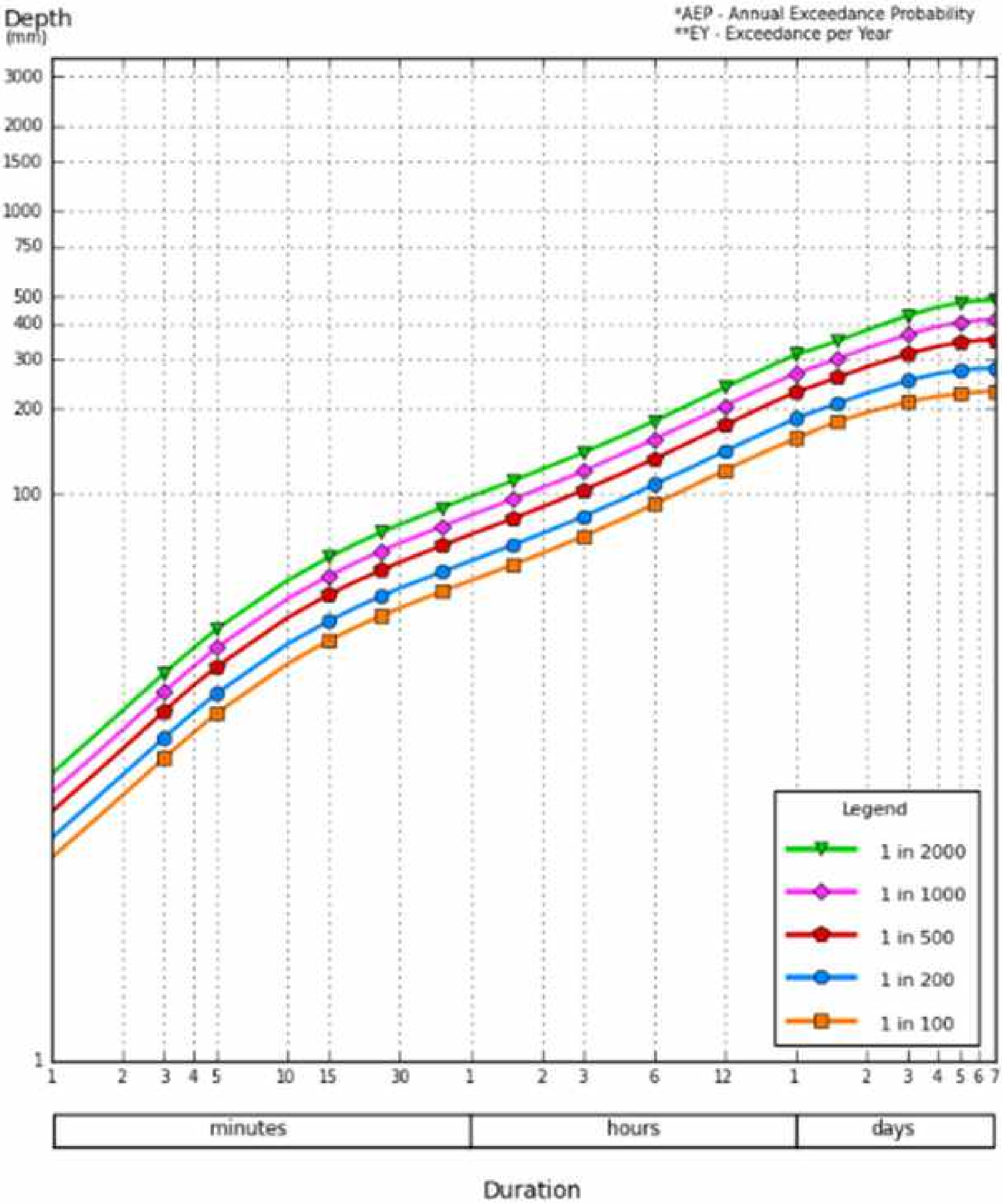
Issued: 23 September 2021

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).

FAQ for New ARR probability terminology

Table | Chart

Unit: mm



APPENDIX C

Fingals Mining Centre Probable Maximum Precipitation Estimate

GROUNDWATER RESOURCE MANAGEMENT

APPENDIX C - MEMORANDUM

[redacted]		Date: 23 September 2021	Project: J2134R01
		Company: Black Cat Syndicate Ltd	
Re: Fingals Mining Centre – Probable Maximum Precipitation Estimate			

INTRODUCTION

This memorandum has been prepared to support the Fingals Mining Centre (FMC) Feasibility Study. An assessment of the Probable Maximum Precipitation (PMP) is typically required to identify potential impacts on the design of waste rock landforms and surface water management measures e.g. diversions, flood protection bunds, spillways etc. Pit hydrology modelling should also take PMP conditions into consideration post-closure.

The estimation of the PMP event for the FMC site has therefore been presented in the following sections. This memorandum builds on the hydro-meteorological information presented in the Hydro-Meteorological Study (GRM report J2134R01 *currently in preparation*). It is assumed that the reader is familiar with the content and findings of that report.

Background

At the outset it should be noted that the PMP has been defined by the World Meteorological Organisation as the "greatest depth of precipitation for a given duration, meteorologically possible for a given size storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends"[1]. It is a *conceptual event* based around the hypothesis that the rainfall results from the simultaneous occurrence of a storm of optimal efficiency together with maximum moisture availability which is approximated by assuming maximum moisture inflow to the storm.

As such, it can be thought of as an *upper limit* ***estimate*** of the rainfall depth that could occur in the future. The PMP is a key design rainfall input, along with spatial and temporal distributions and other factors, to the calculation of the probable maximum flood (PMF) which is often used as the design flood event for large dams and for other sensitive water management works and floodplain management studies.

[1] *"Manual for Estimation of Probable Maximum Precipitation"* Operational Hydrology Report No. 1, 2nd Edition (World Meteorological Organization, 1986).

T: (+61 8) 9433 2222 **F:** (+61 8) 9433 2322 **ABN**: 97 107 493 292 **A:** 15 Harborne Street, Wembley, WA 6014
P: Po Box 442, Bayswater, WA 6933

A number of different methods have been used historically in Australia for PMP estimation including the in-situ maximisation of data recorded at a specific location and also storm transposition methods which allowed the displacement of a storm from the location where it occurred to a target location assuming the storm could just as likely have occurred there. However since the mid 1970's generalised methods have been developed that allow rainfall from much wider geographical regions to be analysed and these are generally considered to be an improvement over the earlier transposition methods.

Successive revisions of these generalised methods have, in turn, brought progressively higher estimates of PMP depths for individual catchments as each revision has utilised a greater amount of data and better analytical techniques. Currently the Generalised Short Duration Method (GSDM[2], also known as the "Thunderstorm Method") is used to derive PMP estimates for durations less than six hours across all of Australia, while the Revised Generalised Tropical Storm Method (GTSMR[3]) is used for longer duration events and covers the majority of continental Australia affected by tropical storms. The Generalised Southeast Australia Method (GSAM) is used for longer-duration PMP estimates in south-east Australia[4].

Although, the WMO definition of PMP relates to the "theoretical" greatest rainfall depth of precipitation for a given duration that is physically possible, it is recognised that limitations in data and understanding of extreme meteorological conditions means that there is a finite probability, albeit small, of the PMP estimate being exceeded. In order to take into consideration the inability to accurately estimate the theoretical upper limit of rainfall, the term "*operational estimate of the PMP"* has been adopted[5]. This represents the best estimate of the PMP depth for a particular location that can currently be made using information obtained from observed large events and the generalised PMP methods. Therefore, it should be noted that the GSDM and GTSMR PMP estimates presented in this memorandum are the *operational estimates* of the PMP as opposed to the theoretical PMP. This distinction acknowledges the finite probability of occurrence of the PMP as discussed above.

The average recurrence interval (ARI) or annual exceedance probability (AEP) of the PMP is uncertain and results in much debate within the field of hydrology. However, it is considered to be an extremely rare event of at least 100,000 to 1 million year ARI (i.e. 0.001% to 0.0001% AEP). The PMF is considered to be an even more extreme event as it not only requires the PMP to occur, but also needs the most severe antecedent moisture and other hydrological conditions to prevail. Consequently the PMF is generally considered to be one or two orders of magnitude greater than the PMP (i.e. at least 1 million to 10 million year ARI or 0.0001% to 0.00001% AEP).

[2] "*The Estimation or Probable Precipitation in Australia: Generalised Short-Duration Method"* (BoM, 2003).
[3] *"Revision of the Generalised Tropical Storm Method for Estimating Probable Maximum Precipitation*", Hydrology Report Series No. 8, Hydrometeorological Advisory Service (BoM, 2003).
[4] "*Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Southeast Australia Method"*, Hydrometeorological Advisory Service (BoM, 2006)
[5] "*PMP and Other Extreme Storms: Concepts and Probabilities*" (Schaefer, M.G., 1994).

PMP Estimation

The selection of the PMP estimation methods is summarised on the PMP Method Selection Worksheet (refer to Attachment 1). The FMC location within the "WA Transition Zone" means that the GSDM can be applied for summer and winter events of up to three hours duration, while both the GTSMR Coastal/GSAM Inland methods should be applied for annual events of between 24 and 120 hour duration and the method generating the higher values adopted, as outlined below.

Generalised Short Duration Method (GSDM)

Given that the FMC is located on the local watershed with essentially no upstream catchment areas, the GSDM has been applied to an assumed FMC upstream catchment area of 1 km^2 in accordance with the published BoM method and accompanying datasets (referenced earlier) and is summarised in the GSDM Calculation Sheet (refer to Attachment 2). The key steps were as follows:

- *Selection of Terrain Category* – factors of 10% and 90% were applied to the FMC catchment falling within the "Rough" and "Smooth" categories respectively.
- *Adjustment for Catchment Elevation* – an Elevation Adjustment Factor (EAF) of 1.0 was adopted as the 390 mAHD mean elevation of the FMC is lower than 1,500 mAHD elevation above which the EAF requires adjustment.
- *Adjustment for Moisture* – the catchment average MAF of 0.72 was read directly from Figure 3 in the BoM text.
- *Initial PMP Rainfall Depth Estimates* – values for "Rough" and "Smooth" catchments for an area of 1 km^2 were read from the "Depth-Duration-Area Curves of Short Duration Rainfall" figure (refer to Attachment 3) to give initial rainfall depths for event durations of between 15 minutes (0.25 hours) and 3 hours.
- The initial PMP rainfall depth estimates were then multiplied by the EAF and MAF and rounded to the nearest 10 mm to yield the PMP depths summarised in Table 1.

Table 1: GSDM PMP Rainfall Depth Estimates

Duration (hours)	**0.25**	**0.5**	**0.75**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**
PMP Depth (mm)	180	250	320	370	420	470	510	540

Generalised Tropical Storm Method (GTSMR) - Coastal Zone

The GTSMR Coastal Zone method was applied for annual events in accordance with the published BoM method and accompanying datasets (referenced above) and is summarised in the GTSMR Calculation Sheet (refer to Attachment 4). The key steps were as follows:

- *Obtain Raw PMP Rainfall Depths* – were interpolated for the assumed 1 km^2 FMC upstream catchment area using the depth-area data for the Coastal-Summer dataset for event durations of between 24 and 120 hours.
- *Adjustment for Moisture* – The MAF is the ratio of the extreme precipitable water at the catchment site ($EPW_{catchment}$) to the standard extreme precipitable water ($EPW_{standard}$) which is 120.0 mm. The gridded EPW dataset was imported using GIS tools and an average

$EPW_{catchment}$ value of 75 mm was obtained for the FMC, resulting in a MAF adjustment factor of 0.625.

- *Adjustment for Decay Amplitude* – the gridded decay amplitude factor (DAF) dataset was imported using GIS tools and a DAF factor of 0.70 was obtained.
- *Adjustment for Topography* – the gridded topographic adjustment factor (TAF) dataset was imported using GIS tools and a TAF factor of 1.23 was obtained.
- *Preliminary GTSMR PMP Rainfall Depths* – the raw depths for each standard duration were multiplied by the three catchment adjustment factors (i.e. PMP Estimate = Raw PMP depth × MAF × DAF × TAF) which were then rounded to the nearest 10 mm to yield the "Preliminary PMP Estimates" shown on the GTSMR calculation sheet. The GSDM values (estimated above) for event durations of between 1 and 3 hours were also added.
- *Final GTSMR PMP Rainfall Depths* – the PMP values were then graphically interpolated between the 3 hour GSDM and 24 hour GTSMR values.

The resulting combined GSDM and GTSMR depth estimates are summarised in Table 2.

Table 2: Combined GSDM & GTSMR PMP Rainfall Depth Estimates

Duration (hours)	**1**	**2**	**3**	**4**	**5**	**6**	**12**	**24**	**36**	**48**	**72**	**96**	**120**
PMP Depth (mm)	370	470	540	580	590	600	650	740	910	1,070	1,350	1,510	1,590

Generalised Southeast Australia Storm Method (GSAM) - Inland Zone

The GSAM Inland Zone method was applied in accordance with the published BoM method and accompanying datasets (referenced above) and is summarised in the GSAM Calculation Sheet (refer to Attachment 5). The key steps were as follows:

- *Obtain Raw PMP Rainfall Depths* – were interpolated for the assumed 1 km^2 FMC upstream catchment area using the depth-area data for the Inland dataset for event durations of between 24 and 96 hours.
- *Adjustment for Moisture* – The MAF is the ratio of the extreme precipitable water at the catchment site ($EPW_{catchment}$) to the standard extreme precipitable water ($EPW_{standard}$). The gridded EPW datasets were imported using GIS tools and average $EPW_{catchment}$ values of 75.00 mm and 56.28 mm were obtained for the FMC, resulting in MAF adjustment factors of 0.928 and 0.793 for Summer and Autumn events respectively. Given that the Summer events were found to have higher rainfall depths, the Summer values were adopted for the PMP estimation.
- *Adjustment for Topography* – the gridded topographic adjustment factor (TAF) dataset was imported using GIS tools and a TAF factor of 1.153 was obtained.
- *Preliminary GSAM PMP Rainfall Depths* – the raw depths for each standard duration were multiplied by the two catchment adjustment factors (i.e. PMP Estimate = Raw PMP depth × MAF × TAF) which were then rounded to the nearest 10 mm to yield the "Preliminary PMP

Estimates" shown on the GSAM calculation sheet. The GSDM values (estimated above) for event durations of between 1 and 3 hours were also added.

- *Final GTSMR PMP Rainfall Depths* – the PMP values were then graphically interpolated between the 3 hour GSDM and 24 hour GTSMR values.

The resulting combined GSDM and GSAM depth estimates for durations between 1 and 96 hours are summarised in Table 3.

Table 3: Combined GSDM & GSAM PMP Rainfall Depth Estimates

Duration (hours)	**1**	**2**	**3**	**4**	**5**	**6**	**12**	**24**	**36**	**48**	**72**	**96**
PMP Depth (mm)	370	470	540	560	580	600	630	650	760	810	860	880

Comparison of GTSMR and GSAM Methods

Comparison of the resulting long duration PMP values i.e. PMP durations greater than 3 hours, shows that the GTSMR method reproduces significantly higher (more conservative) values and is therefore recommended for FMC design purposes.

The resulting GTSMR PMP depth estimates have been plotted along with the intensity-duration-frequency (IDF) and depth-duration-frequency (DDF) data developed previously for the FMC using the recently updated BoM 2016 dataset and shown in Figure 1 and 2 on the following pages.

Inspection of Figures 1 and 2 clearly demonstrates the extreme nature of the PMP event with rainfall intensities and depths, on average, some five to six times greater than the corresponding values for the 1% AEP event.

Figure 1: PMP Rainfall Intensity Estimates and Fingals Mining Centre Rainfall Intensity-Duration-Frequency Relationship (BoM, 2016)

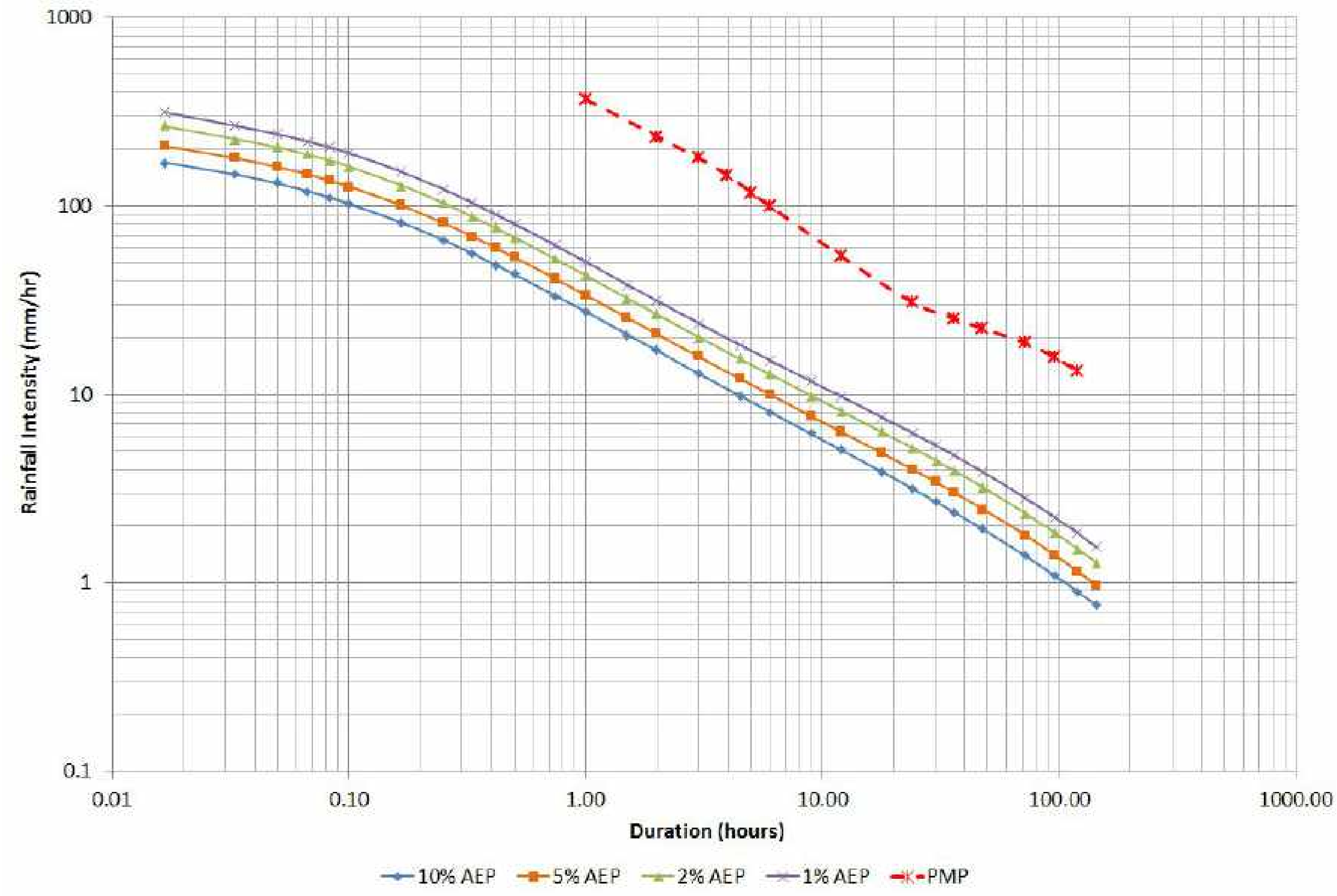
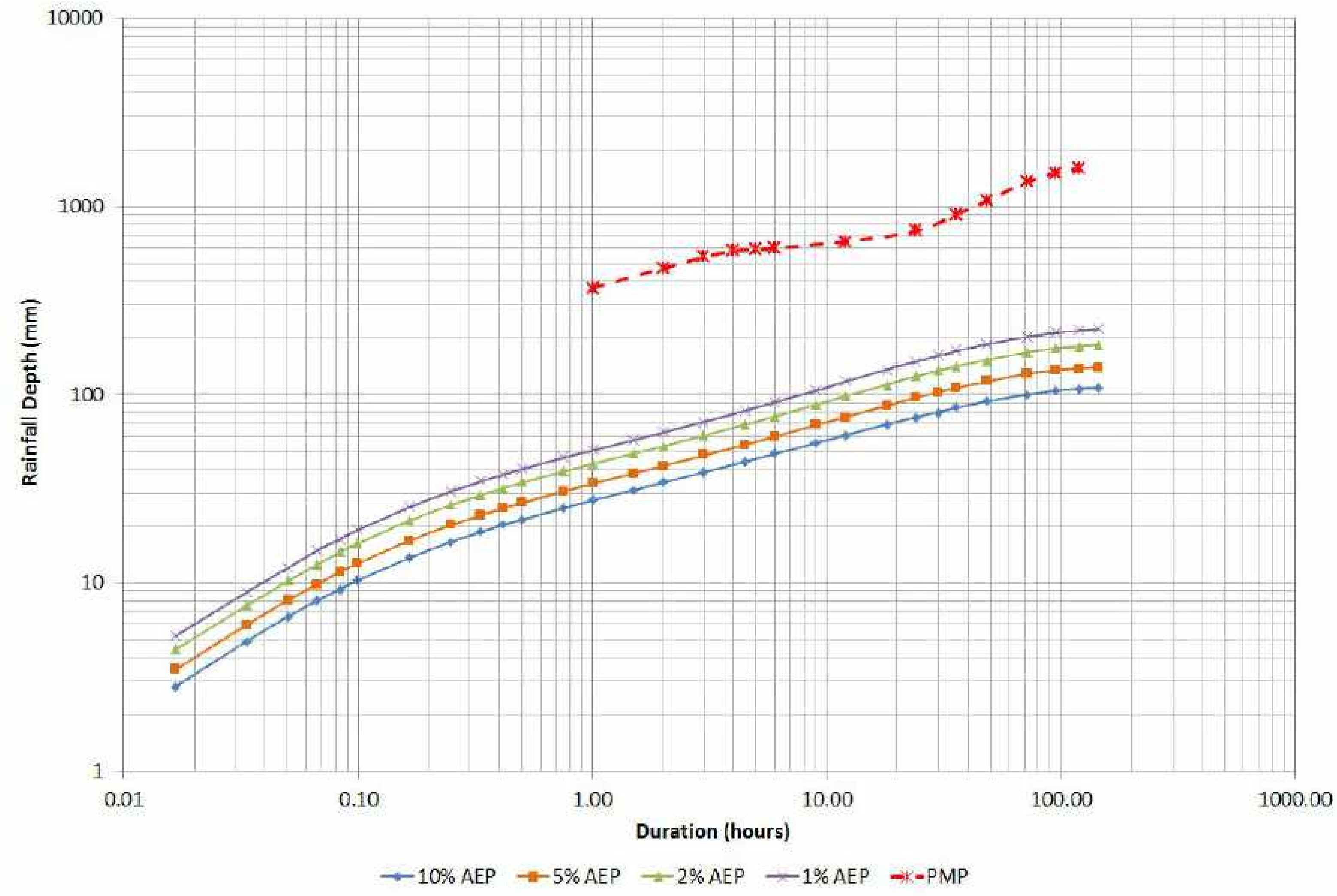


Figure 2: PMP Rainfall Depth Estimates and Fingals Mining Centre Rainfall Depth-Duration-Frequency Relationship (BoM, 2016)



PMP Spatial Distribution

Given the lack of an upstream catchment area that reports to the FMC , it can be assumed that there is no spatial distribution of the PMP and that, if it were to occur, it would be distributed uniformly across the site i.e. all parts would experience the same rainfall depth.

If a larger catchment area (say >200 km^2) was being considered, then it would be prudent to make allowances for the spatial distribution as it is unlikely that all parts of the catchment would record the same rainfall depth.

PMP Temporal Distribution

In order to transform the PMP into PMF design flood events of various durations it is necessary to consider the temporal distribution of the rainfall during the storm as it is highly unlikely that it will occur with the same intensity throughout the entire storm. Both the GSDM and GTSMR methodologies include design temporal patterns that have been based on temporal patterns of observed significant storms. These design patterns will be reviewed and adopted as necessary in the PMF estimates to be used for the project (to come).

Conclusion

PMP and PMF estimates have been developed for the proposed Fingals MiningCentre site. These estimates show that PMP rainfall depths of approximately 370, 740 and 1,350 mm could occur over 1, 24 and 72 hour periods respectively.

Should you have any queries regarding the findings of this memorandum please do not hesitate to contact us.

Yours sincerely,

[redacted]

[redacted]

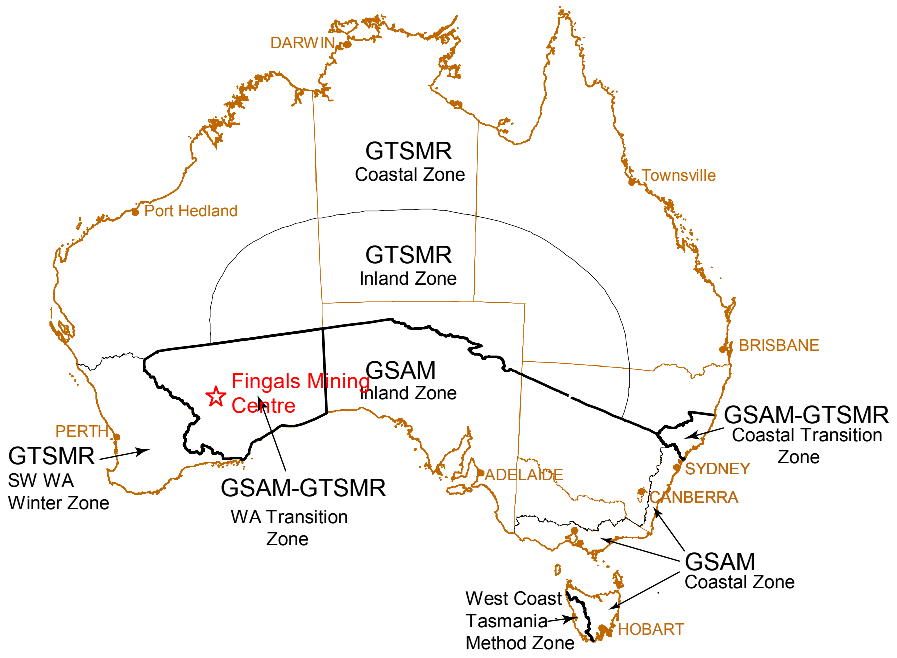
Attachments:

1. PMP Method Selection Worksheet
2. GSDM Calculation Sheet
3. GSDM Depth-Duration-Area Curves of Short Duration Rainfall
4. GTSMR Calculation Sheet
5. GSAM Calculation Sheet

ATTACHMENT No. 1 - PMP METHOD SELECTION WORKSHEET

Catchment Name: **Fingals Mining Centre** | Upstream Catchment Area: **1 km^2**

LONG DURATION PMP



Note: Not to Scale – Project location approximate.

CIRCLE THE ZONE IN WHICH THE CATCHMENT IS LOCATED:

~~GTSMR (Coastal)~~	~~GTSMR (Inland)~~
~~GTSMR (Coastal & SWWA)~~	~~Coastal Transition - GTSMR Coastal - GSAM Coastal~~
~~GSAM (Coastal)~~	WA Transition - GTSMR Coastal - GSAM Inland
~~GSAM (Inland)~~	~~WCTas~~

SHORT DURATION PMP (GSDM)

Is the catchment less than 1000km²? — NO → Short duration PMP estimates can **not** be calculated for the catchment

YES ↓

Is the catchment less than 500km² and south of 30°S? — NO → PMP estimates for up to 6 hours can be calculated using the **GSDM** for this catchment

YES → PMP estimates for up to 6 hours can be calculated using the **GSDM** for this catchment and can include **winter** estimates

PMP METHOD SUMMARY

Fill in the table below with the PMP method/s applicable to the catchment, referring to Table 1.1 for any additional information needed. NB: for the Transition zones, write separate entries for GTSMR and GSAM.

METHOD	ZONE	SEASON	DURATIONS
GSDM	3 hours	Monthly (inc. winter)	1-3 hours
GTSMR	Coastal	Annual	24-120 hours
GSAM	Inland	Annual	24-72 hours

WHAT NEXT?

GTSMR: Calculate the PMP estimates for the catchment following the procedures in BoM guidebook

GSDM: Calculate the PMP estimates for the catchment following the procedures in BoM guidebook

GSAM: Calculate the PMP estimates for the catchment following the procedures in BoM guidebook

~~**WCTas:** Contact the Hydrometeorological Advisory Service, Bureau of Meteorology~~

ATTACHMENT No. 2 - GSDM CALCULATION SHEET

LOCATION INFORMATION

Catchment: **Fingals Mining Centre** Area: **1 km^2**

State: **W.A.** Duration Limit: **Three hours**

Latitude: **30.967° S** Longitude: **121.903° E**

Portion of Area Considered:

Smooth , **S** = **0.9** (0.0 - 1.0) Rough , **R** = **0.1** (0.0 -1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation: **390 m**

Adjustment for Elevation (-0.05 per 300 m above 1500 m): **Nil**

EAF = 1.0 (0.85 - 1.00)

GSDM MOISTURE ADJUSTMENT FACTOR (MAF)

~~**$EPW_{catchment}$= XXX**~~

~~GSDM MAF=$EPW_{catchment}$/XXX~~

OR

read directly off GSDM Moisture Adjustment Factor chart (Figure 3)

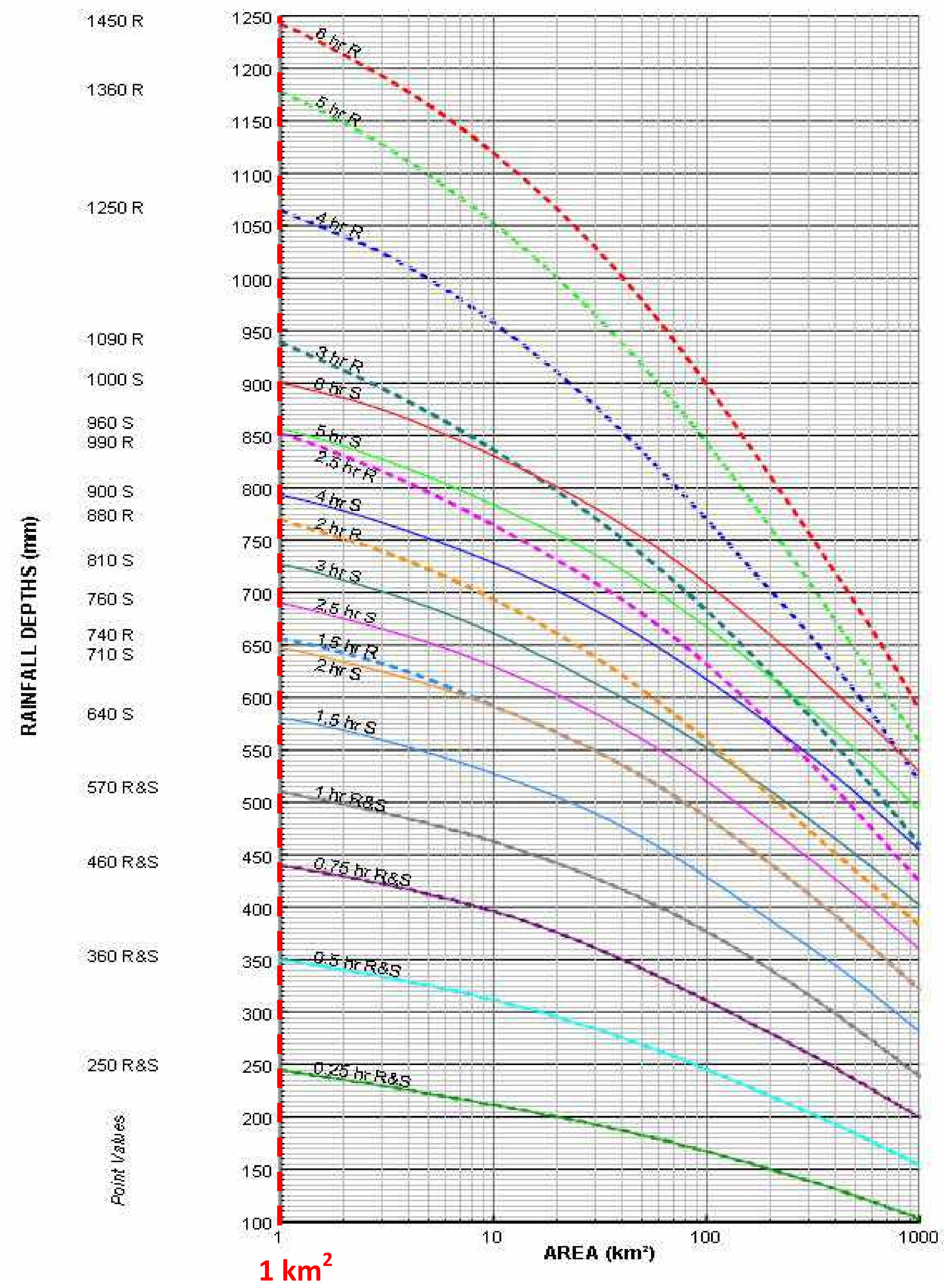
GSDM MAF = **0.72** (0.46-1.19)

PMP VALUES (mm)

Duration (hours)	Initial Depth - Smooth (D_S)	Initial Depth - Rough (D_R)	PMP Estimate = (D_S×S + D_R×R) × MAF × EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	245	245	176.4	180
0.50	350	350	252.0	250
0.75	440	440	316.8	320
1.0	515	515	370.8	370
1.5	580	655	423.0	420
2.0	645	765	473.0	470
2.5	690	850	508.3	510
3.0	725	940	537.5	540
4.0	-	-	-	-
5.0	-	-	-	-
6.0	-	-	-	-

Prepared by: Alistair Lowry Date: 23 Sept 2021.

ATTACHMENT No. 3 - GSDM DEPTH-DURATION-AREA CURVES OF SHORT DURATION RAINFALL



ATTACHMENT No. 4: GTSMR CALCULATION WORKSHEET

LOCATION INFORMATION

Catchment Name: **Fingals Mining Centre** State: **W.A.**

GTSMR zone(s): **Coastal Zone**

CATCHMENT FACTORS

Topographical Adjustment Factor	**TAF** = 1.23 (1.0 – 2.0)
Decay Amplitude Factor	**DAF** = 0.70 (0.7 – 1.0)
Annual Moisture Adjustment Factor	MAF_a = $EPW_{catchment}$/120.00
Extreme Precipitable Water ($EPW_{catchment}$) = 85.1	**MAF_a** = 0.709 (0.4 - 1.1)
~~**Winter Moisture Adjustment Factor** (where applicable)~~	~~MAF_w = $EPW_{catchment\_winter}$/82.30~~
~~Winter EPW ($EPW_{catchment\_winter}$) = …………~~	~~**MAF_w** = ……………….. (0.4 – 1.1)~~

PMP VALUES (mm) - Annual

Duration (hours)	Initial Depth (D_a)	PMP Estimate $=D_a x TAF x DAF x MAF_a$	Preliminary PMP Estimate (nearest 10mm)	Final PMP Estimate (from envelope)
1	Where applicable, calculate GSDM (Bureau of Meteorology, 2003) depths		370	370
2			470	470
3			540	540
4			-	580
5			-	590
6			-	600
12	(no preliminary estimates available)			650
24	1380	742.6	740	740
36	1697	913.2	910	910
48	1991	1071.4	1,070	1,070
72	2512	1351.8	1,350	1,350
96	2810	1512.1	1,510	1,510
120	2960	1592.9	1,590	1,590

~~PMP VALUES (mm) – Winter (where applicable)~~

~~Duration (hours)~~	~~Initial Depth (D_w)~~	~~PMP Estimate $=D_w x TAF x DAF x MAF_w$~~	~~Preliminary PMP Estimate (nearest 10mm)~~	~~Final PMP Estimate (from envelope)~~
~~1~~	~~Where applicable, calculate GSDM (Bureau of Meteorology, 2003) depths~~			N/A
~~2~~				N/A
~~3~~				N/A
4				N/A
~~5~~				N/A
~~6~~				N/A
~~12~~	~~(no preliminary estimates available)~~			N/A
~~24~~				N/A
~~36~~				N/A
~~48~~				N/A
~~72~~				N/A
~~96~~				N/A

Prepared by: Alistair Lowry Date: 23 Sept 2021

ATTACHMENT 5: Generalised Southeast Australia Storm Method (GSAM)

LOCATION INFORMATION	
Catchment Name: **Fingals Mining Centre**	State: **W.A.**
GSAM zone: **Inland**	Area: **1 km^2**

CATCHMENT FACTORS

Topographical Adjustment Factor **TAF = 1.153** (1.0 – 2.0)

Annual Moisture Adjustment Factor

$$MAF = \frac{EPW_{seasonal\ catchment\ average}}{EPW_{seasonal\ standard}}$$

Season	$EPW_{seasonal\ catchment\ average}$	$EPW_{seasonal\ standard}$	MAF	
Summer (Annual)	75.00	80.80	**0.928**	(0.60 - 1.05)
Autumn	56.28	71.00	**0.793**	(0.56 - 0.91)

Summer PMP values (mm)			Autumn PMP values (mm)		
Duration (hours)	Initial Depth (D_{summer})	PMP Estimate (D_sxTAFxMAF$_s$)	Duration (hours)	Initial Depth (D_{autumn})	PMP Estimate (D_axTAFxMAF$_a$)
24	498	533	24	709	648
36	533	570	36	831	760
48	559	598	48	891	815
72	605	647	72	939	859
96	620	663	96	959	877

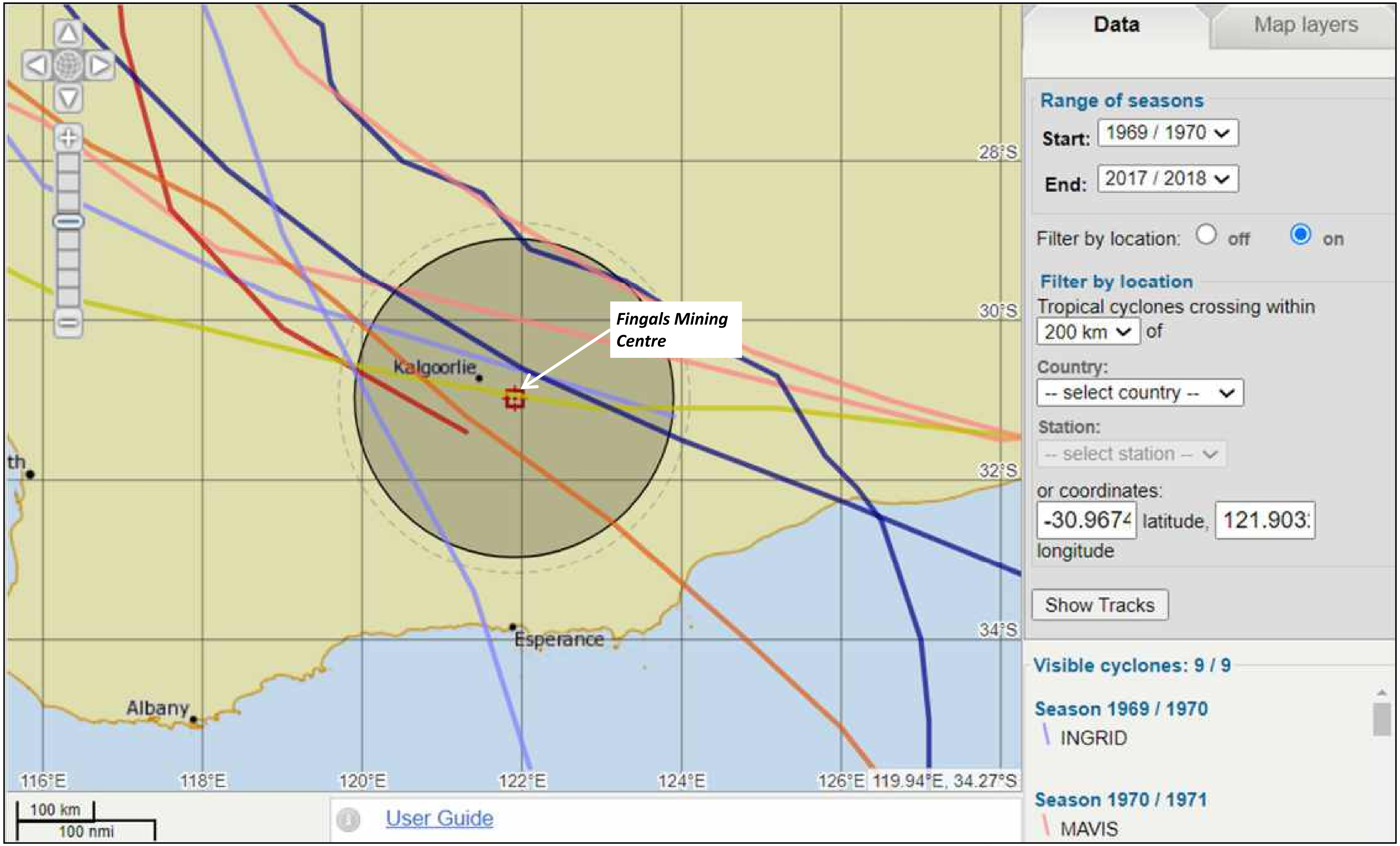
Final GSAM PMP Estimates

Duration (hours)	Maximum of the Seasonal Depths	Preliminary PMP Estimate (nearest 10mm)	Final PMP Estimate (from envelope)
1	Where applicable, calculate GSDM depths (Bureau of Meteorology, 2003)	370	**370**
2		470	**470**
3		540	**540**
4		-	**560**
5		-	**580**
6		-	**600**
12	(no preliminary estimates available)		**630**
24	648	650	**650**
36	760	760	**760**
48	815	810	**810**
72	859	860	**860**
96	877	880	**880**

Prepared by: Alistair Lowry Date: 23 Sept 2021

APPENDIX D

Cyclone Path Analysis

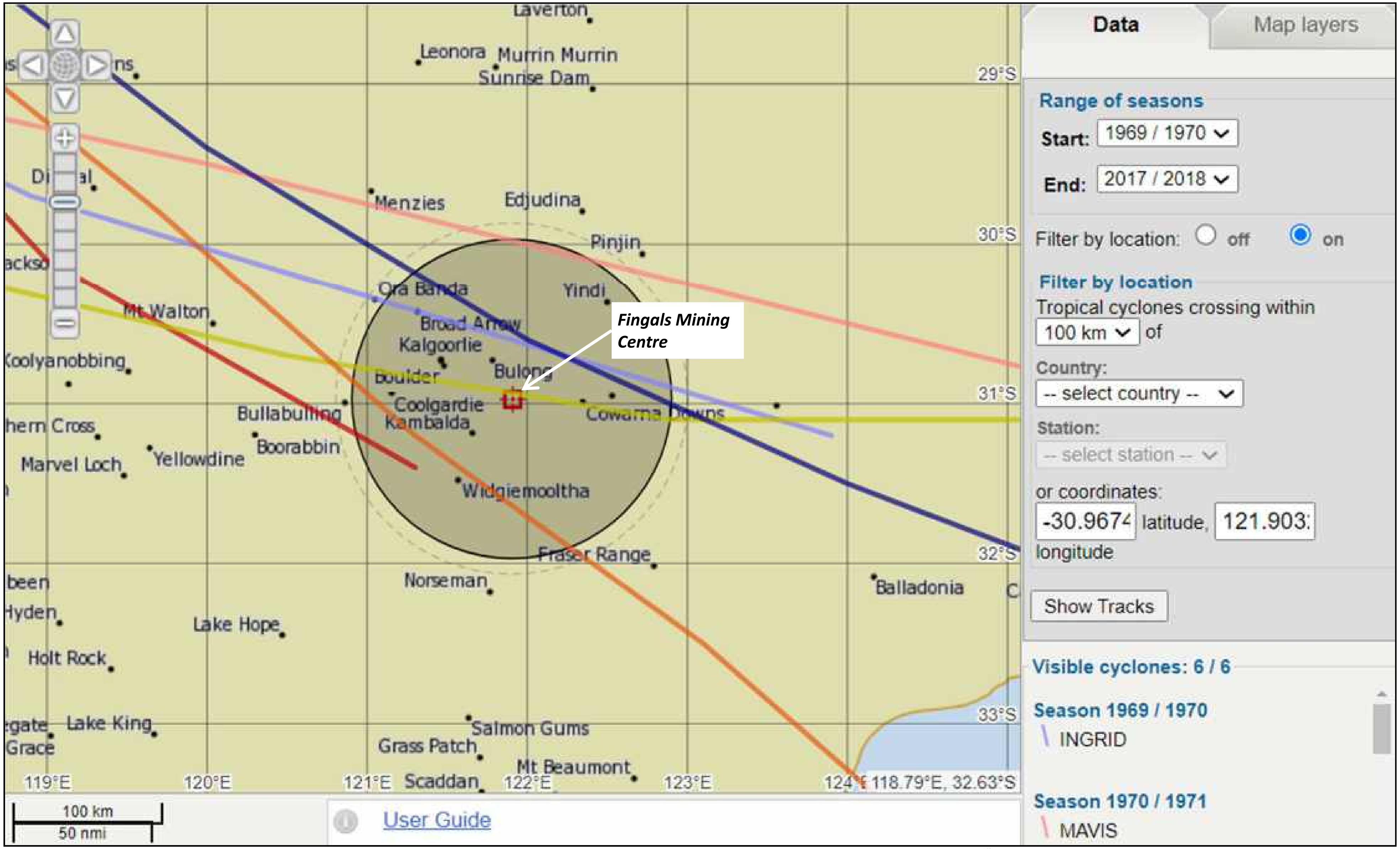


GROUNDWATER RESOURCE MANAGEMENT

APPENDIX D1
FINGALS MINING CENTRE
CYCLONE PATHS WITHIN 200 KM OF SITE

Date Sep 21
Client Black Cat Syndicate Ltd
Project Bulong Gold Project
Document J2134R01

Notes
1. Cyclone paths from BoM data portal.

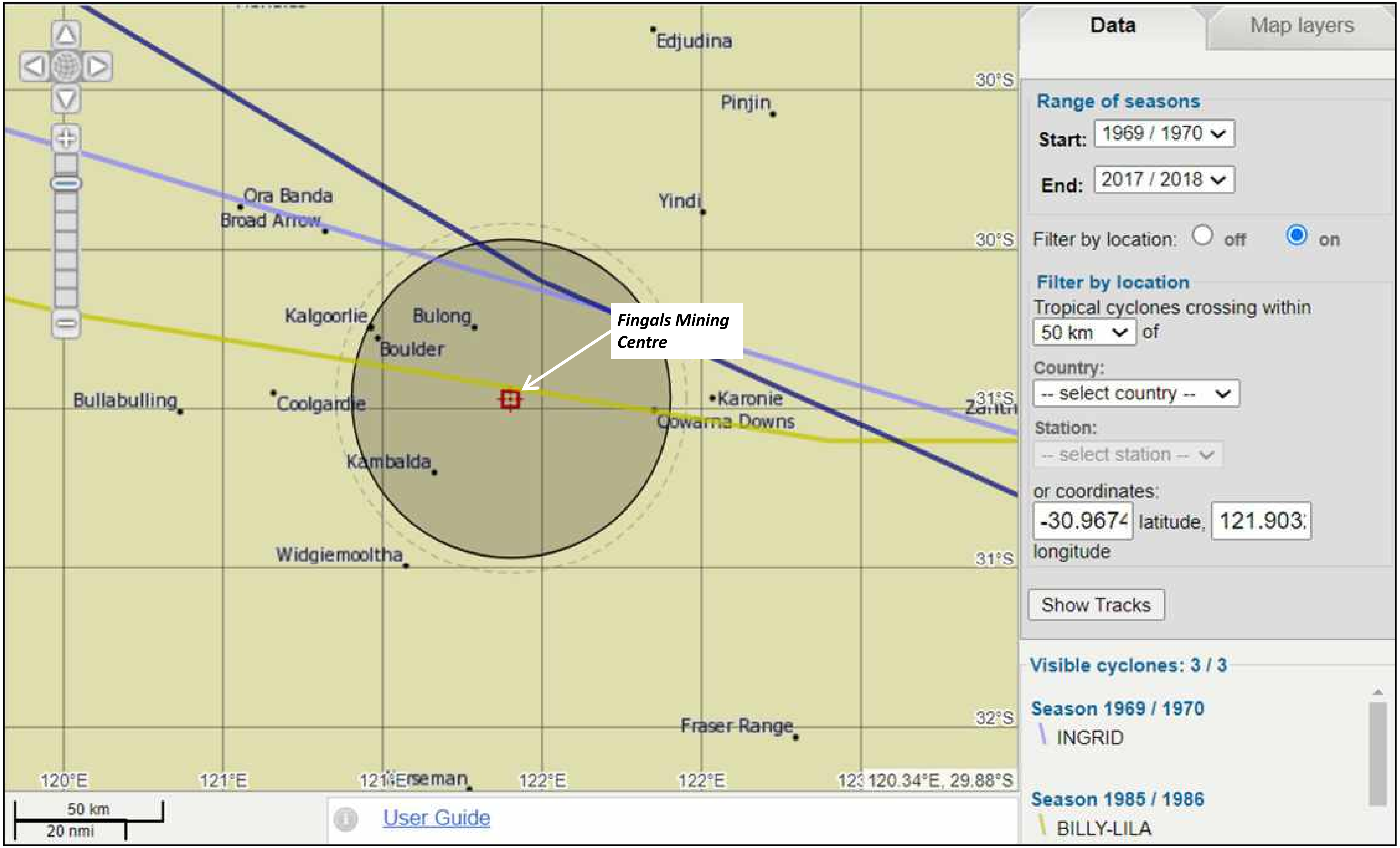


GROUNDWATER RESOURCE MANAGEMENT

APPENDIX D2
FINGALS MINING CENTRE
CYCLONE PATHS WITHIN
100 KM OF SITE

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Cyclone paths from BoM dataset.



GROUNDWATER RESOURCE MANAGEMENT

APPENDIX D3
FINGALS MINING CENTRE
CYCLONE PATHS WITHIN
50 KM OF SITE

Date Sep 21
Client Black Cat Syndicate Ltd
Project Fingals Mining Centre
Document J2134R01

Notes
1. Cyclone paths from BoM dataset.

REVISION	DESCRIPTION	INITS	DATE	INITS	DATE
A	ISSUED FOR CLIENT REVIEW	AL	01/11/19	–	–
		CHECKED		APPROVED	

PRELIMINARY NOT FOR CONSTRUCTION

GROUNDWATER RESOURCE MANAGEMENT

CLIENT: BLACK CAT SYNDICATE LTD.

DRAWN: AL, DATE: 21-SEP-21 | DRAWING CHECK | DATE

DESIGNED: AL, DATE: 21-SEP-21 | DESIGN CHECK | DATE

AUTHORISED | DATE | SCALE: AS SHOWN

PROJECT: FINGALS MINING CENTRE

DRAWING TITLE: PRELIMINARY DESIGN OF SURFACE WATER MANAGEMENT MEASURES GENERAL ARRANGEMENT PLAN

PROJECT No: J2134R01 | DWG. No. D01 | A

A1

Appendix G: Fingals Desktop Hydrogeological Assessment

Technical Memorandum

Date: April 11 2022 Project No.: J2207TM01

To: Peter Bayliss

Cc: Alistair Thornton

From: Peter Mayers Email: pmayers@g-r-m.com.au

BLACK CAT SYNDICATE- FINGALS DESKTOP HYDROGEOLOGICAL ASSESSMENT

Introduction

Black Cat Syndicate Ltd (Black Cat) owns the Kal East Gold Project (Kal East) comprising 756 km² of prospective tenements in the Eastern Goldfields Region of Western Australia, with the current focus of activities on the Bulong and the Imperial-Majestic (Majestic) gold projects. Black Cat are proposing to construct a 800 ktpa gold processing plant at Majestic, with ore feed for processing to be supplied from the adjacent Majestic mine as well as via a trucking operation from Bulong, and after 2022, from the Fingals Mining Centre (Fingals) located about 10 km south of Majestic. A map showing Black Cat's main mining areas within the greater Kal East project area is provided in Figure 1.

Fingals proposes a cut back and deepening of the existing Fingals Fortune open pit, and redevelopment of the currently backfilled Bagus and Futi Bagus pits. The initial two-staged Fingals Fortune cutback is understood to take around 20 months to complete, before the final Stage 3 mining takes the pit floor below the water table in the southern part of the pit. The Bagus and Futi Bagus expansions are understood to be modest and will not go below the water table, at least in the initial stages.

Black Cat have engaged Groundwater Resource Management Pty Ltd (GRM) to undertake a desktop hydrogeological study to review and characterise the local groundwater environment in the Fingals area. The aim of the desk study is to identify the field assessment required to estimate the mine dewatering rates and drawdown impacts on the local groundwater system from the Fingals development. This technical memorandum presents the findings of the desktop study.

Background

Geology

Fingals is located within the Eastern Goldfields Province of the Archean Norseman - Wiluna Greenstone Belt, and on the western limb of the regional scale, north striking Bulong Anticline. The geological sequence comprises mafic units in the core of the anticline, with bedding parallel intrusive dolerite sills and cross cutting quartz-feldspar porphyries. Previous mining was undertaken across the Fingals area where a number of open pits were developed in the 1990s including the original Fingals Fortune, Bagus and Futi Bagus pits.

In the Fingals mine area, High-Mg pillow basalts are positioned in the footwall of the deposit and separated from the overlying dolerite sills and basalts by a structural disconformity comprising a series of bedding parallel shears. Northwest striking quartz-feldspar porphyry dykes post-date the mafic sequence but exhibit signs of shearing which is likely related to the regional greenschist metamorphism.

A deep weathering profile of up to 60 m exists in the deposit area with mineralisation influenced by locally stacked, shallow west dipping shear sets associated with sericite schist, porphyry and mafic hosts.

Hydrogeology

Two hydrostratigraphic units have been identified in the Fingals project region, specifically;

- fractured rock aquifers associated with the Archean greenstone rocks, and
- palaeochannel aquifers associated with high permeability units at the thalweg of paleochannel systems.

Fractured-bedrock aquifers are the dominant aquifer type in the immediate Fingals mine area. These develop from open fractures which can extend to depths of around 120 m in greenstones and possibly to similar depths along major faults and shear zones. Early stage fractures are often found to be fully healed, with groundwater occurrences generally associated with later stage open geological structures. Minor dolerite dykes are mostly undeformed and generally lack open fractures, making them resistant to weathering, hence they can form hydraulic barriers to groundwater movement.

Palaeochannel aquifers are the largest source of groundwater in the region (Kern, 1996)[1] . Within these systems, the lower Wollubar Sandstone, which occurs at the thalweg of major paleochannels, is highly permeable and contains significant volumes of groundwater. The overlying infill sediments within these paleochannel systems have a low hydraulic conductivity, though minor groundwater volumes occur in sandy units within the infill sediments. The yields from the Wollubar Sandstone units are typically much higher than fractured rock aquifers, ranging between 7 L/s and 14 L/s, compared to less than 10 L/s for fractured systems (Kern, 1996)[1]. A paleochannel tributary possibly extends into the northeast of the Fingals area as shown by the mapped alluvium and colluvium channel in Figure 2. This tributary drains northwards into the main trunk paleodrainage at Lake Yindarlgooda.

Most local and regional aquifers are recharged through rainfall that infiltrates the surface outcrop or alluvial cover and percolates to the lower aquifer system. Rainfall recharge rates are very low, typically less than 1% of rainfall (less than 2mm/year) and reflect the desert type region, with most of the rainfall lost through evaporation and transpiration.

Groundwater quality is variable across the region ranging from saline to hypersaline. Fresh to brackish groundwater sources (<3,000 mg/L Total Dissolved Solids (TDS) are rare and restricted to perched aquifers and soaks. Saline groundwater (3,000 to 30,000 mg/L TDS) is widely distributed and typically found in shallow pastoral boreholes within low-yielding surficial deposits and lateritic units. Hypersaline groundwater (>30,000 mg/L TDS) occurs mainly in palaeochannels and in bedrock aquifers below and adjacent to alluvial flats and playa lakes.

The pre-mining groundwater level in the Fingals Fortune pit area is indicated from resource drilling to be around 90 m below surface (roughly 314mRL) which is probably slightly below the base of the existing pit. However, the local groundwater table has not been measured accurately and so will need to be confirmed during field testing. A regional watershed divide passes through the Fingals area (Figure 2) which separates the Lake-Raeside-Ponton catchment to the north, from the Lake Lefroy Catchment to the south. The proximity of the catchment divide contributes to the deep groundwater level in the

[1] *Kern, A.M.: 1996: Hydrogeology of the Kurnalpi 1:250,000 Sheet. Western Australia Geological Survey, 1:250,000 Series Explanatory Notes.*

Fingals area, with the groundwater flow direction either northward, towards Lake Yindarlgooda, or south towards Lake Lefroy.

Any elevated permeability in the Fingals mine area will be associated with fracture zones within the main mafic rock packages, which are understood to be deeply weathered (up to around 60 m below ground level (mbgl)). Some elevated permeability will also likely develop in the weathered and fractured transition (saprock) zone above the fresh mafic bedrock. The saprock zone can typically be around 10 to 15 m in thickness, and underlie the clay dominant saprolite. In the Fingals area, drilling data indicates that the depth to the top of fresh rock averages around 75 to 80 mbgl and so the saprock zone may potentially be mostly unsaturated. This could result in the Fingals area having fairly very low permeability outside of any discrete fracture zones. A hydrogeological map of the Fingals area is provided in Figure 2.

Other Groundwater Users

A search was undertaken of the Department of Water and Environmental Regulation (DWER) Water Information Reporting (WIR) database for all registered bores or wells within a 10 km radius of Fingals. No registered bores or wells were identified within the search zone, with the closest registered bores KRO1 and KRO2, owned by the DWER and located around 12.7 km to the northwest of Fingals.

The nearest registered groundwater licence is GWL162889 which covers an 8 km long group of tenements trending southeast, starting at around 3 km to the south of Fingals. The extraction licence is owned by Silver Lake Resources Ltd, and covers their Mt Monger mining operations, with an annual entitlement of 295,000 kL (around 9 L/s).

Dewatering Assessment

As the Bagus and Futi Bagus (Fingals East) pits are not proposed to be developed below the water table at this stage, the Fingals dewatering assessment mainly focuses in and around the Fingals Fortune pit. The pit shells provided by Black Cat indicate that the Stage 3 development will take the final floor level of the southern part of the Fingals Fortune mine to around 60 m below the water table.

Using the Black Cat provided information and the available open file geological, geophysical and hydrogeological data, five existing RC holes have been selected for follow-up hydraulic testing using airlift-recovery methods. The airlift-recovery testing will involve using a drilling rig to line-up over the existing RC drill holes, reinstalling the drill rods and cleaning the hole out back to its base. Compressed air will then be applied to the hole, airlifting groundwater from the hole for around one hour. When the air is turned off, the recovering water table will be measured for between one and two hours depending on airlift yield and water table recovery rate. The drill rig will need to be able to access historical RC drill collars, which may require some site clearing ahead of time by Black Cat’s site staff. If any of the RC holes have been rehabilitated, alternative drill holes will need to be selected. The hole IDs, locations and summary information of the RC holes to be tested is provided in Table 1, with a map showing the hole locations with their surface projected hole traces in Figure 3.

Table 1:- Airlift-Recovery Test RC Holes

Hole ID	Coordinates MGA94zn51		Azimuth (deg)	Dip (deg)	Depth (m)
	Easting (m)	Northing (m)			
20FIRC_013	394,624	6,572,999	90	60	168
20FIRC_091	394,574	6,573,125	80	60	170
20FIRC_020	394,725	6,573,099	90	60	150
20FIRC_076	394,422	6,573,350	90	60	144
20FIRC_045	394,651	6,573,507	90	60	130

In addition to the hydraulic testing of existing RC drill holes, it is proposed to install two new groundwater monitoring bores to measure medium and longer term impacts from dewatering activities at Fingals. The proposed monitoring bore locations and summary information are provided in Table 2 below and also shown on the map in Figure 3.

Table 2:- Proposed Monitoring Bores

Bore ID	Coordinates MGA94zn51		Depth (m)	Target Comment
	Easting (m)	Northing (m)		
FMB01	394,729	6,573,724	120	Northeast of the Fingals pit, across catchment divide.
FMB02	394,943	6,572,618	120	South of the Fingals pit, testing a subtle east-west striking air-magnetic feature

It would also be recommended to undertake airlift-recovery testing of the monitoring bores at the end of their drilling phase; prior to each monitoring bore being constructed. The monitoring bores should be completed with slotted and blank Class 12 uPVC slotted and blank casing. A proposed monitoring bore design is provided in Figure 4.

Water samples should be collected during the monitoring bore drilling and submitted for laboratory analysis to establish a background water quality profile. Given the project location and mining depth, it is likely that the groundwater quality will be hypersaline.

[redacted]

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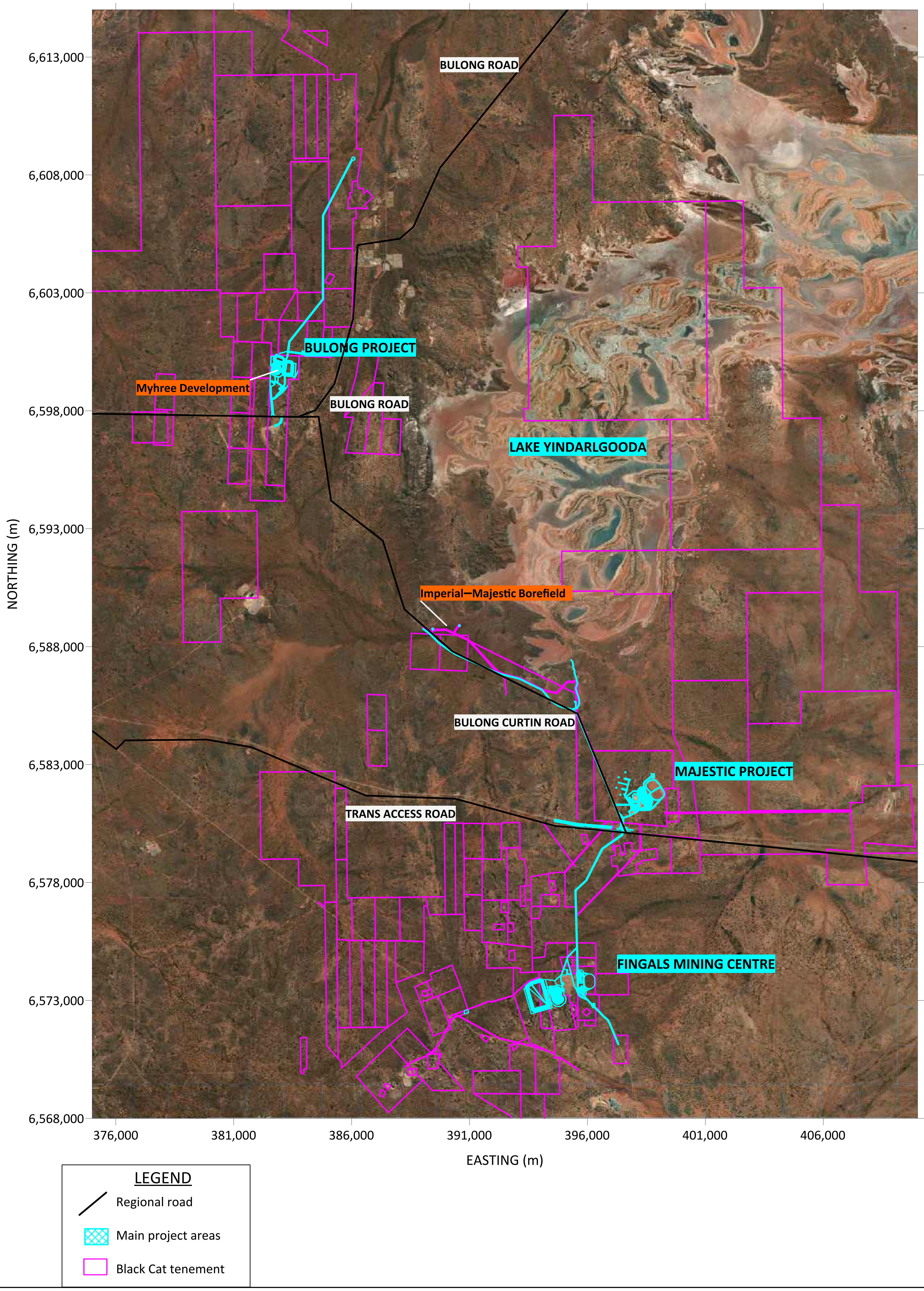
Attachments:-

Figure 1:-Project Location Plan
Figure 2:-Regional Hydrogeology
Figure 3:-Airlift Holes & MB locations
Figure 4:-Monitoring Bore Design



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 1
KAL EAST
PROJECT LOCATION

Date Apr22
Client Black Cat Syndicate
Project Fingals Development
Document J2207TM01

Coordinate System
GDA94 Zone 51

SCALE 1:150,000
0m 5,000m 10,000m

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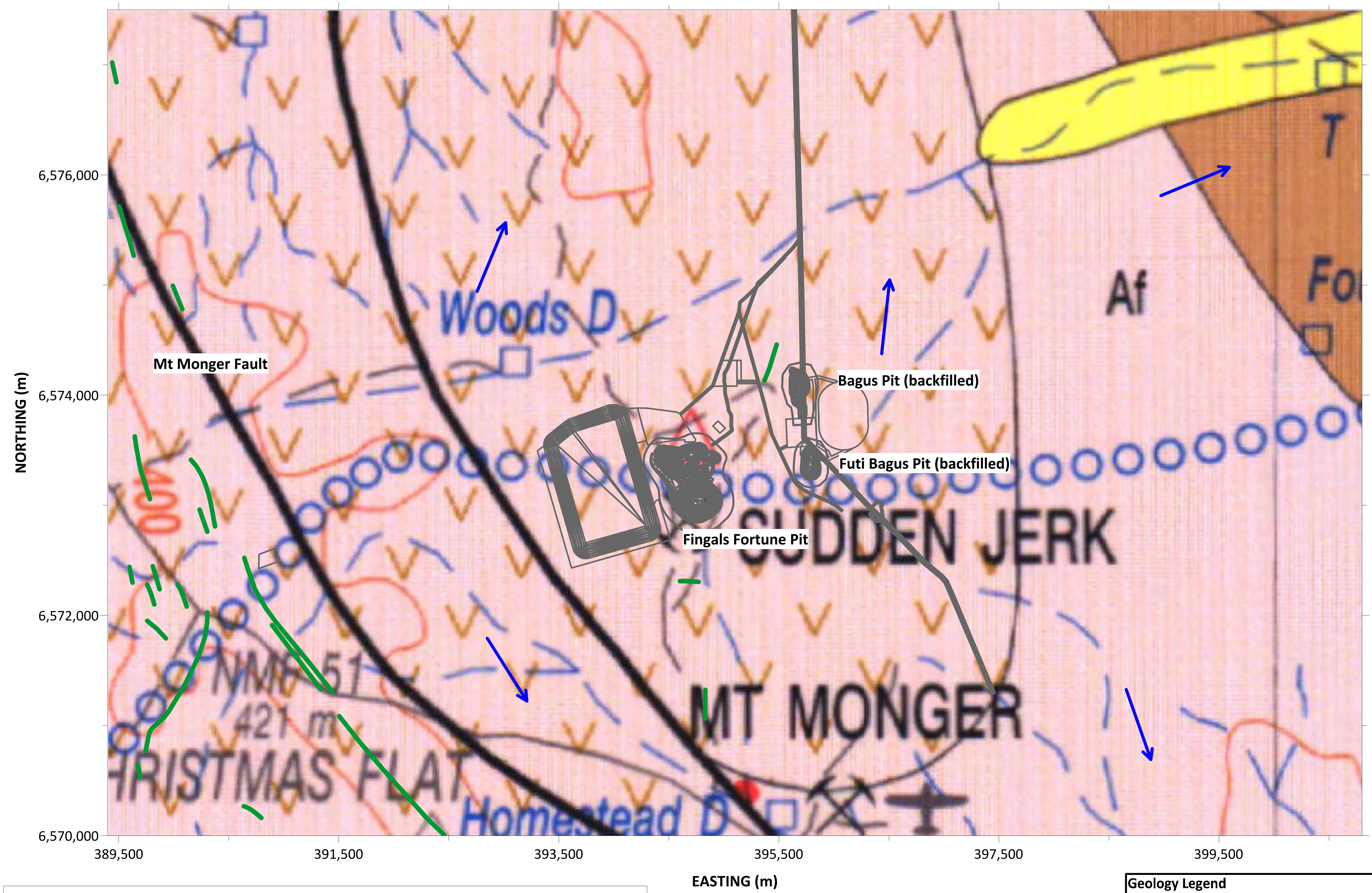

LEGEND

Major regional fault | Groundwater flow direction | Surface water divide | Proposed infrastructure | Dolerite dyke

Geology Legend

Ql	Playa lake sediments - mostly clay
Cz	Alluvium and colluvium - clay, sand gravel
Tw	Wollubar Sandstone - sandstone, siltstone, gravel
Ed	Mafic and ultramafic dykes
q	Quartz veins
Ac	Chert and banded iron formations
Af	Sedimentary and felsic volcanic and volcanoclastic rocks
	Mafic and ultramafic rocks
Ag	Granitoid rocks, includes porphyry

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 2
REGIONAL HYDROGEOLOGY

Date April 2022
Client Black Cat Syndicate
Project Fingals Development
Document J2207TM01

Coordinate System
MGA94 Zn51

SCALE 1:35,000
0m 2000m

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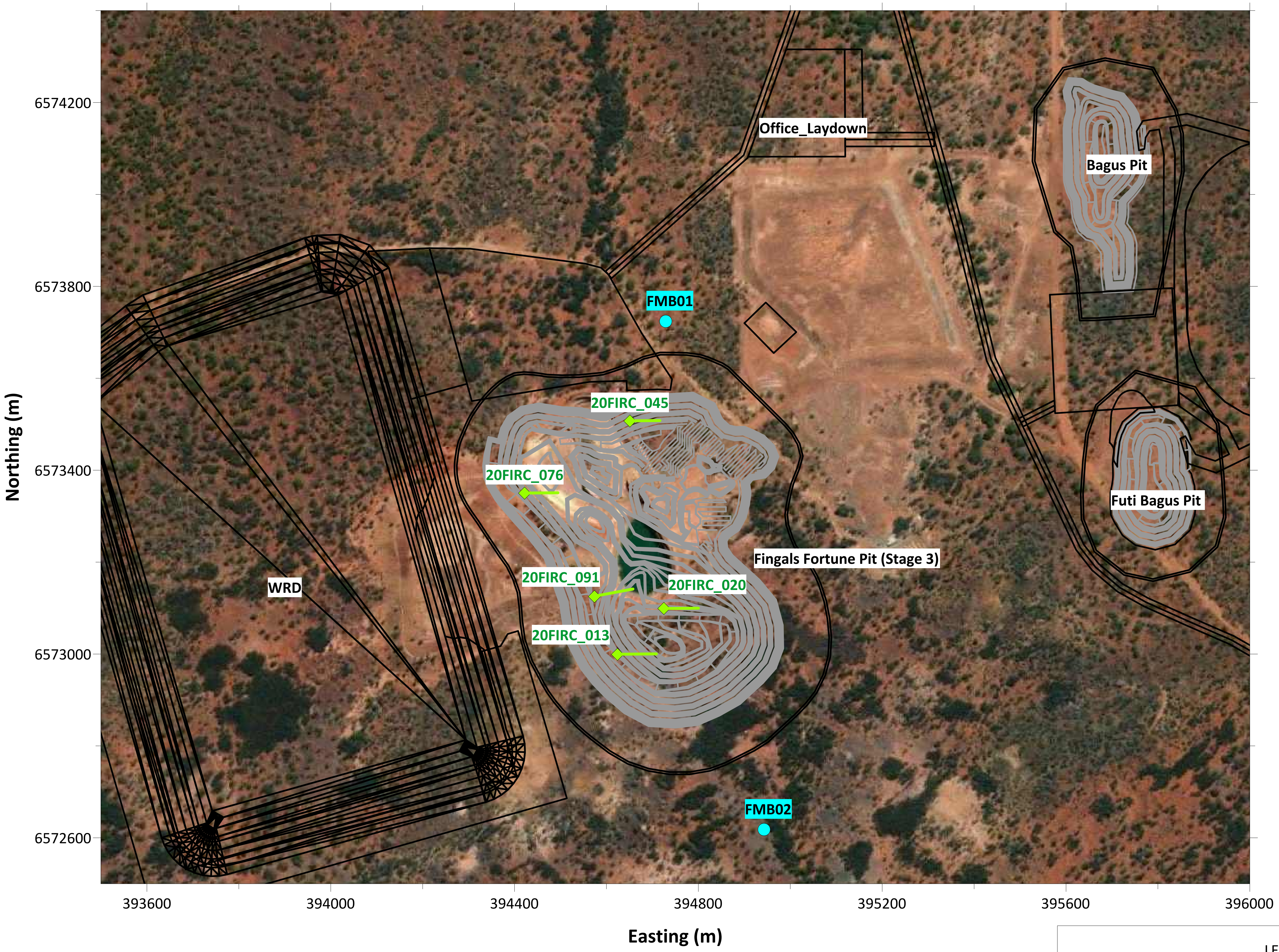

LEGEND

- Proposed mine developments
- Proposed infrastructure footprint
- New monitoring bore
- Airlift test RC drill hole with hole trace

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 3
AIRLIFT TEST HOLES
& MB LOCATIONS

Date Apr 2022
Client Black Cat Syndicate
Project Fingals Development
Document J2207TM01

Coordinate System
MGA 94 (Zn51)

SCALE 1:9,000
0m 400m

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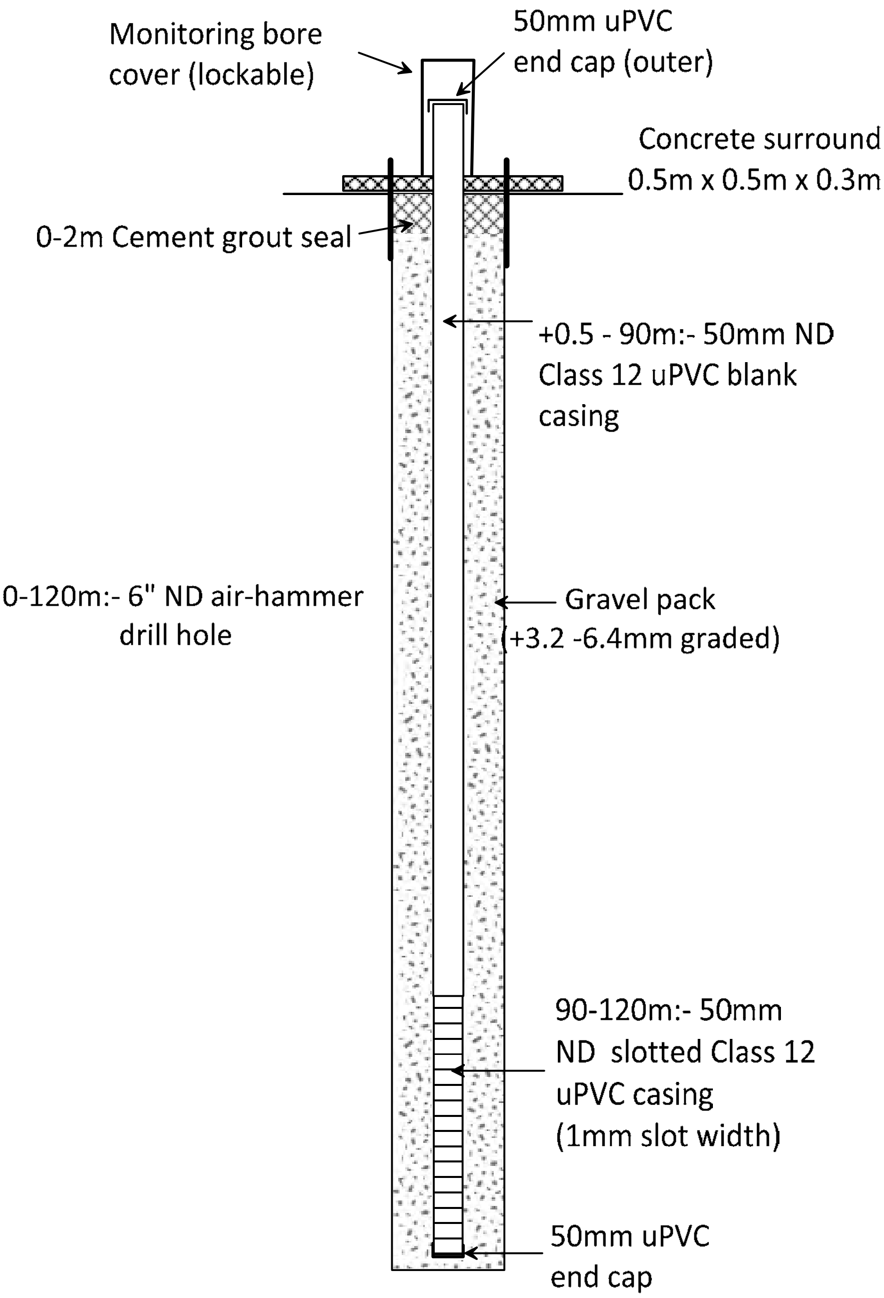
SEEPAGE MONITORING
BORE DESIGN



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 4
MONITORING BORE DESIGN

Date Apr 2022
Client Black Cat Syndicate
Project Fingals Developent
Document J2207TM01

Coordinate System
GDA94 Zone 51

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