ABRA BASE METALS PROJECT

MINING PROPOSAL

Revision 5

M52/776; G52/292; L52/194; L52/198 L52/205; L52/206; L52/207

ENVIRONMENTAL GROUP SITE NAME: Abra Environmental Group (S0237582)

ENVIRONMENTAL GROUP SITE CODE: Abra-Mulgul (J00545)

18 JULY 2019

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Mining Proposal Checklist

Q No	Mining Proposal (MP) Checklist	Y/N/NA	Comments	Changes from previous Version (Y/N)	Page No.	Summary
1	Has the checklist been endorsed by a tenement holder(s) or a senior representative authorised by the tenement holder(s), such as a Registered Manager or Company Director?	Y				
2	Are you the tenement holder of all tenements associated with the Mining Proposal /group site? **Mining Proposals which have not been submitted by the tenement holder must include an authorisation from the tenement holder or an explanation of the company linkage to the tenement holder (eg. for subsidiary companies).**	Y	Section 2		4	
3	For tenements with multiple tenement holders, have all of the other holders consented to this proposal being submitted? **Mining Proposals which have not been submitted by the tenement holder must include an authorisation from the tenement holder or an explanation of the company linkage to the tenement holder (eg. for subsidiary companies).**	NA				
4	Have contact details for questions on the Mining Proposal been provided?	Y	Section 2		4	
5	Are all mining operations within granted tenement boundaries?	Y				
6	Is this the first Mining Proposal submitted for these tenements? If **No**, the version number of the revised Mining Proposal must be stated on the cover and a summary of changes included	Y				
7	Have all tenement conditions been reviewed to ensure activities proposed in the Mining Proposal are in compliance?	Y	Compliance Register			
8	Has a Mine Closure Plan been provided? **It is a requirement that every mining proposal include a mine closure plan.**	Y	Appendix H			

Q No	Mining Proposal (MP) Checklist	Y/N/NA	Comments	Changes from previous Version (Y/N)	Page No.	Summary
PUBLIC AVAILABILITY						
9	Are you aware that this Mining Proposal is publicly available?	Y				
10	Is there any information in this Mining Proposal that should not be publicly available? If **Yes**, refer to Appendix B, section 7 of the guidelines for more information. Note: A non-confidential version of all mining proposals will be made available to the public	Y				
11	If 'Yes' to Q10, has confidential information been submitted in a separate document?	N	Confidential information in Appendix K		82	
MINING PROPOSAL DETAILS						
12	Does the Mining Proposal cover page include: • Environmental Group Site name • Environmental Group Site code • company name (including telephone numbers and email addresses) • contact details • version number • date of submission.	Y				
13	Has information regarding the Environmental Group Site (EGS) been provided in accordance with the requirements of Appendix G of the guidelines?	Y	Section 2		4	
14	Has a disturbance table been provided in accordance with the requirements of Appendix G of the guidelines?	Y	2		4	
15	Has spatial data for all Mine Activity Types been provided in accordance with the specified properties and allowances (see section 3.5.3)?	Y				
16	Has a site plan, consistent with all spatial data and activity details, been provided? The site plan must show existing and proposed activities and other relevant information including tenement boundaries	Y	Figure 1		2	

Q No	Mining Proposal (MP) Checklist	Y/N/NA	Comments	Changes from previous Version (Y/N)	Page No.	Summary
	and other land tenure (eg. Reserves and pastoral lease boundaries).					
17	Do you have and maintain an Environmental Management System?	Y	Appendix E			
ENVIRONMENTAL LEGISLATIVE FRAMEWORK						
18	Does the Mining Proposal include a list of all relevant environmental approvals that have been sought or are required before the proposal may be implemented?	Y	Table 22		9	
19	Does the Mining Proposal trigger any criteria for referral to the EPA within the DMP/EPA Memorandum of Understanding?	N	Table 21		8	
20	Has the Mining Proposal been referred to the EPA? If **Yes**, indicate date of referral in comments	N				
21	Has the proposal been deemed to not warrant formal assessment under Part IV of the EP Act, is currently under assessment by the EPA, or has been approved via a Ministerial Statement? If **Yes**, ensure details of Ministerial Statement, assessment level and/or assessment number are provided within the Mining Proposal	NA				
22	Is a clearing permit required? If 'No' then explain why in space below	Y				
23	If 'Yes' at Q22 then has a clearing permit been applied for?	Y	Appendix C			
24	Is the Mining Proposal located on reserve land? If "Yes" state reserve types	N				
25	Is the Mining Proposal wholly or partially within Department of Parks and Wildlife (DPaW) managed areas?	N				
26	If 'Yes' at Q25 has DPaW been consulted?					
27	Will any threatened or protected flora and/or fauna be impacted by this proposal?	N	5.5		45	
28	Have the DAA/DPC 'Aboriginal Heritage Due Diligence Guidelines' been used to identify the risk of impacts to aboriginal heritage sites?	Y	5.6		47	
29	If any aboriginal heritage sites will be impacted, has appropriate consent been	N/A				

Q No	Mining Proposal (MP) Checklist	Y/N/NA	Comments	Changes from previous Version (Y/N)	Page No.	Summary
	sought under the *Aboriginal Heritage Act 1972*?					
30	Does the Mining Proposal include a tailings storage facility? Mining Proposals that include tailings storage facilities must include the relevant design reports outlined in the DMP's *Guide to the preparation of a design report for tailings storage facilities (TSFs),* August 2015.	Y	Appendix F		77	
31	Does the Mining Proposal include the backfilling of mine voids? If Yes, the Mining Proposal must include a Sterilisation Report.	Y	Backfill of completed UG stopes for ground support			
32	Is the mining proposal located on pre-1899 Crown Grant lands? (not subject to the Mining Act)	N				
33	Has the construction of an airstrip been proposed? If Yes, indicate the date when Civil Aviation Safety Authority, Airservices Australia and the Local Government Authority were advised (in writing) of the proposal to construct an airstrip.	Y	Email CASA 28/5/2019. Email LG 28/5/2019			

Corporate endorsement:

I hereby certify that to the best of my knowledge, the information contained within this Mining Proposal and checklist is true and correct and addresses all the requirements of the Guidelines for Mining Proposals in Western Australia approved by the Director General of Mines.

Name: Troy Flannery **Signed**:

Position: Chief Executive Officer **Date**: 18 July 2019

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

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1. Background Information

The Abra base metals project is located in the East Gascoyne area of Western Australia, approximately 170 km southwest of Newman, 180 km north of Meekatharra and 100 km west of the Great Northern Highway. The area was first explored from 1976 by Amoco, in the 1990's by Renison Goldfields Consolidated Limited, Oldcity Nominees Pty Ltd from 2000 and from 2005 by Abra Mining Limited. The project is now 100% owned by Galena Mining Limited (Galena).

The project comprises of a new underground mining operation and ore processing via a conventional flotation process plant to produce a lead / silver concentrate. The concentrate will be transported on public roads to the Port of Geraldton for export. The mine has an approximate life span of 15 years based on the planned production rate.

The Department of Mines, Industry Regulation and Safety (DMIRS) Mining Proposal (MP) guidelines define an Environmental Group Site (EGS) as a group of individual tenements that make up a particular operation and which the proponent wants to report on as a single entity. It will have one Mining Proposal, one Mine Closure Plan and one Annual Environmental Report (AER).

Galena submitted Mining Proposal ID 76773 Rev 1 on 30/10/2018 for mining activities on tenements M52/776, G52/292 and L52/194. Mining Proposal ID 76773 Rev 3 was approved on 10/6/2019.

Due to a number of factors, some components of the project could not be located on the above tenements and required new tenements to be lodged. For this reason, this infrastructure was excluded from Mining Proposal ID 76773 Rev 3 while the tenement lodgement and grant process occurred.

Now that grant of this tenure has occurred, this Mining Proposal amendment seeks to add these infrastructure components in to the overall Abra project EGS. The scope of this Mining Proposal amendment is to include the following components into the Abra project:

1. L52/198 Aerodrome and associated infrastructure.
2. L52/205 Communications facility (Dunns Range).
3. L52/206 Communications facility (Facey).
4. L52/207 Communications facility and access road (Flynn).

1.1 Document History

Mining Proposal (MP) Rev 1 and accompanying Mine Closure Plan (MCP) was submitted to DMIRS in October 2018. This was registered as ID 76773

AMPL received correspondence from DMIRS in a letter dated 21/2/2019 requesting further information. This correspondence is attached in **Appendix J**.

AMPL submitted draft responses to the items raised by DMIRS via email on 15/3/2019 (**Appendix J**) and followed this up with a meeting on 20/3/2019. The agreed responses have been incorporated into Rev 2 versions of the MP and MCP, which were re-submitted to DMIRS on 9 April 2019.

AMPL received further correspondence from DMIRS via email on 23/5/2019 (**Appendix J**). The requested information was incorporated into Rev 3 and resubmitted on 24/5/2019. DMIRS approved the MP Rev 3 on 10/6/2019. **Table 1** summarises the history of the mining proposal document.

Table 2 provides a summary of the revised content of this mining proposal (Rev 5) to the approved Rev 3 document.

Table 1: Document History

Revision	Date	Description	Date DMIRS Approved
A	5/6/2018	First draft	-
B	14/8/2018	Internal review	-
C	10/9/2018	Input by Client	-
1	22/10/2018	Final for issue to DMIRS	-
2	12/3/2019	Incorporate comments from DMIRS letter 21/2/2019 and email 9/4/2019	-
3	24/5/2019	Incorporate comments from DMIRS email 23/5/2019	10/6/2019
4	12/6/2019	Include tenements for aerodrome and communications facilities into the approved MP	-
5	18/7/2019	Incorporates comments from DMIRS letter 17/9/2019	

Table 2: Revision Summary

Reason for Revision	MP Section	Summary of Amendments
Revision 4		
Revised MP from initial approved MP (Rev 3) to include tenements and activities for aerodrome and communications facilities	1. Background Information	Updated text on aerodrome and communications facilities
	2. Environmental Group Site Details	Updated EGS, Activity Details and Disturbance Area tables. Updated Figure 1: Regional location Insert Figure 5: Aerodrome tenement and Figure 6: Aerodrome Preliminary Design
	3. Legislative Framework	Updated Table 22: Other Approvals and Licences Updated Section 3.3 Vegetation Clearing and Table 23: Clearing principles
	4. Stakeholder Engagement	Updated Table 24: Key Stakeholders and moved MP Rev 3 Table 19 (Consultation Register) into Appendix D
	5. Baseline Environmental Data	New text added in Section 5.4 Water Resources New text added in Section 5.5 Biodiversity and Ecosystem New text added in Section 5.6 Other Factors

Reason for Revision	MP Section	Summary of Amendments
	6. Risk Assessment	Updated risk pathway text in Table 41: Risk Assessment and Table 42: Risk Assessment Summary
	7. Outcomes and Reporting	No change
	8. Environmental Management System	Fauna management procedure added to EMS
	Appendix A Process Plant Drawings	No change
	Appendix B Ecology Reports	New ecology report added
	Appendix C Vegetation Clearing Application	New clearing application added
	Appendix D Consultation Register	Moved MP Rev 3 Table 19 (Consultation Register) into Appendix D
	Appendix E Environmental Management System	Fauna management procedure added to EMS
	Appendix F TSF design reports	No change
	Appendix G Waste Characterisation	No change
	Appendix H Mine Closure Plan	New tenements and updated text added to MCP Rev 4.
	Appendix I Water Resources Reports	No change
	Appendix J DMIRS Correspondence	No change
	Appendix K Confidential Information	Updated information

2. Environmental Group Site Details

The Abra base metals project is located in the East Gascoyne area of Western Australia, approximately 170 km southwest of Newman, 180 km north of Meekatharra and 100 km west of the Great Northern Highway. The area was first explored from 1976 by Amoco, in the 1990's by Renison Goldfields Consolidated Limited, Oldcity Nominees Pty Ltd from 2000 and from 2005 by Abra Mining Limited. The project is now 100% owned by Abra Mining Pty Ltd (AMPL).

The Department of Mines, Industry Regulation and Safety (DMIRS) *mining proposal guidelines* define an Environmental Group Site (EGS) as a group of individual tenements that make up a particular operation and which the proponent wants to report on as a single entity. It will have one Mining Proposal, one Mine Closure Plan and one Annual Environmental Report (AER). **Table 3** provides the EGS details for the Abra proposal.

Table 3: EGS details

SITE DETAILS	
EGS Name	Abra Environmental Group (S0237582)
EGS Code *Code is derived from the EARS2 system.* *(Leave blank if new project)*	Abra-Mulgul (J00545)
Description of Operation	New underground mine with entry via a boxcut. On site processing of ore through a conventional flotation process. Discharge of process tailings to a purpose built tailings storage facility (TSF). On site power generation using diesel fuel. Mine ancillary infrastructure including accommodation village, waste water treatment plant (WWTP), potable water supply, water supply bores, pipelines and powerlines. Aerodrome and associated infrastructure to cater for Fly In Fly Out (FIFO) workforce roster change at the mine. Three new tenements to locate communications infrastructure that connect the mine to the existing Telstra towers at Dunns Range, Facey and Doolgunna.
Mine Status	New project under construction
Commodity mined	Base metals – lead, silver, copper, gold
Project commencement date	Construction to end 2020
Estimated completion date of the project	2035

Tenement Details	Tenement	Tenement Holder
	L52/198	Abra Mining Pty Ltd
	L52/205	Abra Mining Pty Ltd
	L52/206	Abra Mining Pty Ltd
	L52/207	Abra Mining Pty Ltd
	M52/776	Abra Mining Pty Ltd
	G52/292	Abra Mining Pty Ltd
	L52/194	Abra Mining Pty Ltd
PROPONENT DETAILS		
Company or Individual Name	Abra Mining Pty Ltd	
ACN/ABN:	ABN 30 110 233 577	
Address	Ground Floor, 1 Centro Avenue Subiaco WA 6008 Australia	
Postal Address	As above	

Table 4: Contact Representative

Key Contact Representative *Key contact for any enquires regarding the operation of the mine site. This may be different from the key contact associated with the Mining Proposal*	Name:	Troy Flannery
	Position	Chief Operating Officer
	Phone Number	0417 966 926
	Email	tflannery@galenamining.com.au

Table 5: Approved Activities

Mine Activity	Mine Activity Reference	Tenement	Current Area of Activity (Ha)	Total Approved Area (Ha)
Mine void >5m in depth	Boxcut	M52/776	0.000	1.516
Plant site	Paste plant	M52/776	0.000	0.250
TSF	TSF	G52/292	0.000	64.000
WRD	WRD	G52/292	0.000	7.276
ROM	ROM	G52/292	0.000	3.499
Plant site	Process plant	G52/292	0.000	5.684
Miscellaneous mine activities	Borefield and pipelines, Ventillation fans	M52/776	0.000	1.000
	Accommodation village, Borrow pits, Magazine, Core yard, Borefield, Admin buildings, Communications, Fuel storage, Workshop, Dam – fresh water, Hardstand – machinery, Landfill, Roads / tracks, WWTP and ponds	G52/292	0.000	44.748
	Roads / tracks	L52/194	0.000	0.400
TOTAL AREA FOR MINE SITE			**0.000**	**128.373**

2.1 Activity Details

Table 6: Activity Details

Proposal Information (*available for public viewing)*	
Proposal Summary	The Abra project is located in the eastern Gascoyne region, approximately 180 kilometres north of Meekatharra, 170 kilometres south of Newman and 100 kilometres west of the Great Northern Highway. The mine has an approximate life span of 15 years based on the planned production rate. The project comprises of a new underground mining operation and ore processing via a conventional flotation process plant to produce a lead / silver concentrate. The concentrate will be transported on public roads to the Port of Geraldton or Port Hedland for export. The base metals orebody commences at approximately 280 metres below ground level (mbgl), with the bulk of high-grade ore located between 350-500 mbgl. Metallurgical test-work has delivered results of up to 96% lead recovery and up to 90% silver recovery using conventional flotation methods. The project is based on a design mining rate of 1.2 million tonnes per annum (mtpa). This will produce approximately 100,000 tonnes per annum (tpa) of lead/silver concentrate and 1,100,000 tpa of process residue that will be deposited in a tailings storage facility (TSF). Approximately one third of the total tailings produced during the life of mine will be re-processing in a paste plant and returning underground to fill completed mine voids. Spatial data for relevant project components is also supplied electronically with the mining proposal. A summary description of the main project components is as follows; **Mine landforms**. This comprises of a boxcut to provide the entry portal to the underground decline, the waste rock dump (WRD) and the run of mine (ROM) pad. The main constituent of the WRD will be the material excavated from the development waste of the underground. **Process plant and mine infrastructure**. This domain comprises of the crushing circuit and flotation process plant, concentrate loadout facility, power station, fuel storage, underground mine workshop, office and equipment parking area. The power station will provide approximately 10 MW of power. Process design drawings are provided in **Appendix A**. **Tailings Storage Facility**. The TSF and associated infrastructure (toe drains, seepage recovery bores and powerlines). **Accommodation village**. This will comprise of accommodation units for approximately 200 people, kitchen, mess and laundry facilities, recreation area, potable water and waste water treatment systems. **Ancillary infrastructure**. This comprises of the remaining infrastructure on site and includes administration area, weighbridge, borefield, explosive magazines, landfill, internal roads, powerlines, pipelines and sundry items. MP Rev 4 includes additional ancillary infrastructure of aerodrome and communications facilities
Mine Activities approval is being sought for (*available for public viewing)* *Only include Mine Activities which are being proposed or amended within the tables below. Previously approved Mine Activities are to be displayed in the Environmental Group Site Details Section of a Mining Proposal.*	

Table 7: Activity Details G52/292

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
G52/292	**Key Mine Activities**					
	Tailings or residue storage facility (class 1)		0.0	64.000		
	Waste dump or overburden stockpile (class 1)		0.0	7.276		
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site		0.0	5.684		
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad		0.0	3.499		
	Miscellaneous Mine Activities					
	Accommodation village		*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Borrow pits					
	Magazine					
	Core yard					
	Borefield					
	Admin buildings					
	Communications					
	Fuel storage					
	Workshop					
	Dam – fresh water					
	Hardstand - machinery					
	Landfill					
	Roads / tracks					
	WWTP and ponds					
	Miscellaneous Mine Activity Area		0.0	**44.748**		
	TOTAL TENEMENT ACTIVITY AREA			125.207		
	Total activity area			**128.373**	**48.000**	

Table 8: Activity Details M52/776

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
M52/776	**Key Mine Activities**					
	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Paste Plant site			0.250		
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)			1.516		
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Borefield and pipelines		*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Ventillation fans					
	Miscellaneous Mine Activity Area			**1.0**		
				2.766		

Table 9: Activity Details L52/194

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
L52/194	**Key Mine Activities**					
	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site					
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Roads / tracks	Roads	*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Miscellaneous Mine Activity Area			**0.400**		
	TOTAL TENEMENT ACTIVITY AREA			0.400		

Table 10: Activity Details L52/198

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
L52/198	**Key Mine Activities**					
	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site					
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Aerodrome and associated infrastructure	Aerodrome	*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Miscellaneous Mine Activity Area				**45.000**	
	TOTAL TENEMENT ACTIVITY AREA				45.000	

Table 11: Activity Details L52/205

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
L52/205	**Key Mine Activities**					
Dunns Range	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site					
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Communications facility		*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Roads					
	Miscellaneous Mine Activity Area				**0.200**	
	TOTAL TENEMENT ACTIVITY AREA				0.200	

Table 12: Activity Details L52/206

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
L52/206	**Key Mine Activities**					
Facey	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site					
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Communications facility		*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Roads					
	Miscellaneous Mine Activity Area				**0.200**	
	TOTAL TENEMENT ACTIVITY AREA				0.200	

Table 13: Activity Details L52/207

Tenement	Activity Category	Mine Activity Reference	Current Area of Activity (Ha)	TOTAL Current Approved Area (Ha)	Proposed Change (Ha)	New Total Approved Area (Ha)
L52/207	**Key Mine Activities**					
Flynn	Tailings or residue storage facility (class 1)					
	Waste dump or overburden stockpile (class 1)					
	Heap or vat leach facility					
	Evaporation pond					
	Dam – saline water or process liquor					
	Tailings or residue storage facility (class 2)					
	Waste dump or overburden stockpile (class 2)					
	Low-grade ore stockpile (class 1)					
	Plant site					
	Mining void (depth greater than 5m – below ground water)					
	Mining void (depth greater than 5m – above groundwater)					
	Run-of-mine pad					
	Miscellaneous Mine Activities					
	Communications facility		*Footprints not required for each miscellaneous activity type – see section 3.5.1 of the Guidelines*			
	Roads					
	Miscellaneous Mine Activity Area			**2.6**		
	TOTAL TENEMENT ACTIVITY AREA			2.6		

Key Mine Activity Information

Table 14: TSF Information

Tailings or residue storage facility			
Mine Activity Reference	TSF Cell A and B		
Area	64.000 ha		
Area per tenement	64.000 ha on G52/292		
Design	Design – Paddock Max Height -15 metres Number of Cells - 2 Construction method – Upstream Lining – Yes, geosynethic clay liner (GCL) Final outer embankment batter 18^0 (1:3)		
Material Characteristics	Fibrous minerals – see WRD text	☐- Yes ☒- No	*Details*
	Radioactive material – see WRD text	☐- Yes ☒- No	*Details*
	Materials capable of generating acid and metalliferous drainage, including neutral drainage and saline drainage	☐- Yes ☒- No	*NAF mine waste used to construct embankment*
	Highly erodible material that is capable of compromising the structure of the storage facility.	☐- Yes ☒- No	*Outer embankment sheeted with competent mine waste from decline development*

Table 15: WRD information

Waste dump or overburden stockpile			
Mine Activity Reference	Waste Rock Dump (WRD)		
Area	7.276 ha		
Area per tenement	7.276 ha in G52/292		
Design	Max Height - 20 metres		
Material Characteristics	Fibrous minerals The host geology for the Abra deposit is 100% Proterozoic sediments dominated by sandstones, siltstones, shales, conglomerates and dolomites. These rocks do not contain fibrous material and asbestiform minerals.	☐- Yes ☒- No	*Details*
	Radioactive material Uranium can possibly occur in sedimentary rocks. There have been 2,423 samples assayed for U with an average U content of 81.7ppm, which is considered a very low level.	☐- Yes ☒- No	*Details*
	Materials capable of generating acid and/or metalliferous drainage, including neutral drainage and saline drainage Waste characterisation has identified minor quantity of mine waste with potential to generate acid and significant quantity of mine waste with potential to neutralise acid.	☒- Yes ☐- No	*Details*
	Highly erodible material that is capable of compromising the structure of the waste dump. Underground mine waste is competent material	☐- Yes ☒- No	*Details*

Table 16: Boxcut information

Mining void			
Mine Activity Reference	Boxcut		
Area	1.516 ha		
Area per tenement	1.516 ha in M52/776		
Design	Design – Boxcut Depth – 25 metres		
Material Characteristics	Fibrous minerals – See text on WRD.	☐- Yes ☒- No	*Details*
	Radioactive material -– See text on WRD.	☐- Yes ☒- No	*Details*
	Materials capable of generating acid and metalliferous drainage, including neutral drainage and saline drainage, within pit walls or underground workings	☐- Yes ☒- No	*Details*
	Highly erodible material that is capable of compromising the long-term stability of the pit or underground workings	☐- Yes ☒- No	*Details*

Table 17: Process plant information

Plant Site	
Mine Activity Reference	Process Plant
Area	5.684 ha
Area per tenement	5.684 in G52/292
Type/ Design	Process plant design : • Three stage crushing; • Ball mill with a flash flotation cell and pebble crusher; • Flotation and concentrate regrind to produce a lead/silver concentrate; • Concentrate dewatering utilising a thickener and a filter to produce transportable concentrates; • Tailings thickening • Tailings storage in a designated facility.

Table 18: Paste plant information

Plant Site	
Mine Activity Reference	Paste Plant
Area	0.2500ha ha
Area per tenement	0.2500 ha in M52/776
Type/ Design	Paste plant design will comprise of the following major equipment: • Two vacuum disk filters; • Dual (operating and standby) vacuum pumps and ancillaries; • Filtrate receivers; • Paste mixer feed belt; • Paste mixer; • Cement silo and screw feeder; • Tails hopper; • Air and water services.

Table 19: ROM information

Run-of-mine Pad	
Mine Activity Reference	Run of Mine (ROM)
Area	3.499 ha
Area per tenement	3.499 in G52.292
Material Characteristics	ROM Core – constructed from NAF waste from boxcut and early decline development. ROM Extension – constructed of low grade (Pb 2.5-5%) mine waste. AMD analysis of samples of this material shown it is NAF.

2.2 Site Plans

Table 20 lists the disturbance areas required in each tenement for the project. **Figure 1** shows the regional location. **Figure 2** shows the project location. **Figure 3** shows the site layout and development envelope. **Figure 4** shows the infrastructure layout.

Table 20: Disturbance Area

Mine Feature	Type	M52/776 (ha)	G52/292 (ha)	L52/194 (ha)	L52/198 (ha)	L52/205 (ha)	L52/206 (ha)	L52/207 (ha)
Waste Rock Dump	Major		7.276					
Tailings Storage Facility	Major		64.000					
Box Cut	Major	1.516						
ROM	Major		3.499					
Processing Plant	Major	0.25	5.684					
Village	Minor		3.757					
Power station			0.753					
Admin and security	Minor		0.521					
Mine workshop and laydown	Minor		5.442					
Wastewater Treatment Plant	Minor		1.635					
Dewatering pond	Minor		0.435					
Roads	Minor		8.500					
Landfill	Minor		0.738					
Borrow pits, topsoil & vegetation stockpiles	Minor		6.217					
Laydown areas	Minor		2.000					
Solar power field	Minor		10.000					
bores and pipeline	Minor	1.000						
road entrances	Minor			0.400				
Ancillary infrastructure	Minor		5.000		45.000	0.200	0.200	2.600
Tenement total		2.766	125.207	0.400	45.000	0.200	0.200	2.600
Total		**176.373**						

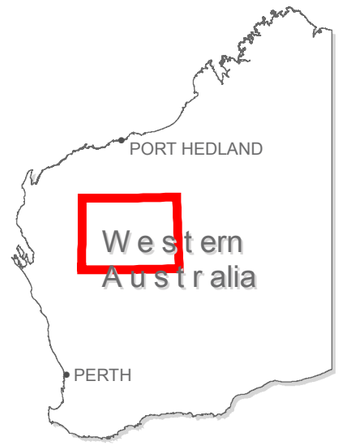
500000
600000
700000
800000
900000
7400000
7300000
7200000
7100000

NEWMAN
TANGADEE
SITE LOCATION
L52/207 - Flynn
WOODLANDS
MULGUL
MINGAH SPRINGS
MILGUN
L52/205 -Dunns Range
FORTNUM GOLD MINE
L52/206 - Facey
YULGA JINNA
Doolgunna
MEEKATHARRA
WILUNA
GOLDFIELDS HIGHWAY

ASHBURTON DOWNS MEEKATHARRA ROAD
PRAIRIE DOWNS TUREE CREEK ROAD
PRAIRIE DOWNS ROAD
SYLVANIA WEELARRANA ROAD
WEELARRANA NORTH ROAD
BULLOO DOWNS ROAD
JIGALONG MISSION ROAD
CREEK ROAD
PINGANDY ROAD
MOUNT AUGUSTUS ROAD
DOOLEY DOWNS ROAD
LANDOR MOUNT AUGUSTUS ROAD
WALDBURG ROAD
MOUNT AUGUSTUS WOODLANDS ROAD
BEYONDIE ROAD
MARYMIA ROAD
DEVERELL MULGUL ROAD
MINGAH SPRINGS ROAD
LANDOR MOUNT CLERE ROAD
MEEKATHARRA MOUNT CLERE ROAD
ASHBURTON DOWNS ROAD
PEAK HILL THREE RIVERS ROAD
WILUNA NORTH ROAD
BERINGARRA CUE ROAD
MILEURA MOUNT HALE ROAD
BELELE MOUNT HALE ROAD
MILEURA NOOKAWARRA ROAD
CARNARVON MEEKATHARRA ROAD
MURCHISON DOWNS ROAD
WILUNA GRANITE PEAK ROAD

N

0 15 30 60
kilometres



Legend
- Access to site
- Site Location
- Principal Road
- Secondary Road
- Minor Road
- Track

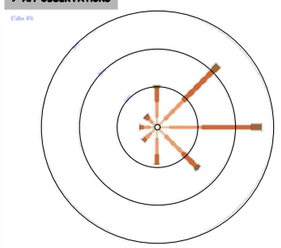
Figure 1

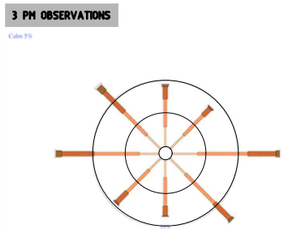
Scale (A3) 1:1,500,000
Datum Geocentric Datum of Australia 1994
Projection Map Grid Australia, Zone 50

Sources Topography: Geoscience Australia, GEODATA Topo 250K V3, © Commonwealth of Australia, 2006

File g003_IW186400_RegionalOverview_RevA (MR 18/07/2018)

JACOBS
JACOBS, 263 Adelaide Terrace, Perth WA 6000
Tel: +61 8 9469 4400 Fax: +61 8 9469 4488





NORTH

5 MILE CREEK
TANGADEE ROAD
5 MILE CREEK CROSSING
EXPLORATION LICENCE BOUNDARY
COLLIER RANGE NATIONAL PARK WESTERN BOUNDARY
ASHBURTON DOWNS - MEEKATHARRA ROAD
TRACK CLOSED
AIRSTRIP
REFER TO DRG.
12535-L-060
EXPLORATION CAMP
EXISTING AIRSTRIP
TSF
EXPLOSIVES
EXCLUSION ZONE
GP LEASE
BOUNDARY
MINING LEASE BOUNDARY
TRACK CLOSED
MINE PORTAL
PASTE PLANT
PRIMARY EXHAUST FAN
TRANSFER
STATION
BORE HOLE 3
AB10
BORE FIELD
DISTURBANCE BOUNDARY
TRACK CLOSED
EXPLORATION LICENCE BOUNDARY
EXPLORATION LICENCE BOUNDARY
PRELIMINARY NOT FOR CONSTRUCTION

657000 658000 659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000
7278000 7277000 7276000 7275000 7274000 7273000 7272000 7271000 7270000 7269000
537 540 531 523 558 578 551 598 562 575 567 578 572 597 605 620 595 605 567 583 662

400 0 400 800 1200 1600 2000m
SCALE 1:20000

M:\1-PROJECT STUDIES\12535 - Abra\Misc\Layout\12535L001-009.dwg - 31/01/2019 - 2:32pm - steve.reed

REFERENCE DRAWINGS	DWG No	REV	DATE	REVISIONS	DRN	CHK	TECH APP	PROJ APP
PROCESSING & MINING FACILITIES SITE ARRANGEMENT	12535-L-002	A		PRELIMINARY				

GR ENGINEERING SERVICES LTD
ENGINEERING CONSULTANTS AND CONTRACTORS
179 Great Eastern Highway, Belmont ACN 121 542 738
Western Australia, 6104
Phone: (08) 6272 6000
Fax: (08) 6272 6001

DRAWN	SLR	OCT '18
CHECKED		
DESIGNED		
TECH APP		
PROJ APP		
CLIENT APP		

GALENA MINING LIMITED
ABRA BASE METALS PROJECT
LOCATION PLAN

Figure 2

SCALE	JOB No	DRG No	REV
A1 1:20000	12535	12535-L-001	A

NORTH

659000 660000 661000 662000

7276000

7275000

VILLAGE ACCESS ROAD

VILLAGE REFER DRG. 12535-L-050

HERITAGE SITE

LANDFILL

WASTE WATER TREATMENT PLANT

SERVICE TRACK AND CORRIDOR

CELL 2 265,000m³

TAILINGS STORAGE FACILITY

CELL 1 265,000m³

ASHBURTON - MEEKATHARRA ROAD

SITE ACCESS ROAD

EXISTING ROAD

COMMUNICATIONS TOWER

SECURITY & ADMINISTRATION REFER DRG. 12535-L-040

PROCESSING REFER DRG. 12535-L-020

CRUSHING & STOCKPILING REFER DRG. 12535-L-010

GP LEASE BOUNDARY

DISTURBANCE BOUNDARY

10 HECTARE (500x200) SOLAR FARM

MINING FACILITIES REFER DRG. 12535-L-030

ROM PAD

MAGAZINES

WASTE DUMP

UNDERGROUND POWER CABLE

UNDERGROUND PORTAL

BORE FIELD PIPELINE, PASTE PLANT FEED & SERVICES

PASTE PLANT ACCESS TRACK

PRELIMINARY / NOT FOR CONSTRUCTION

100 0 100 200 300 400 500m

SCALE 1:5000

LOCATION PLAN	12535-L-001	A		PRELIMINARY				
REFERENCE DRAWINGS	DWG No	REV	DATE	REVISIONS	DRN	CHK	TECH APP	PROJ APP

WHEN IN DOUBT-ASK DO NOT SCALE

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ENGINEERING CONSULTANTS AND CONTRACTORS
179 Great Eastern Highway, Belmont ACN 121 542 738
Western Australia, 6104
Phone: (08) 6272 6000
Fax: (08) 6272 6001

DRAWN	SLR	OCT '18
CHECKED		
DESIGNED		
TECH APP		
PROJ APP		
CLIENT APP		

GALENA MINING LIMITED
ABRA BASE METALS PROJECT
SITE ARRANGEMENT

Figure 3

A1	SCALE 1:5000	JOB No 12535	DRG No 12535-L-002	REV A

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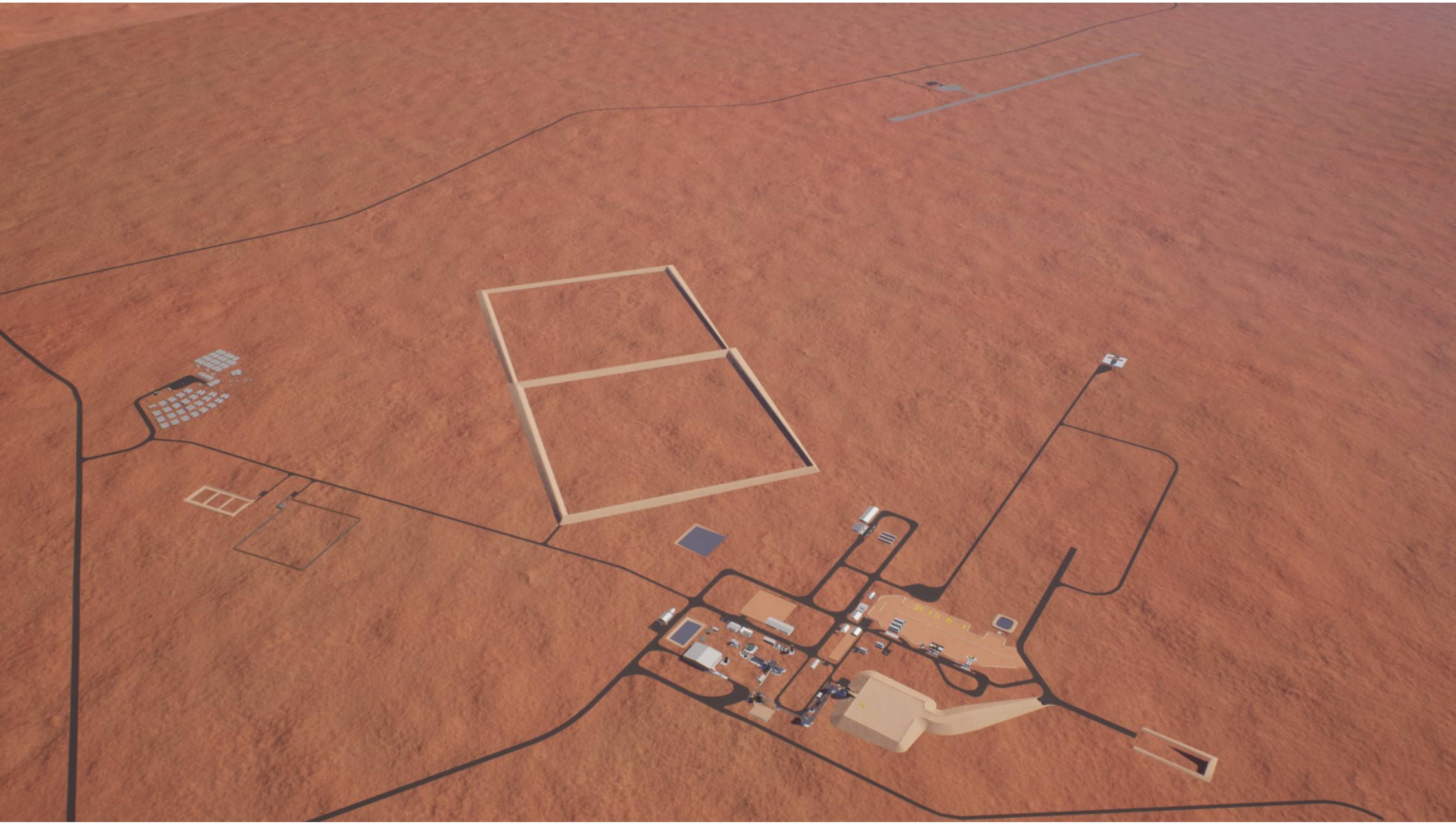


Figure 4

L 52/194

G 52/292

E 52/1455

L 52/198

L 52/121

G 52/286

M 52/776

7,277,000
7,276,000
7,275,000
7,274,000
7,273,000
7,272,000

658,000
659,000
660,000
661,000
662,000
663,000
664,000
665,000
666,000
667,000

LEGEND

Tenements_Live

N

0 250 500 750 1,000 m

GDA94, MGA Zone 50N

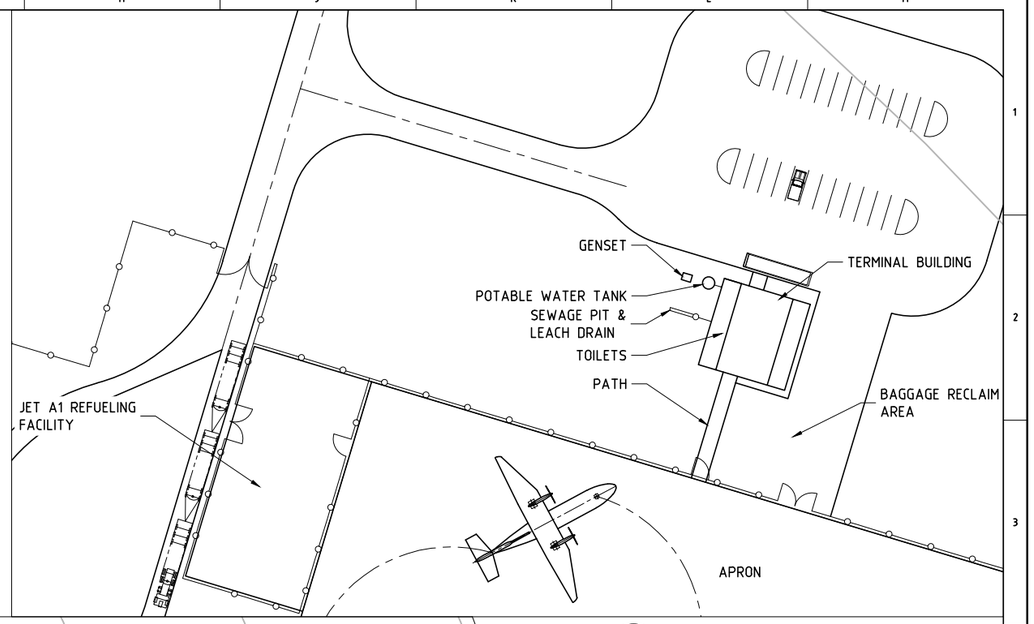
Figure 5

GALENA

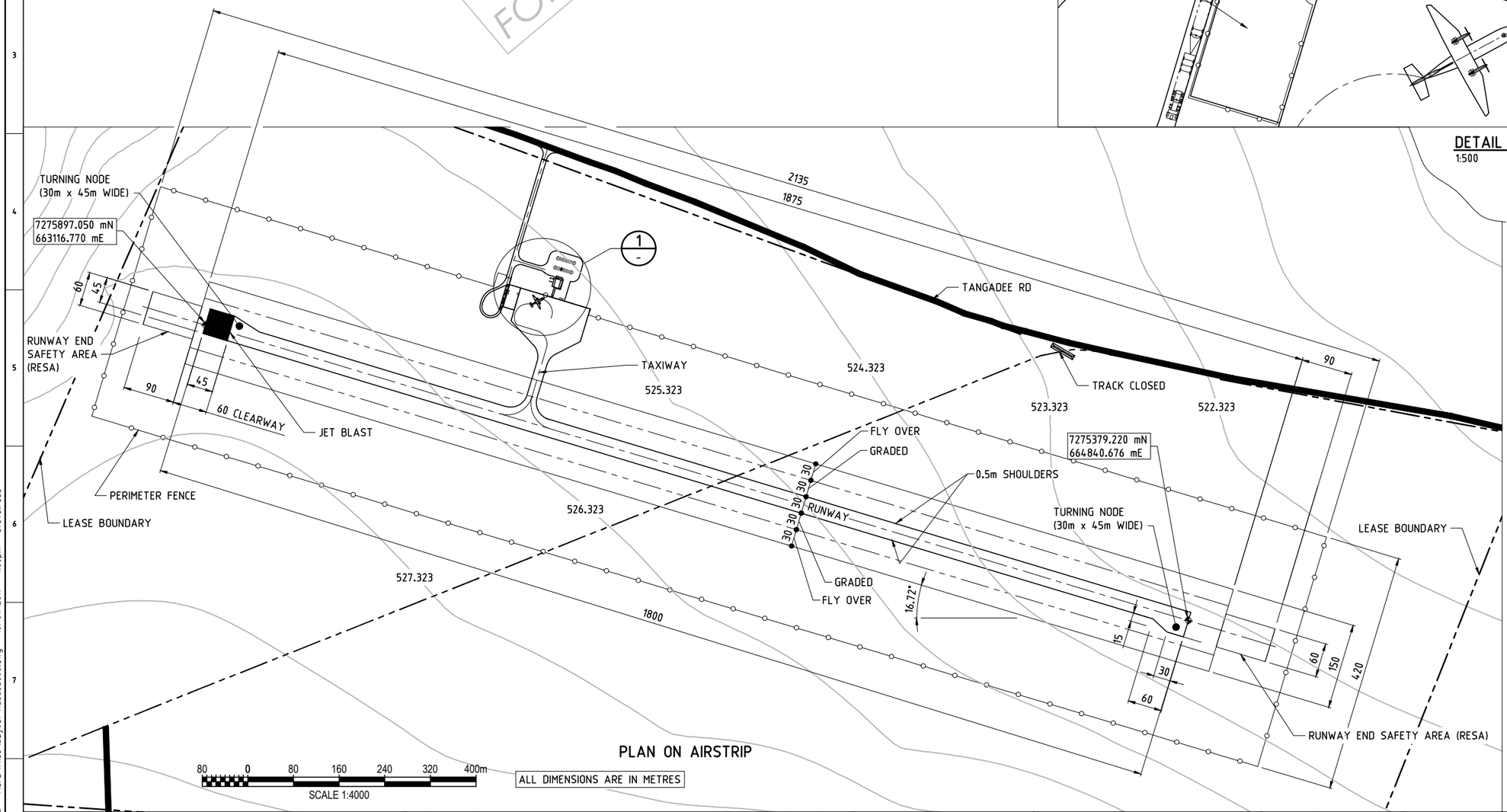
ABRA PROJECT
Site layout

Project: ABRA	Scale: 1:25,000
Drafted by: AS	Date: 12/02/2019

PLANT NORTH



DETAIL 1/- 1:500



PLAN ON AIRSTRIP

80 0 80 160 240 320 400m

SCALE 1:4000

ALL DIMENSIONS ARE IN METRES

REFERENCE DRAWINGS	DWG No	REV	DATE	REVISIONS	DRN	CHK	TECH APP	PROJ APP
		A		PRELIMINARY				

WHEN IN DOUBT-ASK DO NOT SCALE

GR ENGINEERING SERVICES LTD
ENGINEERING CONSULTANTS AND CONTRACTORS
71 Daly Street, Ascot Western Australia. 6104
Phone: (08) 6272 6000
Fax: (08) 6272 6001
ACN 121 542 738

DRAWN	RLW JAN '19
CHECKED	
DESIGNED	TM
TECH APP	
PROJ APP	
CLIENT APP	

GALENA MINING LIMITED
ABRA BASE METALS PROJECT
AIRSTRIP AND TERMINAL PLAN

Figure 6

A1	SCALE 1:4000 UNO	JOB No 12535	DRG No 12535-L-060	REV A

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3. Legislative Framework

3.1 Memorandum of Understanding

The first Memorandum of Understanding (MOU) in relation to referral of onshore mineral exploration and mining development proposals was established in 2004 between the then Department of Industry and Resources and the Environmental Protection Authority.

The initial MOU has been revised a number of times since 2004. The current (2016) MOU between the Office of the Environmental Protection Authority (now the Environmental Protection Authority Services Unit (EPASU) and the Department of Mines and Petroleum (now Department of Mines, Industry Regulation and Safety) sets out the collaborative working arrangements between the two agencies for assessing mining projects. Schedule 2 of the MOU lists triggers where there is a potential for significant environmental impacts and where consultation between the two agencies may need to occur. **Table 21** summarises the onshore criteria from the MOU that triggers consultation between the two agencies and AMPL's assessment of the applicability of these criteria to the Abra project. AMPL considers the outcome of this assessment is that the Abra project does not trigger any of the consultation criteria and DMIRS are able to assess the mining proposal without referral to the EPASU.

Table 21: MOU referral criteria

MOU Criteria	Relevant Project Information	Outcome
Environmentally Sensitive Areas including:		
Within 500m of World Heritage Property	Not applicable. The Abra project is not located within this zone	Consultation / referral with the EPASU not required.
Within 500m of a Bush Forever site	Not applicable. The Abra project is not located within this zone	
Within 500m of a Threatened Ecological Community	Not applicable. The Abra project is not located within this zone	
Within 500m of defined wetlands (including Ramsar wetlands,	Not applicable. The Abra project is not located within this zone	
ANCA wetlands, Conservation category wetlands)	Not applicable. The Abra project is not located within this zone	
Area containing rare flora	Site botanical survey has found no Declared Rare Flora (DRF) or Threatened Ecological Communities (TEC) in the Abra project area.	
Area covered by an Environmental Protection Policy.	Not applicable. The Abra project is not located within this zone	
Within 500m of a declared/proposed State Conservation Estate, including National Park, Nature Reserve, Conservation Park, or State Forest and Timber Reserves.	Not applicable. The Abra project is not located within this zone. The nearest conservation estate (Collier Range National Park) is located approximately 8.7km from the Abra project area.	
Within a Public Drinking Water Source Area.	Not applicable. The Abra project is not located within this zone	
Within 2 kilometres of a declared occupied town site (for Mining Proposals and petroleum Environment Plans only).	Not applicable. The Abra project is not located within this zone	

MOU Criteria	Relevant Project Information	Outcome
Hydraulic fracturing exploration and development activities.	Not Applicable	
Activities within the Strategic Assessment for the Perth Peel Region and potentially in conflict with the outcomes of the Strategic Assessment.	Not applicable. The Abra project is not located within this zone	
Area previously or currently subject to formal assessment by the EPA.	Not Applicable	

3.2 Other Approvals and Licences

In addition to this Mining Proposal, **Table 22** lists a number of other approvals, licences and permits required in order to operate the Abra mine. AMPL will implement the following commitment –

Commitment 1: obtain the required licences and permits for the Abra project listed in **Table 22**.

Table 22: Other Approvals and Licences

Agency	Relevant legislation	Factor / Environmental Objective	Approval Required
DMIRS		Hazardous materials / chemical storage	Dangerous Goods Licence (storage)
DWER	*Environmental Protection Act 1986.*	Landform / soils Water resources	Works Approval for Prescribed Premises categories 85 and 89 received. Draft Works Approval for Prescribed Premises categories 5 received. Licence to operate (once constructed) needs to be obtained.
	Rights in Water and Irrigation Act 1914	Water resources	5C licence application 027461 to take up to 0.8GL/ year of groundwater.
DoH	*Health Act 1911*	Public Health	Approval to operate the WWTP
			Approval to operate a potable water supply
Liquor Commission	*Liquor Control Act 1988*	Accommodation village	Approval of liquor licence for the wet mess at the accommodation village.
CASA	*Civil Aviation Safety Regulations CASR Part 139*	Certification of aerodrome	Certification of aerodrome

3.3 Vegetation Clearing

Clearing of vegetation in WA is assessed against 10 principles outlined in Schedule 5 of the *Environmental Protection Act 1986*. The principles address four key environmental areas of:

1. biodiversity significance,
2. land degradation,
3. conservation estate and

4. water quality (both surface and groundwater).

DMIRS have delegated authority from DWER to approve native vegetation clearing permit applications for mining proposals. A separate Purpose clearing permit application has been prepared for the Abra project. For completeness, this document has also been appended to this mining proposal in **Appendix C**.

Table 23 summarises how AMPL has considered these principles and developed measures to ensure potential impacts from clearing native vegetation can be managed to avoid serious degradation to vegetation systems or fauna habitats.

Clearing will be kept to the minimum required to undertake site operations. AMPL has an internal clearing procedure to cover clearing activities during the construction and operation phases of the project. The procedure involves:

- Site induction informing personnel on the importance of minimising clearing and the internal procedure.
- Internal application to clear with management signoff.
- Marking out the extent of clearing and exclusion areas.
- Supervision of clearing activity.

The extent of clearing will be reported in the annual environmental reporting (AER) processes.

The clearing permit does not include clearing on the communications tenements (L52/205; L52/206 and L52/207). These tenements are very small, with the communication facility component occupying an area of only 50m x 50 m. The extent of infrastructure and possible disturbance required on the tenement is similarly very small. **Figure 7** and **Figure 8** show examples of the type of containerised and modular infrastructure required to be located on these tenements occupies the approximate footprint of a passenger car. This can be located on the tenement with usually little or no clearing. In any event, there is an exemption for miscellaneous clearing on a tenement of up to 10 hectares per year. In the case of the communication tenements, the total area of the tenement is 0.25 ha. Any clearing required on these tenements will be well under the exemption threshold.

Figure 7: Communication Infrastructure

Figure 8: Communication Infrastructure 2

Table 23: Clearing principles

No.	Principle Native vegetation should not be cleared if-	Existing Environment	Potential Impact	Management Action	Outcome
Biodiversity Significance					
1.	it comprises a high level of biological diversity.	Vegetation communities and flora species are well represented in the wider region.	The project will result in only minor biodiversity loss through localised clearing	Seed collection from the local area for use in rehabilitation programmes	Project is not at variance with this principle
2.	it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	Fauna surveys have not identified significant fauna habitat unique to the project area.	The project will result in only minor local habitat loss in the region.	Rehabilitation will return habitat to the majority of the project area at the completion of operation.	Project is not at variance with this principle
3.	it includes, or is necessary for the continued existence of, rare flora.	No Declared Rare Flora (DRF) has been located in the project area	No impact to DRF	No specific management measures necessary for this principle	Project is not at variance with this principle
4.	it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	No Threatened Ecological Community (TEC) is located in the project area	No impact to TEC	No specific management measures necessary for this principle	Project is not at variance with this principle
5.	it is significant as a remnant of native vegetation in an area that has been extensively cleared.	The region is predominantly covered by native vegetation.	No remnant vegetation communities in the project area	No specific management measures necessary for this principle	Project is not at variance with this principle
6.	it is growing in, or in association with, an environment associated with a watercourse or wetland.	There are no permanent watercourses or wetlands in the region. The project will not disturb riparian vegetation on the creek line to the east of the project site	The project has been designed to avoid local drainage lines and watercourses.	No specific management measures necessary for this principle	Project is not at variance with this principle
Land Degradation					
7.	the clearing of vegetation is likely to cause appreciable land degradation.	The region is predominantly covered by native vegetation.	The 45 hectares of additional clearing associated with the project, in a region extensively covered by native vegetation, is unlikely to cause appreciable land degradation.	Clearing procedure is to be implemented as a control measure.	Project is not at variance with this principle
Conservation Estate					
8.	the clearing of vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The nearest gazetted conservation area (Collier Range National Park (R 35104)) is approximately 5 km to the east of the aerodrome and outside the tenements associated with this mining proposal	No impact to the conservation estate	No specific management measures necessary for this principle	Project is not at variance with this principle
Ground and Surface Water Quality					
9.	the clearing of vegetation is likely to cause deterioration in the quality of surface or underground water.	There are no permanent surface water bodies in the vicinity. Short duration surface water flows follow intermittent heavy rainfall. Groundwater is approximately 16 – 54 mbgl depending on local elevation	Turbid water from intense rainfall events may enter local watercourses. Impact to groundwater from TSF seepage.	Detention basins contain sediment off disturbed areas prior to discharge to the environment. Monitoring programme implemented. Baseline assessment indicates tailings has low solubility and leachate is likely to be within ANZECC stock drinking water quality guidelines	Project is not at variance with this principle
10.	clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	The project is located in an arid climate, on a local topographic high.	The project is unlikely to cause or exacerbate the incidence of flooding.	Detention basins contain sediment off disturbed areas prior to discharge to the environment.	Project is not at variance with this principle

4. Stakeholder Engagement

The development of the Abra project has three distinct components, each of which has its own approvals, permits and stakeholders. The components are:

1. **The mine**. The mine comprises the EGS group of tenements that contain the underground mine, processing facility, tailings storage facility, water supply bores, power generation and ancillary infrastructure that includes the accommodation facility. Processing of the ore at the mine site produces a base metals concentrate. In the early stages of mine development, the concentrate is predominantly lead /silver. The deposit transitions to a polymetallic lead/silver/copper/gold concentrate at depth. The mine is situated in a remote location, within pastoral lease LPL N049800 – Mulgul pastoral station. The nearest (non mine related) residential locations are individual pastoral station homesteads approximately 40 kilometres away.
2. **Concentrate transport.** The proposed method of transport is on triple or quad trailer road trains with the concentrate stored in specialised lidded containers (Rotainer /Rotabox) (**Figure 9**). The concentrate is to be transported by road licenced trucks on public roads from the mine to the port of Geraldton or the port of Port Hedland for export. The Abra mine is approximately eqi-distant from both ports and both ports already have the rotabox ship loading infrastructure in place (**Figure 10**). Discussions are continuing with both ports before a final decision is made.

   Key stakeholders for this component are the local governments along the transport route to the chosen port.
3. **Export.** Concentrate export is regulated by the port's DWER operating licence. Geraldton currently handles a similar base metals product from another mine south of Yalgoo and also copper concentrate from a mine north of Meekatharra. Port Hedland currently exports copper and lithium concentrate but would need to amend its existing DWER licence to be able to export lead concentrate.
4. The key stakeholder for this component is the chosen port.

The scope of this mining proposal is only for component 1 – the mine. The mining proposal does not include application for approval for the road transport or export components. Notwithstanding, AMPL recognise that each component of the project is linked and stakeholders view the project holistically. AMPL has therefore undertaken stakeholder engagement for all components. The Stakeholder Register (**Appendix D**) includes a comprehensive record of consultation undertaken to date.

Figure 9: Rotainer/Rotabox

Figure 10: Rotating mechanism used during ship loading

Potential stakeholders and interested parties that have been identified as being relevant to the Abra project are identified in **Table 24**.

Table 24: Key Stakeholders

Stakeholder Type	Stakeholder
Commonwealth Agencies	Civil Aviation Safety Authority (CASA)
State Government regulators	DMIRS DWER Department of Health (DoH) DPLH DPIRD
Local Governments	Shire of Meekatharra Shire of Cue Shire of Mount Magnet Shire of Yalgoo City of Greater Geraldton
Project stakeholders	Port of Geraldton Pilbara Port Authority
Pastoral lease holder	Mulgul pastoral lease – LPL N049800 Mingah Springs pastoral lease – LPL N049520 Woodlands pastoral lease – LPL N 050315 Tangadee pastoral lease – LPL N050276 Bryah Pastoral Lease

Stakeholder Type	Stakeholder
Indigenous/ traditional land owners	Jidi Jidi Aboriginal Corporation (JJAC), being the traditional owner representatives for the Nharnuwangga Wajarri who have granted Native Title for the area.
Non-government organisations (NGOs)	To be identified
Contractors	To be identified

Appendix D records the outcome of stakeholder consultation undertaken to date for the Abra project. This register is a dynamic document and will be updated as additional consultation is undertaken. Closure consultation is structured as follows:

- Regular consultation with government regulatory agencies and project stakeholders occurs through the annual reporting process and during scheduled site audits and inspections.
- Regular consultation with Traditional Owners on a range of project related matters including access agreements, royalty payments, heritage clearance surveys for mine and exploration activities. Dates of meetings held up until the end of January 2019 are included in **Appendix D**.

  For legal and commercial reasons, some consultation with Traditional Owners is regarded as confidential. The dates of meetings, details of this consultation and correspondence records is included in a separate appendix, **Appendix K: Confidential Information** and should not be made publicly available.

- Periodic consultation occurs with pastoral land owners around the mine. This usually occurs as a result of a specific issue / request however annual consultation (at a minimum) will be scheduled.
- Local governments along the transport route from the mine to the port will occur on at least an annual basis.

4.1 Targeted Engagement Strategy

AMPL's stakeholder engagement strategy is based on the following components.

Regulator Consultation. AMPL's engagement with regulators is focussed at this time on the approvals required from each of the relevant state and local governments in order to be able to start construction activities. AMPL commenced early consultation by undertaking scoping meetings with the key approval agencies of DMIRS and DWER. This has allowed early input by these agencies and for AMPL to provide information on baseline surveys and assessments that have been undertaken. This consultation will be ongoing through the various approvals, permits and licences required for the project.

Key Commercial Relationships. Key commercial stakeholders are the Midwest Port Authority (Geraldton Port), transport providers and the Pilbara Ports Authority (Port Hedland Port). These stakeholders provide the export facilities and the infrastructure to load ships using the specialised containers. Other key commercial stakeholders may also be identified as the project develops. AMPL has undertaken early consultation with the stakeholders above and further consultation is planned to ensure the logistics chain is confirmed by the time the project commences production.

Community Stakeholders. AMPL has identified all the local government municipalities that the base metals concentrate is transported through from the mine to the Geraldton port and has contacted each to explain the

project. The City of Greater Geraldton organised meeting on 13 August 2018 for interested stakeholders. This was attended by members of the local government, mid west chamber of commerce, mid west development commission, local Aboriginal contracting companies and a range of specialist service providers.

As negotiations with both ports continue and if the final decision is to export through Port Hedland, a fresh round of consultations will be conducted with relevant stakeholders.

5. Baseline Environmental Data

5.1 Climate

Payne et.al. (1988) undertook an inventory and condition survey of the Ashburton River catchment, which covers an area of approximately 93,600 square kilometres. The region lies between the winter rainfall parts of the State to the south and the summer rainfall parts to the north. Payne et.al. (1988) describe that despite more rain in the region falling in summer than in winter, analysis of rainfall data shows that effective rain for plant growth occurs more often in winter than in summer. The summer season is also characterised by prolonged periods of very hot conditions

The ARWATBAL computer programme was used to define 'pentads' (a five-day period). This programme takes into account water loss from runoff and internal drainage and compares rainfall against a proportion of potential evaporation presumed for plant growth or germination (Payne et.al. 1988). If water remains in the soil water store at the end of five days, then plant growth is considered to have occurred over the pentad. Analysis of data for a number of sites showed that more growth pentads occurred in winter than in summer (Payne et.al. 1988). This information is considered significant when planning for future rehabilitation programmes, in being able to schedule seeding and planting works with the best chance of success.

Bureau of Meteorology (BoM) data has been obtained from the closest recording site, Three Rivers (station number 007080), located approximately 75 kilometres south east of the Abra site. **Table 25** provides data on the two key climate variables of temperature and rainfall, **Figure 11** shows the average annual evaporation at the project site is approximately 3,400 mm/yr. **Figure 12** and **Figure 13** show annual wind roses for 9am and 3pm respectively.

Table 25: Three Rivers Climate Data (BoM 2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean Max Temperature ^{0}C	39.3	36.8	35.4	30.3	25.3	21.1	21.0	23.4	27.8	31.9	35.2	38.0		36
Mean Min Temperature ^{0}C	24.1	22.9	20.6	15.7	10.1	6.6	4.7	6.6	9.7	14.0	18.1	22.0		36
Mean rainfall (mm)	35.5	44.7	37.4	20.7	22.4	23.6	11.7	7.1	2.1	5.8	10.2	18.0	234.0	96
Mean number of days of rain ≥ 1 mm	2.8	3.1	2.6	2.0	1.9	2.2	1.6	0.8	0.4	0.7	1.2	1.7	21.0	92

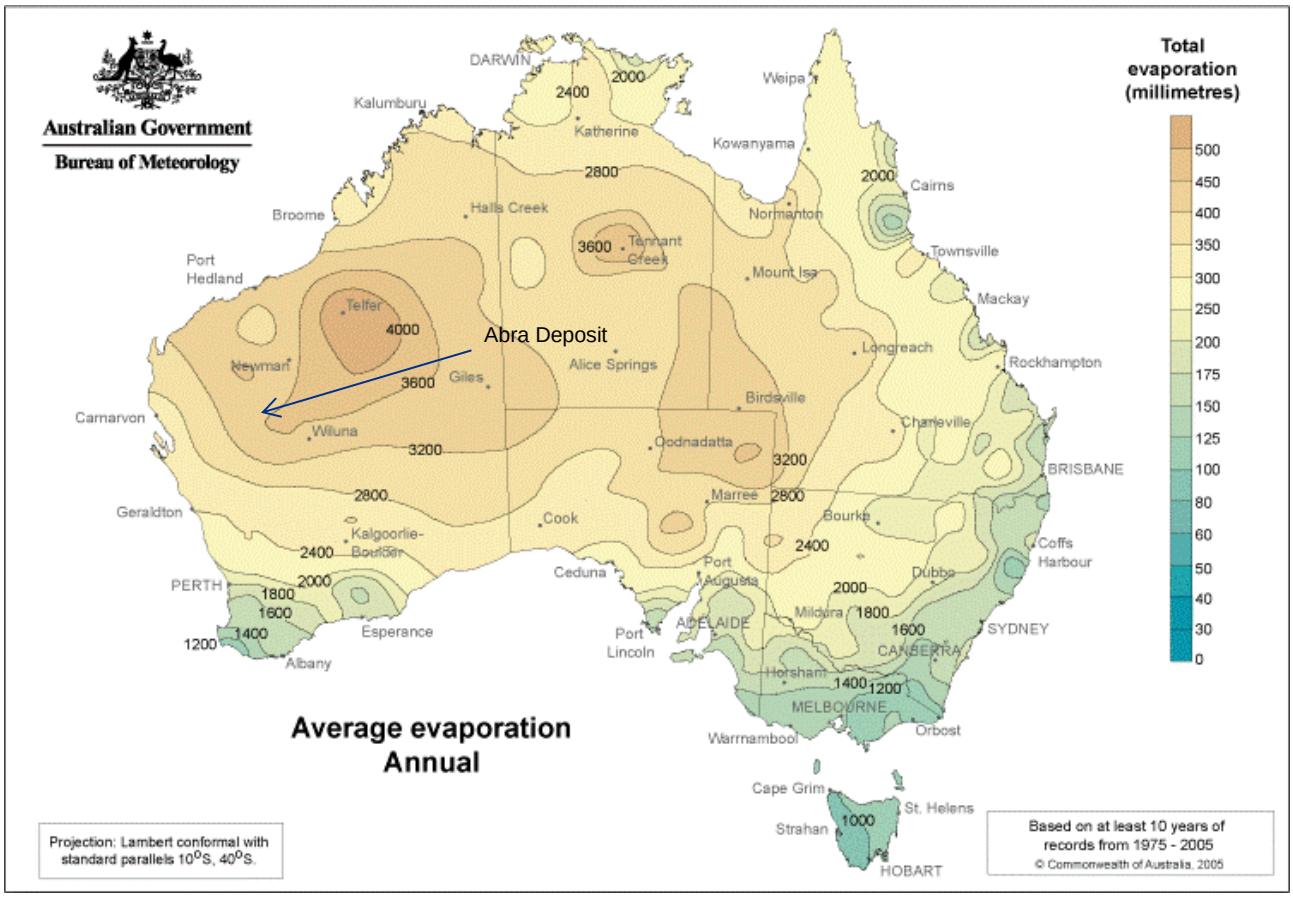

Figure 11: Evaporation Data (BoM 2016)

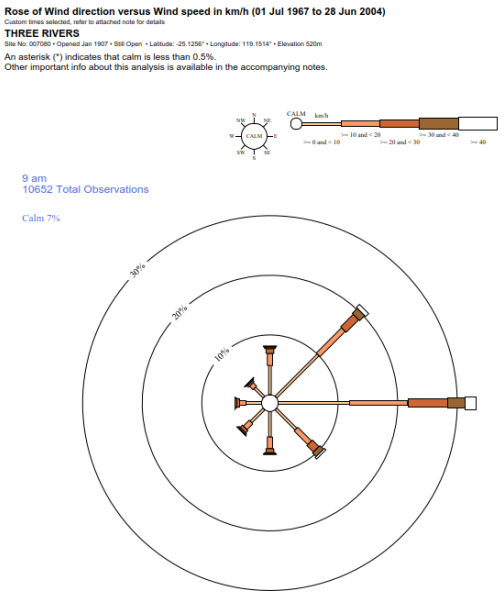

Figure 12: Annual Wind Rose- 9am

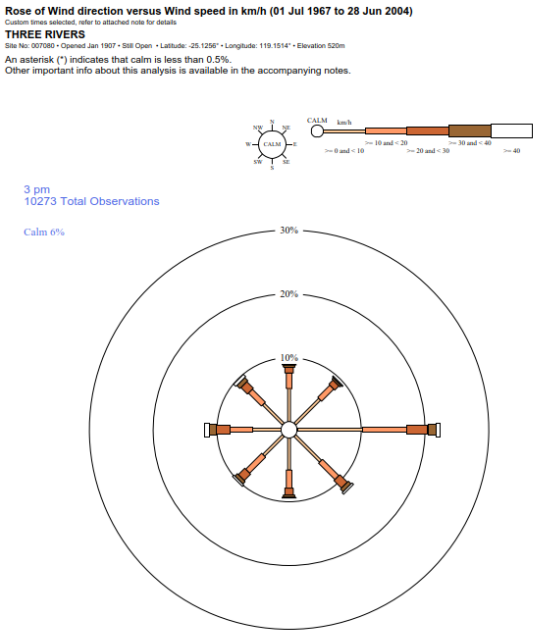

Figure 13: Annual Wind Rose- 3pm

5.1.1 Analysis and Interpretation of climate data

The following analysis and interpretation of the above information is provided:

i. The low annual rainfall and low monthly rainfall in 9 of the 12 months (defined as less than 25 millimetres in a month) indicates the risk of significant surface water flow events that become a potential vector for contaminant transport is considered to be low. With only 21 of 365 days in the year with rainfall events ≥ 1 mm, the risk of significant contaminant transport by surface water flow is considered to be low.

ii. The annual average evaporation exceeds the average annual rainfall by a factor of 10:1. This has implications for low water recovery from the TSF, high efficiency of wastewater evaporation from the WWTP irrigation area and low risk of transport of contaminants in surface water.

iii. The wind rose information shows prevailing winds are very dominantly easterly and of moderate velocity (<30 km/h). This has implications for dust generation and management and siting infrastructure (accommodation village, process plant, site office) in locations to minimise dust exposure from the crushing plant and TSF.

5.2 Landscape

The Abra project occupies a relatively small footprint (less than 200 hectares (ha)) in the extensive rangeland region of Western Australia. It is located on the Mugul pastoral lease, which is approximately 279,850 ha in area and is currently not actively managed, (the station has been destocked).

Payne et.al. (1988) describes the survey area as falling within three broad natural ecological regions as recognised by Beard (1975). These are the Pilbara region, Gascoyne region and the Carnarvon basin. Eight geomorphic provinces were recognised. The Abra project falls within the Bangemall province. This province extends along the southern edge of the survey area and forms the watershed between the Ashburton and Gascoyne Rivers. Soils of the Bangemall province have formed insitu on stripped surfaces or have accumulated on lower slopes and narrow drainage floors by colluvial and alluvial action. The rugged topography of the Bangemall region is responsible for its chief soil characteristic, which is the high proportion (70%) of skeletal and shallow stony loams. Cracking and non-cracking alkaline clays are characteristic of the lower plains. The

narrow drainage floors have widely different drainage conditions and as a result, the soils are variable and may be sands, texture contrast soils or cracking clays.

Figure 2 shows the southern portion of the project site is located on the ridgeline and upper slope of a ridgeline. The boxcut, WRD, ROM and process plant are located on skeletal, rocky soils and (relatively) steep gradients. The central and northern components of the project, comprising the TSF, accommodation village and ancillary infrastructure are located on mid-slope and lower slope topography that comprises more alluvium and colluvium sediments.

5.2.1 Analysis and Interpretation of landscape data

The following analysis and interpretation of the above information is provided:

i. The project site is located high in the landscape with only very small water catchment areas flowing through site. Only minor drainage lines or diversion levy's will be required to manage surface water flows.

ii. The skeletal soils of the project site is likely to limit topsoil recovery over some infrastructure footprints. Until actual clearing and topsoil stripping is completed, an accurate materials balance cannot be undertaken. Topsoil inventory information will be updated in subsequent versions of the MCP.

5.3 Materials Characterisation

5.3.1 Local Geology

AMPL's 2018 (unpublished) internal resource estimation report on the Abra Base Metal Project provides the following information.

The Abra project site is located in the south east corner of the Ashburton survey area. The general geology of the area is about 90% based on Proterozoic rocks of the Bangemall, Bresnahan, Wyloo, Hamersley, and Fortescue geological groups. The Proterozoic rocks have been extensively folded and eroded and form the major hill and mountain land systems that form the watersheds between the Ashburton and Fortescue Rivers and the Ashburton and Gascoyne Rivers (Payne et.al. (1988)).

Locally, several distinctive lithological packages have been identified. These reflect the current understanding of the lithology and its importance relatively to the deposit geology and mineralisation. Five main lithological packages have been identified (**Figure 14**). From the top to the base of the deposit the lithological packages are named as follow:

1) Kiangi Creek interbedded sediment unit;
2) Kiangi Creek lower conglomerate unit;
3) Upper Irregully dolomitic unit
4) Irregully chloritic sediment unit;
5) Irregully fine sediment unit.

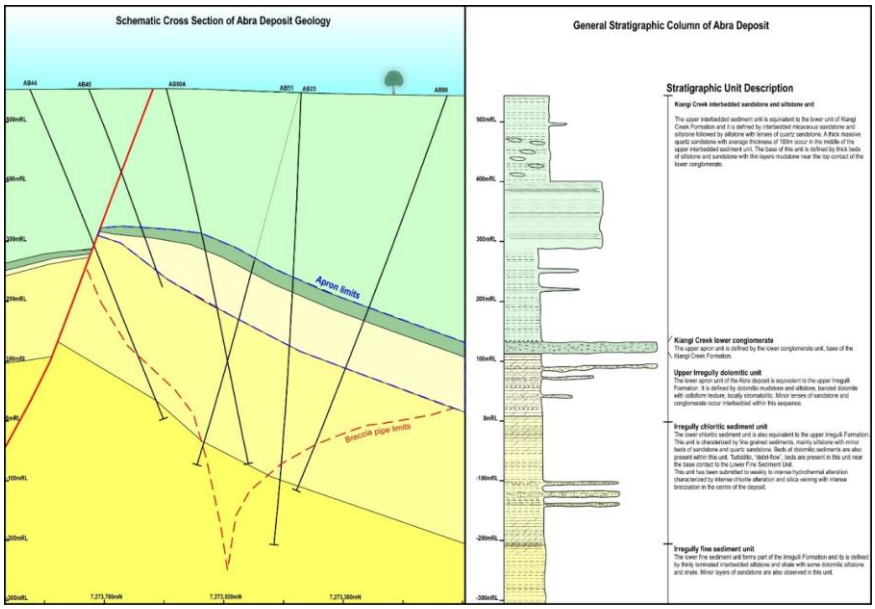

Figure 14: Schematic drill hole cross section with a general stratigraphic column for the Abra deposit

1. **Kiangi Creek interbedded sediment unit**

The Kiangi Creek interbedded sediments unit correlates to the lower sediment package units forming the Kiangi Creek Formation.

This unit is defined from the top to the base by micaceous interbedded sandstone and minor siltstone, with lenticular quartz sandstone beds along an East-West strike direction. A massive quartz sandstone unit is defined below the 100m depth mark in the deposit. This unit varies in thickness with an average thickness of 100m and contain some minor beds siltstone and fine grain sandstone. This massive quartz sandstone package assisted in the identification and location of the north normal fault of the Abra Deposit, showing some significant displacement of the quartz sandstone in cross section.

The unit below the quartz sandstone unit is defined by interbedded well laminated siltstone and sandstone, with some minor carbonaceous shale laminae. This unit transition to a more thickly bedded massive sandstone with some debris-flow beds.

A massive fine to medium grained sandstone unit thickly bedded forms the next lithological unit. This unit is followed by an interbedded sandstone and siltstone unit.

The base of the Kiangi Creek interbedded sediment unit is characterized by interbedded claystone, siltstone and minor sandstone. This unit is very important as it marks the lower contact of this unit with the lower conglomerate unit of the Kiangi Creek Formation, here called Kiangi Creek Lower Conglomerate Unit.

2. **Kiangi Creek Lower Conglomerate Unit**

The Kiangi Creek Lower Conglomerate Unit corresponds to the lower conglomerate unit as defined by the literature in the base of the Kiangi Creek Formation.

This unit forms the top horizon of the Abra Pb-Ag-Zn mineralisation within the apron of the Abra polymetallic deposit and it is characterized by granular to pebbly clast supported polymictic conglomerate and coarse to granular quartz sandstone.

The Kiangi Creek Lower Conglomerate unit has been through a strong hydrothermal alteration process with a non-homogeneous alteration intensity through the sedimentary package and decreasing its intensity away from the centre of the deposit. The main alteration mineral assemblage includes jaspilite, barite, dolomite and haematite.

3. **Upper Irregully Dolomitic Unit**

The Upper Irregully Dolomitic Unit comprises the rocks forming the upper unit of the Irregully Formation and at the Abra deposit they are defined by dolomitic mudstone, banded dolomite with colloform and stromatolitic texture, with minor lenses of conglomerate and sandstone.

This unit form the base of the apron mineralisation of Abra Deposit and it holds the most significant Pb-Ag mineralisation for the deposit.

Extreme hydrothermal alteration has overprinted the rocks forming this unit at various intensities. The alteration mineral assemblage within this unit can be zoned by the significant presence of jaspilite-barite-haematite in the upper portion with a strong presence of magnetite, haematite and silica toward the base of this unit.

4. **Irregully Chloritic Sediment Unit**

The Irreguly Chloritic Sediment Unit forms part of the upper Irregully Formation as described in the literature.

This unit is characterized by chlorite and silica altered fine grained sediments and minor sandstone. This unit presents variable alteration intensity across the deposit, being more intense near the top contact with the Upper Irregully Dolomitic Unit. This unit has gone through intense hydrothermal alteration, veining and brecciation.

The Irregully Chloritic Sediment Unit is of extreme importance for the Abra Deposit as it holds the core of the Abra Pb-Ag-Zn mineralisation as well as the lower Cu-Au mineralisation zones.

5. **Irreguly Fine Sediment Unit**

The Irregully Fine Sediment Unit form the base of Abra deposit and corresponds to some of the upper sediment packages of the Irregully Formation. This unit is defined by well laminated siltstone and shales with some layers of fine dolomitic sediments.

Table 26 lists the nine material types that were identified in drill cores taken through the deposit.

Table 26: Material types

No.	Code	Description
1	SCO	Conglomerate, quart dominant
2	SCOZRB	Conglomerate with intensively altered jaspilite, with subordinate barite, dolomite and silica alteration
3	ZRR	Intense jaspilite, silica and haematite alteration with variable barite and dolomite alteration intensity
4	ZBZ	Intense concentration of barite, where barite is more than 60% of the total mass of the interval
5	ADB	Dolomite zone - intense dolomite alteration zones. This rock group is characterised by colloform banded dolomite units with local stromatolitic texture. Locally, this unit occurs as a very fine-grained dolomitic mudstone (micrite)
6	MIC	Micrite (microcrystalline calcite present in some types of limestone)
7	ZBB	Intense magnetite, hematite and silica alteration. This zone is also enriched in barite and dolomite in places.

No.	Code	Description
8	HYZ	Hydrothermal alteration zone - intense silica, barite alteration, which appears to be parallel to the overall banding plane direction.
9	HYV	Hydrothermal vein zone - intense veining (typically silica, barite, galena, sphalerite, etc). This is the major style of Pb-Ag mineralisation within the Core

5.3.2 Waste Rock Balance

Figure 15 shows a schematic of the proposed decline and ore drives to access the Abra deposit.

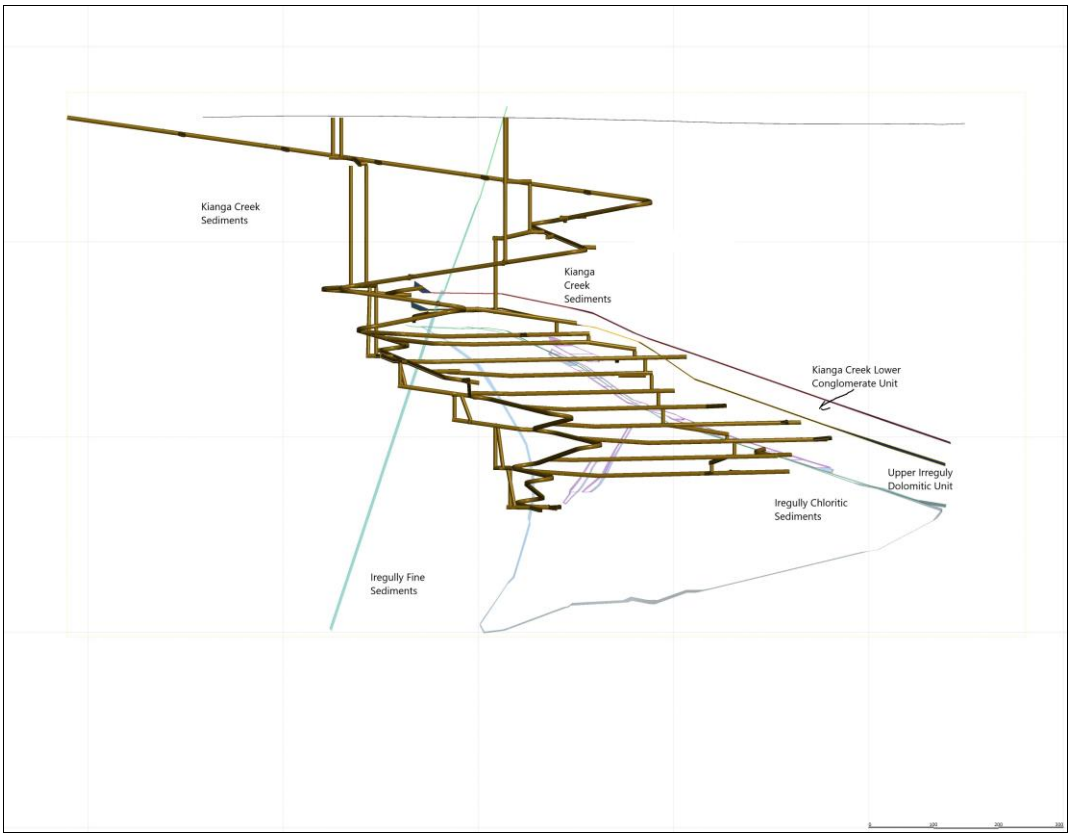

Figure 15: Underground development

Table 27 provides an initial materials balance for the Abra project. This materials balance has been established based on infrastructure designs and estimated materials quantities. As site construction activities occur, actual quantities will be assessed. A revised material balance will then be included in subsequent versions of the MCP. As shown in **Table 27,** it is likely there will be a material deficit at the site as the quantity of material required for the TSF embankments and top cover is more than all the mine waste extracted from the boxcut and underground mine. If this occurs, there will be no WRD and ROM remaining at closure, so closure designs and final embankment angles are not relevant.

- The initial (stage 1) of the ROM will be constructed from material excavated for the boxcut.
- TSF cell A starter embankment will be constructed during the initial construction phase of the project. Material will be sourced from a combination of cut:fill within the TSF footprint and also excavating the WRD footprint.

- TSF cell B starter embankment is not required until about year 2 or 3. This provides sufficient time for underground development to backfill the earlier excavation in the WRD footprint and continue with an above ground paddock style landform. This material will then be reclaimed during cell B construction.

During the mine life, these landforms will be managed to minimise environmental impacts.

- A toe bund will be constructed around the WRD to contain drainage.
- Dust suppression using water cart will be used on active areas of the WRD.
- Stage 2 of the ROM will be constructed using low grade ore. This eliminates 'mine waste' with lead content between 2.5% - 6% from being deposited in the WRD. Characterisation of this waste type (**Table 29**) indicates it is NAF, with final NAG pH between 6-7. Notwithstanding, drainage design from the crushing and processing plants directs stormwater to the process water dam.
- Reclaiming low grade ore at the ROM will be undertaken for blending purposes and also as an emergency process plant feedstock in the event of an extended underground shutdown.
- Current mine planning includes processing of all low grade ore inventory in the long term. Should this situation change and a residual low grade ore stockpile is to remain at mine closure, then a final landform design will be included in the revised MCP.

Table 27: Materials Balance

		Area (ha)	Produced (m^3)	Required (m^3)
Topsoil @ 150mm	**Total**		**166,660**	
	TSF	64.0	96,000	
	Process plant	3.126	4,690	
	Roads	8.500	12,750	
	WRD[1]	7.276	10,910	
	ROM[1]	3.209	4,810	
	Ancillary areas	25.0	37,500	
Mine waste	**Total**		**1,262,300**	
	Boxcut		66,300	
	UG development		1,196,000	
TSF	**Total**			**1,415,425**
Embankments[2]	Cell A-starter embankment			259,585
	Cell B- starter embankment			234,500
	Cell A- lift 1 and 2			185,100
	Cell B- lift 1 and 2			186,240
	Embankment subtotal			*865,425*
TSF top cover @ 1m (at closure)		55.0		550,000
Borrow required at closure			153,125	
Materials balance			1,415,425	1,415,425

Notes:

1. Infrastructure on skeletal soil locations. Not all topsoil may be recoverable.
2. Land & Marine Geological Services Pty Ltd (2018) Abra Base Metals Project TSF PFS Rev 0

The following summary of the above information is provided:

- The top of the mineral deposit commences approximately 250 – 280 metres below ground level. This covering layer is mostly comprised of sandstone, siltstone and quartz. The initial decline development until the top of the orebody will be in the Kianga Creek sediments (sandstone/siltstones etc). This zone will provide the majority of mine waste reporting to the waste rock dump (WRD).
- The boxcut will provide material for Stage 1 of the ROM. This surficial material (approximately 25 metres deep) is composed of oxidised material.
- Mine waste from the ore drives and continued decline development will also report to the WRD. Once down to the orebody, waste development will be in Kianga Creek lower conglomerate unit (hematitic seds, barite etc), Upper Iregully dolomitic unit (dolomitic seds etc), and the Iregguly Chloritic seds. These units typically contain varying quantities of sulphides (magnetite, hematite, pyrite, chalcopyrite, galena etc).
- Nine material types have been classified from drill cores taken through the overburden and ore zones of the deposit.

5.3.3 Waste Rock Characterisation

Acid-Base Accounting (ABA) evaluates the balance between acid generating processes and acid neutralising processes (DITR 2007). This involves determining the maximum potential acidity (MPA) and the inherent acid-neutralising capacity (ANC) of a material, expressed in units of kg H2SO4/ tonne. The Net Acid Producing Potential (NAPP) is the difference between these two factors; the capacity of a material to generate acid and its capacity to neutralise acid and is calculated as:

$$NAPP = MPA-ANC$$

NAPP is negative if the material's acid neutralising capacity is greater than its ability to generate acid (ANC>MPA). If it is highly negative (<-40) the material is regarded as acid consuming. Conversely, if NAPP is positive, the material is likely to be net acid-generating, with highly positive numbers (>40) regarded as strongly acid generating.

Total sulfur content, expressed as a percentage (%S) is commonly used as an estimate to calculate MPA, on the assumption that, when oxidised, sulphur is converted to sulphuric acid. (MPA = %S x 30.6 [to convert units to kg H_2SO_4/ t]).

However, not all minerals containing sulphur are acid generating, so total sulphur content often over estimates MPA. Some minerals contain sulphur in forms that are already oxidised to a sulphate (SO_4) which are very stable and rarely react further to produce sulphuric acid. For example, barite, gypsum, anhydrite, alunite and native sulfur, are non acid generating sulfur forms. Also, sulfur may occur as other metal sulfides (such as covellite, chalcocite, sphalerite and galena) which yield less acidity than iron pyrite or, in some cases, are non-acid-generating.

The above information indicates the ABA methodology is likely to significantly over-estimate MPA because it assumes all sulfur is in a form that will readily react with oxygen and water to produce sulfuric acid. For the Abra deposit, this is not the case.

- **Table 26** identifies barite ($BaSO_4$) in a number of material types through the orebody. In one type, ZBZ, it represents the dominant mineral.
- **Figure 16** shows the zone of high sulfur is mostly located above the orebody. The bulk of this material will not be mined. **Figure 17** shows a high correlation between barium (Ba) and sulphur (S), indicating most of the sulphur is likely to be in barite, a highly stable, non-reactive sulphate form that is unlikely to form sulphuric acid.
- Tailings characterisation (Section **5.3.4**) states that enrichment of residual minerals in tailings indicates that barite will comprise almost one third of the total-tailings mass. The TSF design report (L&MGSPL 2018) provides design details on the facility designed to store 8.48 million tonnes of tailings over a 15 year life. On the above information there will be approximately 2.544 million tonnes of barite in the TSF. Sulfur represents 13.7% of barite and therefore approximately 350,000 tonnes by mass in the tailings.

Using the ABA methodology, all this sulfur would report as MPA where in reality it is locked in a stable, unreactive sulphate form.

- A similar situation to the tailings characterisation also exists for waste rock that reports to the WRD. Barite would also represent some proportion of this waste, further overestimating MPA using the ABA methodology

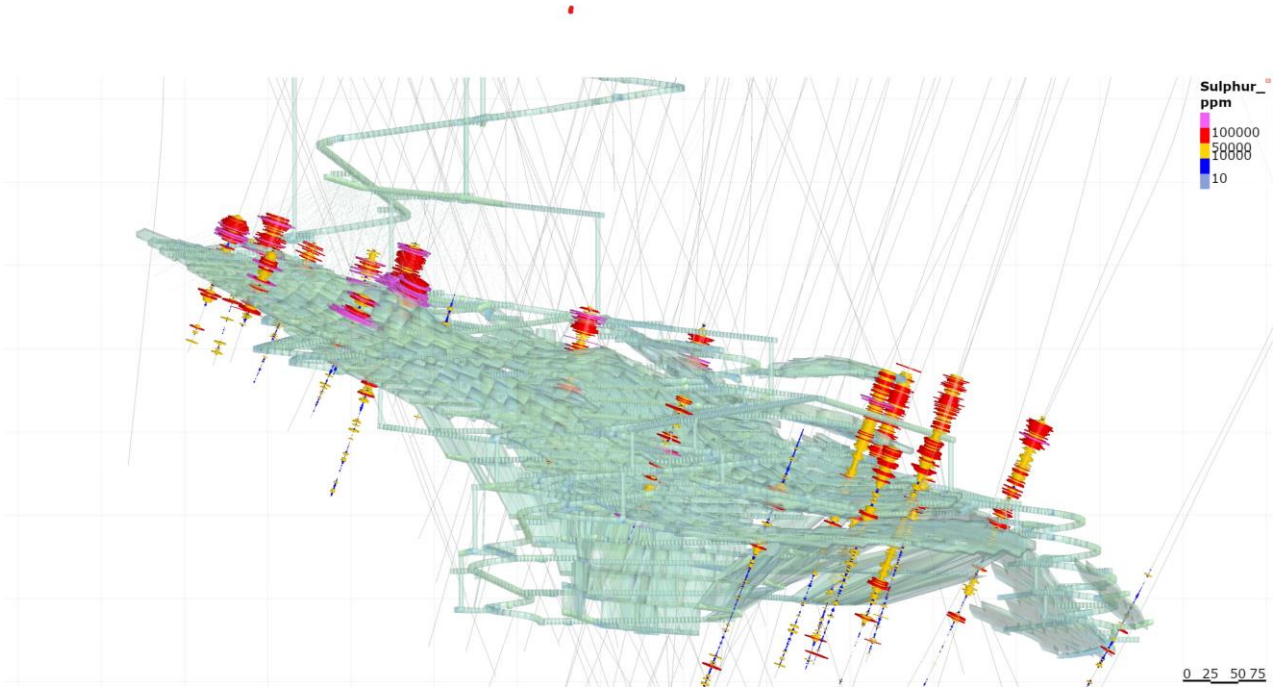

Figure 16: Mine design with sulphur overlay

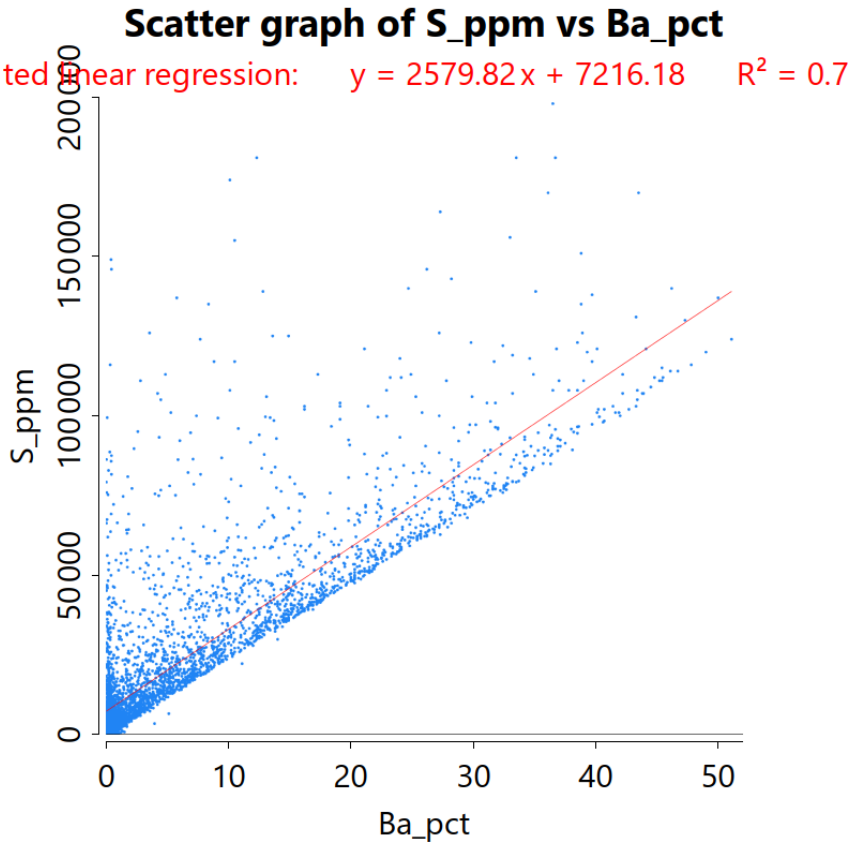

Figure 17: Barium vs Sulphur correlation

The Net Acid Generation (NAG) test is used, in association with the acid–base calculations, to provide greater certainty on the net acid generating potential of a material. The NAG test involves reaction with hydrogen peroxide to rapidly oxidise any reactive sulphide minerals. Both acid generation and acid neutralisation reactions occur simultaneously and the result represents a direct measure of the net acid generation (= net acid producing potential (NAPP)). The amount of acid produced is determined by titration and expressed in units of (kg H_2SO_4/t). A pH after reaction (NAG pH) of < 4.5 indicates the material is acid-generating. A pH after reaction (NAG pH) of ≥ 4.5 indicates the sample is not acid-generating.

Individually, the acid–base calculation and NAG test have limitations, but in combination the reliability of acid generation prediction is greatly enhanced. The risk of misclassifying NAF material as Potentially Acid Forming (PAF), and vice versa, is substantially reduced by conducting both acid–base and NAG tests.

Table 29 shows the results of acid and metalliferous drainage (AMD) laboratory analysis conducted on two samples of each of the nine material types described in **Table 26**. The samples were selected to be representative of material that would present as mine waste to the WRD. In addition, a number of samples were identified with lead grade between 2.5 – 5.5%. This material would be classified as Low Grade ore. The site layout (**Figure 3**) shows low grade ore will be deposited as an extension to the ROM. Initial characterisation is required to determine the potential acid generation of this material and therefore whether specific drainage containment design is required.

The results of the ABA and NAG test work confirms a discrepancy between the two methodologies, likely due to the ABA overestimation of the MPA because of the complicating factor of barite. The following summary of information in **Table 29** is provided:

i. The presence of significant amounts of barite in a number of material types makes acid generating capacity using the acid base accounting (ABA) methodology unreliable. For this reason, the net acid generation (NAG) test has been used to categorise mine waste material.
ii. All samples tested contain significant acid neutralising capacity (ANC), even samples classified as PAF.

iii. Only one material type, ZBZ, is classified as PAF-HC. This material is very restricted in the orebody. The mine plan only removes a small quantity of this material.
iv. Most of the mine waste material types are NAF, with final NAG pH >8. One material type is acid consuming.
v. Low Grade ore samples tested as NAF, with all samples having a final NAG pH between 6-7.

Considering the above information, AMPL has adopted the following classification of potential acid formation from mine waste for the Abra project (**Table 28**). These categories have been colour coded to be consistent with **Table 29**.

Table 28: Mine waste classification

Material	NAG (pH)	NAG pH 4.5 (H_2SO_4/t)
Potential Acid Forming -High Capacity (PAF-HC)	<4	>5
Potential Acid Forming (PAF)	4-5	1-5
Potential Acid Forming -Low Capacity (PAF-LC)	5 - 5.5	0.5 – 1.0
Non Acid Forming (NAF).	5.6-9	<0.5
Acid Consuming (AC)	>9	<0.5

Table 29: Acid generation results

						Acid Base Accounting					Net Acid generation (NAG)					
Rock code	Description	Zone	Sample No.	Pb (%)		Total S (%)	MPA[1] (H_2SO_4/t)	ANC (H_2SO_4/t)	NAPP (H_2SO_4/t))		NAG (pH)	NAG pH 4.5 (H_2SO_4/t)	NAG pH 7 (H_2SO_4/t)		NAG EC (uS/cm)	TDS[2] (ppm)
SCO	Conglomerate, quart dominant	Apron	G14635	0.05		1.68	51.4	4.2	47.2		8.5	<0.5	<0.5		150	96
		Apron	G14636	0.06		1.43	43.8	3.9	39.9		8.3	<0.5	<0.5		150	96
SCOZRB	Conglomerate with intensively altered jaspilite, with subordinate barite, dolomite and silica alteration	Apron	G14047	0.0035		3.46	105.9	140	-34.1		9.2	<0.5	<0.5		220	141
		Apron	G14048	0.0075		2.3	70.4	200	-129.6		9.1	<0.5	<0.5		220	141
ZRR	Intense jaspilite, silica and haematite alteration with variable barite and dolomite alteration intensity	Apron	G16287	0.03		4.61	141.1	150	-8.9		8.5	<0.5	<0.5		150	96
		Apron	G16288	0.12		4.57	139.8	160	-20.2		8.2	<0.5	<0.5		150	96
ZBZ	intense concentration of barite, where barite is more than 60% of the total mass of the interval.	Apron	G13947	0.02		10.8	330.5	13	317.5		2.8	10	12		1300	832
		Apron	G13948	0.01		10.6	324.4	9.3	315.1		2.9	7.5	10		960	614
ADB	Dolomite zone - intense dolomite alteration zones. This rock group is characterised by colloform banded dolomite units with local stromatolitic texture. Locally, this unit occurs as a very fine-grained dolomitic mudstone (micrite)	Apron	G16298	0.01		3.47	106.2	380	-273.8		8.3	<0.5	<0.5		170	109
		Apron	G16307	0.36		3.6	110.2	440	-329.8		8.3	<0.5	<0.5		230	147
MIC	Micrite (microcrystalline calcite present in some types of limestone)	Apron	G17157	1.1		1.78	54.5	2.6	51.9		4.8	<0.5	3.5		240	154
		Apron	G17158	0.23		0.864	26.4	2.0	24.4		4.0	0.8	3.5		260	166
ZBB	Intense magnetite, hematite and silica alteration. This zone is also enriched in barite and dolomite in places.	Apron	G14991	5.11		4.55	139.2	91	48.2		6.5	<0.5	<0.5		230	147
		Apron	G14992	4.06		6.01	183.9	95	88.9		6.8	<0.5	<0.5		310	198
HYZ	Hydothermal alteration zone - intense silica, barite alteration, which appears to be parallel to the overall banding plane direction.	Apron	G16609	0.87		4.49	137.4	120	17.4		6.2	<0.5	<0.5		200	128
		Apron	G16610	2.75		6.56	200.7	95	105.7		6.2	<0.5	<0.5		380	243
HYV	Hydrothermal vein zone - intense veining (typically silica, barite, galena, sphalerite, etc). This is the major style of Pb-Ag mineralisation within the Core.	Core/Apron	G17429	0.82		1.95	59.7	23	36.7		5.9	<0.5	<0.5		270	173
		Core/Apron	G17430	4.23		4.04	123.6	28	95.6		6.6	<0.5	<0.5		320	205

1. (MPA = %S x 30.6 [to convert units to kg H2SO4/ t]).
2. TDS =0.64 x NAG EC

5.3.4 Tailings

Campbell (2018) undertook an assessment of materials characteristics of the process tailings. The complete report is provided in **Appendix G.** A summary of the report findings is provided below.

Tailings Solids

- Classified as Non-Acid Forming (NAF);
- Has a final Net Acid Generation (NAG) pH value of 8.8;
- Contain at least 40-50 kg H_2SO_4/tonne of readily available alkalinity forms;
- Appreciable enrichment of barium (Ba), present as barite ($BaSO_4$) at 15.46%. Barite comprises almost one third of the total-tailings mass;
- Residual lead (Pb) levels of 0.48%, not recovered in the flotation process; and
- Content of all other major/minor elements are either below, or close to, those typically recorded for soils, regoliths and bedrocks derived from unmineralised terrain.

Tailings Water Slurry

- The tailings slurry water sample had a pH value between 7 and 8, and an EC value of 430 µS/cm;
- The concentrations of a wide range of minor-elements in the tailings-slurry-water sample were either below, or close to, the respective detection-limits and at or below ANZECC (2000) guideline values for livestock drinking-water (**Table 30**); and
- Specifically, the Pb concentration of 0.086 mg/L is below the ANZECC (2000) guideline value of 0.1 mg/L for livestock drinking-water (**Table 30**).

Table 30: Analysis of tailings slurry water

Element / Parameter	Value		Element / Parameter	Value	ANZECC (2000) Table 4.3.2.[1]
Major Parameters			**Minor Ions (mg/L)**		
PH	7.6		Ag	0.00025	
EC (µS/cm)	430		Al	0.02	
			As	0.0007	0.5 -5.0
Major Ions (mg/L)			B	0.02	
Na	29.9		Ba	0.06244	
K	16.8		Bi	<0.000005	
Mg	12.36		Cd	<0.0005	0.01
Ca	24.89		Co	0.1599	1
Cl	48		Cr	<0.01	1
SO_4	112		Cu	0.4	0.4 (sheep); 1 (cattle
HCO_3 (as $CaCO_3$)	75		F	0.5	
			Fe	<0.01	
Nitrogen forms (mg/L)			Hg	<0.0001	
NH_3 – N	0.21		Mn	0.14	
NO_3 - N	0.21		Mo	0.00577	

Element / Parameter	Value		Element / Parameter	Value	ANZECC (2000) Table 4.3.2.[1]
			Ni	0.1	1
Cyanide forms (mg/L)			P	<0.1	
Total CN	0.40		Pb	0.086	0.1
WAD CN	0.10		Sb	0.00563	
Free CN	<0/01		Se	0.0005	
SCN (thiocyanate)	8		Sn	0.0003	
			Sr	0.16843	
			Th	<0.000005	
			Ti	0.00021	
			U	0.000092	
			V	<0.01	
			Zn	<0.01	20

[1] - Recommended water quality trigger values (low risk) for heavy metals and metalloids in livestock drinking water.

Table 31 provides the ANZECC guidelines for TDS content in stock drinking water. Using the approximate conversion of EC (µS/cm) x 0.67 = TDS (mg/L), the calculated TDS value from the EC in **Table 30** is 290 mg/L. This is comparable to the existing groundwater value and is less than 10% of the maximum stock drinking water guideline values shown in **Table 31**.

Table 31: Stock Water Quality

ANZECC (2000) Table 4.3.1 TDS (mg/L)			
	No adverse effects	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected.
Beef Cattle	0 - 4,000	4,000 - 5,000	5,000 - 10,000
Sheep	0 - 5,000	5,000 - 10,000	10,000 - 13,000

5.3.5 Topsoil

The Abra project site is located on a regional topographic high point, on the catchment divide between thee Gascoyne River to the south and the Ashburton River to the north. Skeletal soils predominate in the upslope portions of the site which have little or no topsoil that can be readily removed during clearing operations. The mid and lower slopes often have a deeper surface soil profile due to depositional processes over time.

Figure 18 shows the 200 metre grid spacing of auger drilling that has been undertaken to characterise the surficial horizons in the project area. The description of the top one metre of soil in the northern half of the project area (mid to lower slope of the site) is typically described as fine sand /silt with very low level of organic matter with gravel overlying rock. In the southern portion of the site (upper slope), the top metre of the soil

profile has little or no clay and typically described as shallow, sandy with rock fragments and pisolith or exposed rock (no soil).

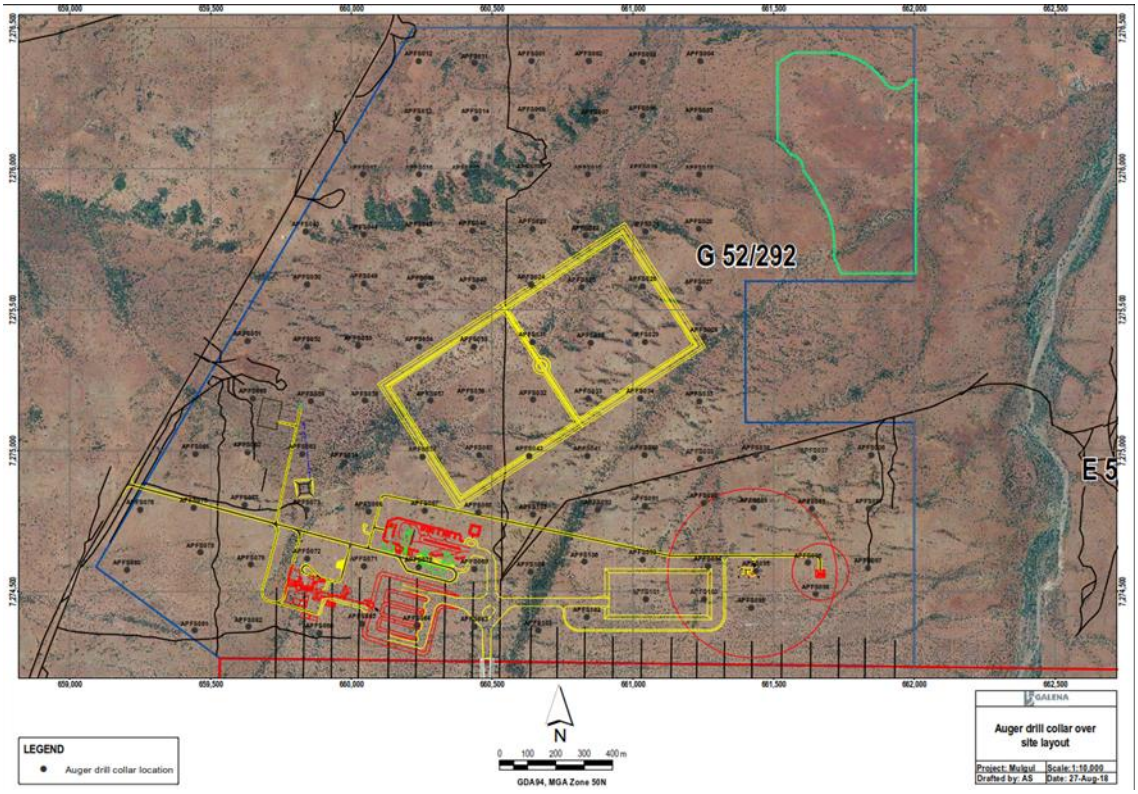

Figure 18: Soil auger drilling

A number of test pits were also dug, principally for the purpose of civil earthworks planning. Soil depth above hardpan duricrust is variable. Soil depth of approximately 300mm is common but can range from duricrust at surface (no soil) (**Photograph 2**) up to soil depths of 1 metre (**Photograph 3**). Soils description of fine sand/silt interspersed with gravel and stone between 200 – 500mm in depth before encountering hard duricrust is shown in **Photograph 1, Photograph 4** and **Photograph 5**.

Photograph 1: General view of WWTP irrigation field

Photograph 2: Test pit 1

Photograph 3: Test pit 9

Photograph 4: Test pit 10

Photograph 5: Test pit 11

The topsoil falls into two possible soil group classes as described in Schoknecht and Pathan (2013)

1. Stony Soils – 203.

Characteristics:

- Rocks and stones or coarse gravels dominant throughout the profile
- Usually very shallow
- Sandy, loamy, clayey or gravelly soil matrix
- Neutral to acid pH

2. Red Shallow Loam - 522

Characteristics

- Red loam over rock, hardpan or other cemented layer by 80 cm, and often <30 cm
- A surface mantle of stones may be common
- Gravel may be present
- Usually neutral to acid pH

AMPL considers topsoil at the Abra project most closely falls into soil group 522, which is scattered throughout the Pilbara, Gascoyne, Murchison, Goldfields and South-west. The two most likely qualifiers of red shallow loam at the site are:

- VSH - very shallow rock substrate
- LMR - loam, rock substrate

Dominant soil attributes of red shallow loam are provided in **Table 32**.

Table 32: Topsoil attributes

Attribute	VSH	LMR
Inherent fertility	Moderate	Moderate
Permeability 0-50 cm	Moderate	Moderate
pH at 0-10 cm	Slightly acid	Slightly acid
Profile stones and gravels	Many	Few
Rooting depth	Moderate	Moderate
Soil water storage	Low	Moderately low
Subsurface acidification	Moderate	High
Subsurface compaction	Moderate	Moderate
Surface organic carbon	Low	Low
Surface soil structure decline	Low	Moderate
Water repellence	Nil	Nil

Source: Schoknecht and Pathan (2013)

Two main processes which contribute to soil structural decline are slaking and dispersion. Slaking is mainly a physical process where aggregates collapse into micro-aggregates or primary particles when wet. Slaking soils reduce infiltration because the smaller aggregates block soil pores. Dispersion is predominantly a chemical process and results from the breakdown of aggregates into primary particles of sand, silt and clay. A characteristic of dispersion is muddy or cloudy water, the cloudiness being dispersed clay in suspension.

The Emerson aggregate test is used to broadly define the stability of soils and differentiating between the processes of slaking and dispersion. Hazelton and Murphy (2007) provides the following description of Emerson aggregate classes:

1. Aggregates most certainly indicate high tunnelling susceptibility and are dispersive
2. Aggregates indicate some degree of tunnelling susceptibility
3. Aggregates generally stable and indicate a more desirable material for conservation earthworks. If surface aggregates are cultivated, crusting may become a problem.
4. Aggregate materials may not hold water in a dam, depending on particle size distribution and degree of dispersion
5. Aggregate materials may not hold water in a dam, depending on particle size distribution and degree of dispersion
6. Aggregate materials unlikely to hold water in a dam

Table 33 provides results of characterisation of topsoil samples for the following chemical and physical parameters:

- Emerson class – to describe the dispersive or slaking properties of the topsoil.
- Electrical Conductivity (EC) – to record the level of soluble salts in topsoil
- Cation Exchange Capacity (CEC) – to characterise the sodic status of the topsoil.
- Major nutrients – to record total nitrogen, phosphorus and potassium levels.
- Particle size distribution (PSD) – to describe the physical properties of the topsoil.

Table 33: Topsoil properties

Analyte Name	Units	Topsoil 1	Topsoil 2	Topsoil 3					
Conductivity (1:5)	µS/cm	15	18	12					
TDS by calculation	mg/kg	10	12	8					
Passing 9.5mm	%w/w	92	87	93					
Passing 4.75mm	%w/w	86	81	86					
Passing 2.36mm	%w/w	81	78	75					
Passing 1.18mm	%w/w	77	74	70					
Passing 710µm	%w/w	73	71	67					
Passing 600µm	%w/w	72	70	66					
Passing 425µm	%w/w	68	65	62					
Passing 300µm	%w/w	63	57	57					
Passing 150µm	%w/w	52	43	49					
Passing 75µm	%w/w	41	35	41					
					Very Low	Low	Moderate	High	Very High
Exchangeable Sodium, Na	meq/100g	<0.01	<0.01	<0.01	0-0.1	0.1-0.3	0.3-07	0.7-2.0	>2
Exchangeable Potassium, K	meq/100g	0.12	0.10	0.12	0-0.2	0.2-0.3	0.3-07	0.7-2.0	>2
Exchangeable Calcium, Ca	meq/100g	0.16	0.10	0.17	0-2	2-5	5-10	10-20	>20
Exchangeable Magnesium, Mg	meq/100g	0.09	0.06	0.09	0-0.3	0.3-1.0	1-3	3-8	>8
Cation Exchange Capacity	meq/100g	0.38	0.27	0.38	<6	6-12	12-25	25-40	>40
Water Soluble Nitrate	mg/kg	1.2	1.2	1.2					
Total Nitrogen	mg/kg	400	280	390					
Total Phosphorus, P	mg/kg	200	230	200					
Total Potassium, K	mg/kg	300	300	390					
Emerson Class Number	-	3	3	3					

Coarse gravel	mm	>6
Fine gravel	mm	2-6
Coarse sand	mm	0.2-2
Fine sand	µm	20-200
Silt	µm	2-20
clay	µm	2

Interpretation of topsoil data in **Table 33** is as follows:

- Topsoil is not sodic. The EC and calculated TDS shows very low levels of mobile salts.
- PSD is approximately 20% gravel, 30% sand and 50% 'fines' (silt and clay). The topsoil would generally be described as a sandy loam.
- The CEC is very low, indicating the soil has a low resistance to changes in chemistry and structure.
- The levels of major nutrients (N, P and K) are also considered to be low. Most analysis of soil nutrient levels are usually made in an agricultural context, with reference to available nutrients for crop growth. Hazelton and Murphy (2007) provide information on major nutrients that confirm the total values for N, P and K in the topsoil samples are very low in the context of agricultural soils. Fertiliser addition would be required during mine rehabilitation.
- The Emerson class of 3 places the topsoil in an acceptable category for rehabilitation earthworks. It shows the topsoil is not highly susceptible to tunnelling or dispersion.

5.3.6 Analysis and Interpretation of materials characterisation data

The following analysis and interpretation of the above information is provided:

i. The presence of significant amounts of barite in a number of material types makes acid generating capacity using the acid base accounting (ABA) methodology unreliable. For this reason, the net acid generation (NAG) test has been used to categorise mine waste material.
ii. All samples tested contain significant acid neutralising capacity (ANC), even samples classified as PAF.
iii. Only one material type is classified as PAF-HC. This material will only be mined in small quantity.
iv. The majority of mine waste is classified as NAF, with significant ANC. This supports co-disposal of mine waste, rather than a dedicated encapsulation cell design.
v. Tailings is classified as NAF, with significant ANC.
vi. Tailings slurry water is low in soluble metals, including lead.
vii. Tailings slurry water quality is within stock drinking water guidelines for soluble metals and TDS.
viii. There is no evidence that topsoil possess properties likely to inhibit plant growth.

The above points indicate all major mine waste landforms (WRD, ROM and TSF) will have a low risk of significant potential contamination.

5.4 Water Resources

Rockwater (2018) undertook an assessment of local hydrogeology resources. The complete report is attached in **Appendix I**.

The objective was to identify possible locations for water abstraction bores to provide the water requirements for the site. Initially, water demand has been calculated at approximately 24L/sec (approximately 0.8 GL/yr) to supply the project process, dust suppression and accommodation village needs. However, as water recovery from the TSF increases, the 'steady state' new water demand is estimated at 12 – 15 L/sec (0.38 – 0.48 GL/yr)

Previous reports indicated much of the host rocks around the Abra deposit are of low permeability. Groundwater level measurements indicate a northerly direction of flow and a possible higher permeability zone centred near the ore body.

Rockwater (2018) reported that Geopeko drilled at least 22 holes in 1990 to depths of 28 – 76m for the purpose of obtaining water samples and drill cuttings. Groundwater quality is regarded as fresh, with salinities in a range around 500 mg/L Total Dissolved Solids (TDS). Local water table ranges from about 16 to 54 m below ground surface depending on local elevation. **Table 34** shows results of raw water quality analysis from a range of bores and compared against the Australian Drinking Water Guideline health and aesthetic values. They show groundwater in the locality can generally be described as within drinking water standards for chemical constituents, without treatment. Some values, shown in bold, are outside drinking water guideline values. Metals are mostly at or below limits of reporting, total nitrogen ranges from 3-16.7 mg/L and phosphorous is low.

The report also states there are no known groundwater dependent vegetation or ecosystems that could be impacted.

Of the existing bores, previous pump testing identified bores (AB10, EP1 and HY1) had yields of 7, 6 and 8 L/sec respectively. These three bores are within a two kilometre radius of the project site.

Rockwater (2018) reported on regional bores, wells and springs recorded in the Department of Water and Environmental Regulation (DWER) Water Information Reporting (WIR) database. Only two sites are located within 15km of the Abra project; Bedford bore and Chalk Spring in the Ethel River. They conclude there is no possibility that pumping from bores at Abra would have any impact on these features.

This information in the Rockwater report indicates a dedicated water boring programme in the vicinity of existing bores on approved tenements M52/776 and G52/292 will provide a sufficient water resource for the project.

AMPL received Department of Water and Environmental Regulation (DWER) approval to construct water abstraction bores on 16 November 2018. CAW202141(1) provides approval for up to 6 non artesian wells. In April 2019, work commenced on establishing large diameter (300 mm) cased bores to between 100 – 150 m below ground level. Three bores have been constructed (APB001, APB002 and APB003). Test pumping has been completed and a hydrogeology report prepared by Rockwater. The results indicate sustainable yields for up to three years of 8 L/s, 12 L/s and 5 L/s for APB001, APB002 and APB003 respectively.

However, to build future redundancy into the water resource system, AMPL will undertake further groundwater exploration during the first 3 years of mine life to establish additional bores and lodge additional miscellaneous licences if these are outside the existing mine tenure. This will enable rotation from each extraction source and resting/recovery of individual bores. AMPL will implement the following commitment:

Commitment 2: To secure a sustainable, life of mine water resource, AMPL will undertake further groundwater exploration during the first 3 years of mine life to establish additional production bores.

Table 34: Local groundwater quality

							Australian Drinking Water Guidelines (ADWG)		
Analyte	Unit	AB10	AB7	EP1	Ethel River Bore	HY1	Health	Aesthetic	Comment
pH	pH unit	8.29	7.93	8.36	8.21	8.4		6.5 -8.5	>8 progressively decreases efficiency of chlorination. >8.5 may cause scale and taste problems
EC @25^{0}C	µS/cm	864	772	678	1040	1160			
TDS @180^{0}C	mg/L	462	408	391	578	669		<500	500-1000mg/L is acceptable based on taste
TSS	mg/L	13	<5	819	105	41			
Turbidity	NTU	8.6	0.2	562	64.6	27.7			
Total alkalinity as $CaCO_3$	mg/L	310	263	168	263	254		200	60-200mg/L good quality. 200 -500 mg/L increasing scaling problems
Acidity as $CaCO_3$	mg/L	<1	11	<1	4	<1			
Sulphate as SO_4	mg/L	44	48	39	61	121			
Chloride	mg/L	69	65	58	147	142			
Calcium	mg/L	42	46	38	56	60			
Magnesium	mg/L	31	35	28	43	50			
Sodium	mg/L	75	50	34	65	76			
Potassium	mg/L	9	9	8	18	11			
Aluminium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01		0.2	
Arsenic	mg/L	0.061	0.006	<0.001	<0.001	0.001	0.007		
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002		
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001			
Manganese	mg/L	0.253	0.41	<0.001	<0.001	0.16			
Nickel	mg/L	<0.001	0.004	<0.001	<0.001	<0.001	0.020		

							Australian Drinking Water Guidelines (ADWG)		
Analyte	Unit	AB10	AB7	EP1	Ethel River Bore	HY1	Health	Aesthetic	Comment
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01			
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005		3	
Iron	mg/L	0.11	<0.05	<0.05	<0.05	<0.05		0.3	
Chromium VI	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	0.050		
Nitrate – N	mg/L	4.46	2.69	13.4	4.7	14.7	50		
Total nitrogen -N	mg/L	5.2	3	15.1	5.4	16.7			
Total phosphorous - P	mg/L	0.06	<0.02	<0.05	0.04	<0.05			

Rockwater (2018) undertook an assessment of local surface hydrology resources. The complete report is attached in **Appendix I**. Salient extracts from the report are provided below.

The Abra project is elevated well above the surrounding major drainage lines. However, the project's planned infrastructure intersects or lies close to two minor creeks.

There are two major catchments with the potential for peak flows to impact the project area and underground mine, and three smaller catchments that could impact the project's surface infrastructure. The characteristics of the catchments which could impact the Abra project are listed in **Table 35**.

Table 35: Catchment Characteristics

Type	Catchment	Area (km^2)	Length (km)
Major	A	40.5	7.6
	B	5.5	4.0
Minor	C	0.12	0.7
	D	0.74	1.5
	E	1.17	2.1

Figure 19 and **Figure 20** reproduce Figure 1 and Figure 3 respectively from the Rockwater (2018) report.

Flows in major catchments were analysed to assess whether the 1 in 100 year ARI peak flows and Probable Maximum Flood (PMF) could reach the project area and underground mines. Hydraulic analyses were conducted at four cross-sections to assess whether the peak flows would reach the project's boundaries. The analysis showed no impact to mine infrastructure.

Flows in the minor catchments which could impact the infrastructure area were also analysed to assess the impact of the 1 in 100 year ARI peak flows and Probable Maximum Flood (PMF) on the surface infrastructure to determine the protective measures required. The planned infrastructure intersects or is very close to two small natural drainage lines that could impact the project during high rainfall events. Hydraulic analyses were conducted at three critical locations to assess the impact of the peak flows. The peak flows from these catchments could result in scouring and damage to infrastructure. The report recommends slightly change to the footprint of the tailings storage facility (TSF) and to construct diversion channels and drainage structures to either eliminate the interaction or reduce the extent of the peak floods.

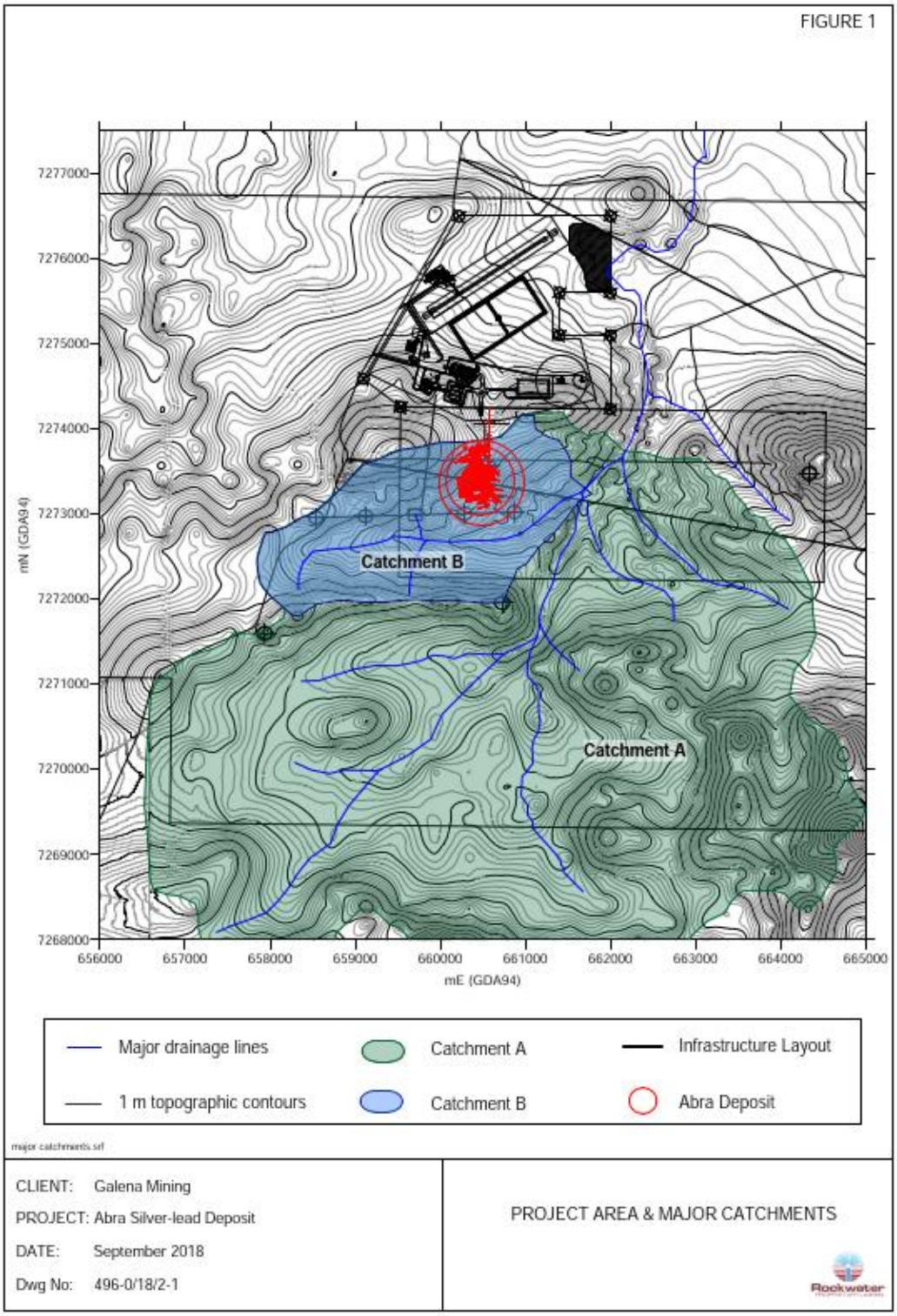

Figure 19: Major catchments

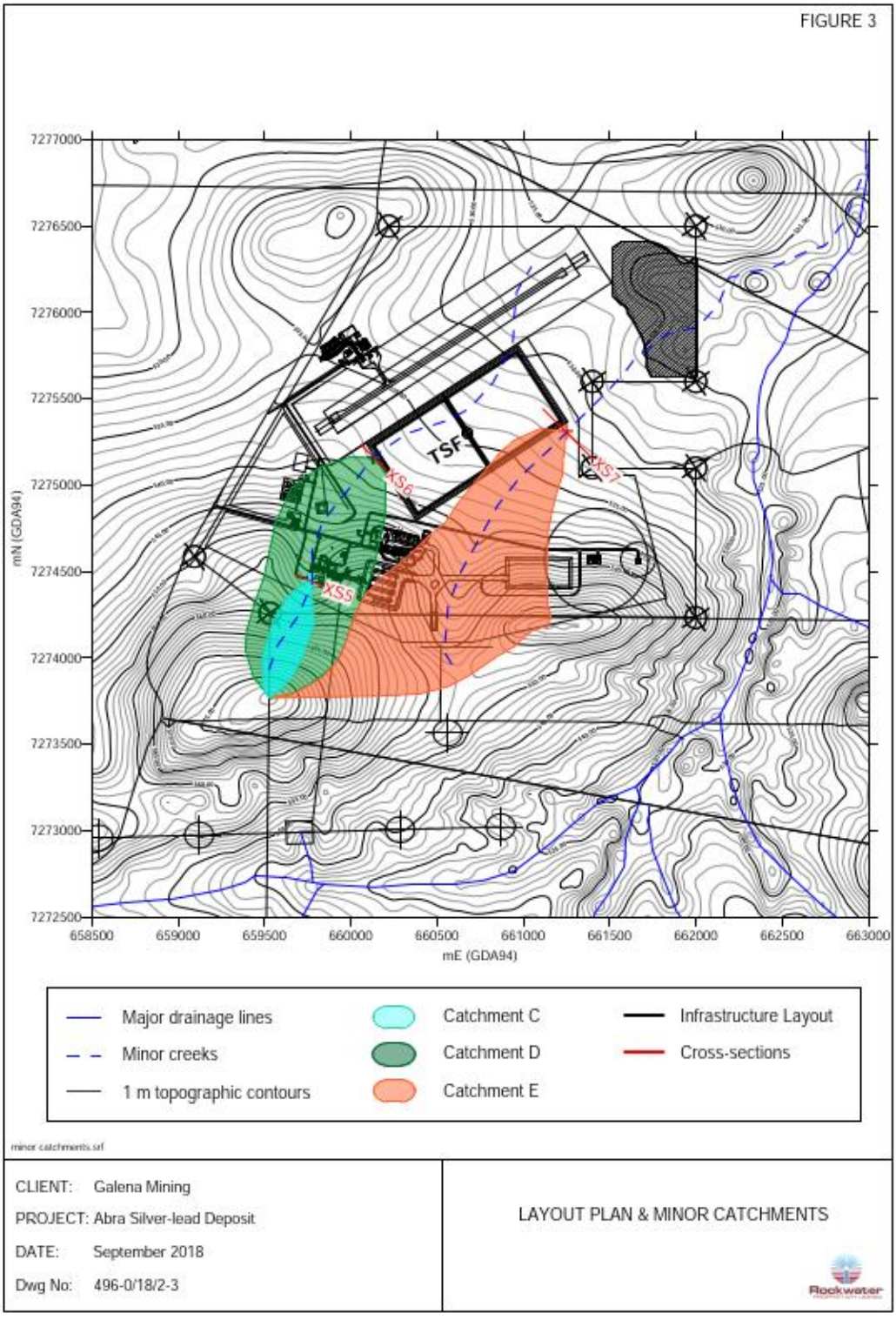

Figure 20: Minor catchments

5.4.1 Analysis and Interpretation of water resources data

The following analysis and interpretation of the above information is provided:

i. Only two regional bores, wells and springs are recorded in the DWER Water Information Reporting (WIR) database within 15km of the Abra project - Bedford bore and Chalk Spring in the Ethel River. Rockwater conclude there is no possibility that pumping from bores at Abra would have any impact on these features. This indicates a negligible risk to water resources beyond the project boundary
ii. Groundwater quality is regarded as fresh, with salinities in a range around 500 mg/L Total Dissolved Solids (TDS). This information, in combination to the relatively good quality of TSF slurry water (Section 5.3.4) indicates a low risk of significant contamination and deterioration of local or regional groundwater quality from project infrastructure.
iii. Only minor surface catchments occur through the mine infrastructure area. The TSF has been located to reduce interaction with natural drainage lines and diversions drains included in the design to direct surface water around the facility. In addition, process plant design includes diversion drains where required that direct all surface water flow to the raw water dam. This eliminates or reduces the risk of contaminated surface water exiting the project area.

5.5 Biodiversity and Ecosystem

Stantec (2018) undertook a Detailed flora and vegetation survey and a Level 1 terrestrial fauna survey over a study area of approximately 1,357 hectares (ha) in size that encompasses all the tenements of the Abra project. The complete report is provided in **Appendix B**. A summary of key points from the report is provided below.

Flora

- There were 101 vascular flora species recorded, representing 25 families and 58 genera.
- No Threatened flora from either the State or Commonwealth databases was recorded in the survey.
- One Commonwealth listed threatened species *Pityrodia augustensis*, was identified in the Protected Matters Search Tool, which listed the species or species habitat as 'likely to occur within the area'. The species was not detected in the site survey and a review of the recorded specimens of this taxa held by the WA Herbarium indicate that the closest record of this species is approximately150 km west of the study area.
- No State listed Priority species were recorded during the survey.
- Review of the Priority species *Acacia tuberculata, Eremophila appressa, Eremophila coacta, Owenia acidula, Ptilotus actinocladus* T.Hammer & R.W.Davis *and Thysanotus* sp. Desert East of Newman (R.P. Hart 964) indicated that all of the above taxa records within the last 20 years do not occur in close proximity to the study area. The closest of these occurs greater than 90km from the study area, with some occurring over 200km from the study area. Further, none of these species have been recorded during previous surveys within the vicinity of the study area.
- One species, *Centipeda minima* subsp*. macrocephala*, recorded from one quadrat is considered to be a range extension. This species is recorded further to the west in the Augustus subregion and right through the Carnarvon, Central Kimberley, Dampierland, Great Sandy Desert, Little Sandy Desert, Northern Kimberley and the Ord Victoria Plain IBRA regions.
- Weed diversity is considered to be low, with only two introduced species recorded. **Bidens bipinna* and **Malvastrum amercanum*, were recorded in low densities growing in association with 5 Mile Creek and other smaller incised drainage lines. Neither of these species represents a declared pest or Weed of National Significance.

Vegetation

- No Threatened Ecological Community (TEC) or Priority Ecological Community (PEC) from either the State or Commonwealth databases was recorded in the study area. The nearest State listed PEC (Diorite Land System P3)) is located approximately 12 km south west.

- Eight vegetation types, including one mosaic vegetation type, were described and mapped.
- Vegetation condition ranged from 'Degraded' to 'Excellent' with the majority of the study area mapped as either 'Very Good' or 'Excellent'. Vegetation considered to be in 'Degraded' condition had been cleared for exploration drilling or historical access tracks.

Terrestrial Fauna

- A total of 27 species of vertebrate fauna were recorded during the field survey, none of which were of conservation significance.
- Only one fauna species of conservation significance was considered to possibly occur based on habitat suitability, species range and previous records; the Peregrine Falcon (S7).
- Five fauna habitats were identified:
    1) Banded mulga on plain;
    2) Riparian;
    3) Open shrubland on stony plain,
    4) Drainage; and
    5) Gully.

    Of these habitats, Riparian habitat was considered locally significant owing to the potential foraging suitability for the Peregrine Falcon (S7).

Stantec (2018a) also undertook subterranean surveys for both stygofauna and troglofauna species. The complete report is also provided in **Appendix B**. A summary of key points from the report is provided below.

Stygofauna

- No stygofauna were recorded from within the deposit area.
- A total of 18 stygofauna specimens, representing four species from three higher level taxonomic groups, Amphipoda, Bathynellacea, and Oligochaeta, were recorded from six of the 40 sites sampled.
- Only one species, the oligochaete *Phreodrilus* OES25, was collected from within the potential groundwater dewatering drawdown impact zone, approximately 760 m north of the deposit area. *Phreodrilus* OES25 was also recorded on multiple occasions from outside the potential groundwater drawdown impact zone, collected from three non-impact sites, up to 3.6 km from the deposit area.

Troglofauna

- No troglofauna species were recorded from 25 sites located in and around the study area.

The report concluded that for both subterranean fauna groups, the deposit area was found not to host any subterranean habitat values. The subterranean habitat in the deposit area was found to not be prospective for subterranean fauna as the overlying regolith was clay dominated and deep, extending to below the standing water level and considered to be an aquitard, offering limited interstitial pore space and hydrological exchange (for stygofauna) and limited interstitial pore space (for troglofauna). This geologically non-prospective habitat was verified by two rounds of sampling that failed to record any subterranean species within the orebody.

Stantec (2019) undertook a flora, vegetation and fauna survey of the aerodrome tenement (L52/198) in October 2018. The complete report is provided in **Appendix B**. A summary of key points from the report is provided below.

- A total of 55 flora taxa (including subspecies, varieties and forms) were recorded from the Study Area, representing 19 families and 26 genera

- No State or Commonwealth listed Threated flora or DBCA listed Priority flora were recorded within the Study Area.
- The native vascular flora taxa recorded from the Study Area are all represented in the local and regional area and no unique taxa were recorded.
- No introduced flora taxa were recorded from the Study Area.
- The most extensive vegetation type was a mosaic of two vegetation types also recorded in the Abra Project Area and occupied just under 50% of the Study Area.
- With the exception of a previously cleared access track vegetation condition of the Study Area was assessed as 'excellent'
- Three broad fauna habitats were identified within the Study Area; open shrubland on sandy plain, open shrubland on stony plain and drainage. All were considered widespread and of limited significance for potential conservation significant vertebrate fauna.
- No species of conservation significance were recorded during the current survey.
- One species of conservation significance was considered 'possible' to occur based on species range and previous records; the Peregrine Falcon (S7). The Study Area does not contain suitable nesting habitat for the species, however it may forage over the Study Area from time to time without being dependent on any particular habitat.

5.5.1 Analysis and Interpretation of ecological data

The following analysis and interpretation of the above information is provided:

i. With the absence of significant flora and vegetation values (DRF, Priority flora, TEC, PEC) there is no risk of over clearing having a significant impact on these factors.

ii. No troglofauna were recorded in the project area. There is no risk to this environmental factor.

iii. No stygofauna were recorded in the deposit area (the potential area of maximum water drawdown). Stygofauna species that were identified in the wider project area were also recorded beyond the project area. There is low risk of the project impacting the regional distribution of stygofauna species.

5.6 Other Factors

Terra Rosa Consulting (2018) conducted an archaeological and ethnographic site avoidance survey if the project area in July 2018. The heritage survey was conducted to a site avoidance standard. The objective of site avoidance heritage surveys is to identify, and record brief details of Aboriginal sites as defined under s5 of the Act, to negotiate deviations around such places where possible, and to provide AMPL with heritage management considerations for heritage values that would otherwise be impacted by the proposed development. As such, a site avoidance method is designed to document Aboriginal heritage values to a standard sufficient to provide a preliminary understanding of a site's characteristics, and to allow the proponent to proceed with works that will not impact those places. **Figure 21** shows the results of the survey.

Terra Rosa Consulting (2018) conducted an archaeological and ethnographic site avoidance survey if the project area in October 2018. The heritage survey was conducted to a work area clearance standard. The objective of a work area clearance assessment is to establish the existence of any archaeological and ethnographic values within the project area, to establish avoidance boundaries around sites likely to be

impacted by the proposed works, and to address any heritage concerns arising from discussions with the Traditional Owners present. The surveyed area has been assessed as heritage clear by the Nharnuwangga Wajarri and Ngarlawangga Traditional Owner representatives for the airstrip works to proceed. **Figure 22** shows the results of the survey

5.6.1 Analysis and Interpretation of Aboriginal heritage data

The following analysis and interpretation of the above information is provided:

i. Project components have been located to avoid the known heritage site within G52/292. There is a low risk of impact to this factor.

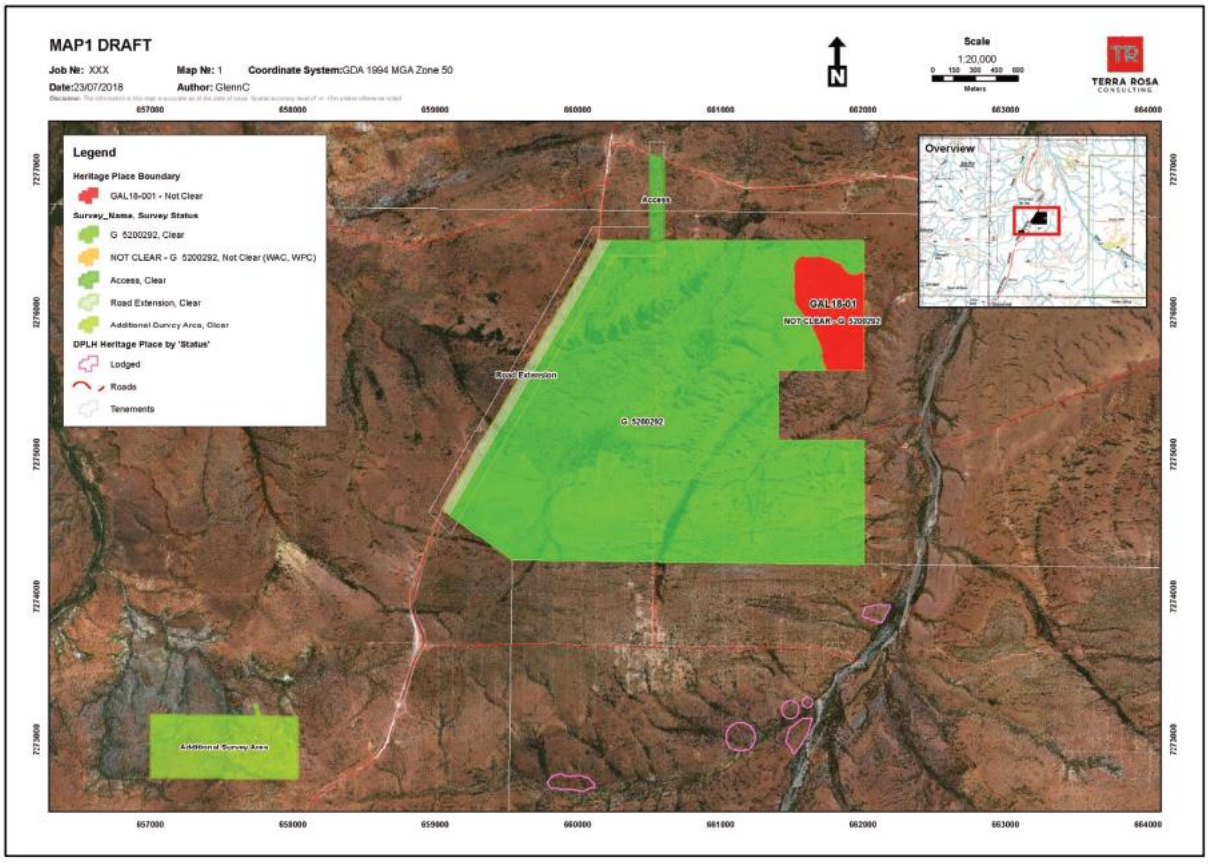

Figure 21: Heritage survey findings

Source Terra Rosa (2018)

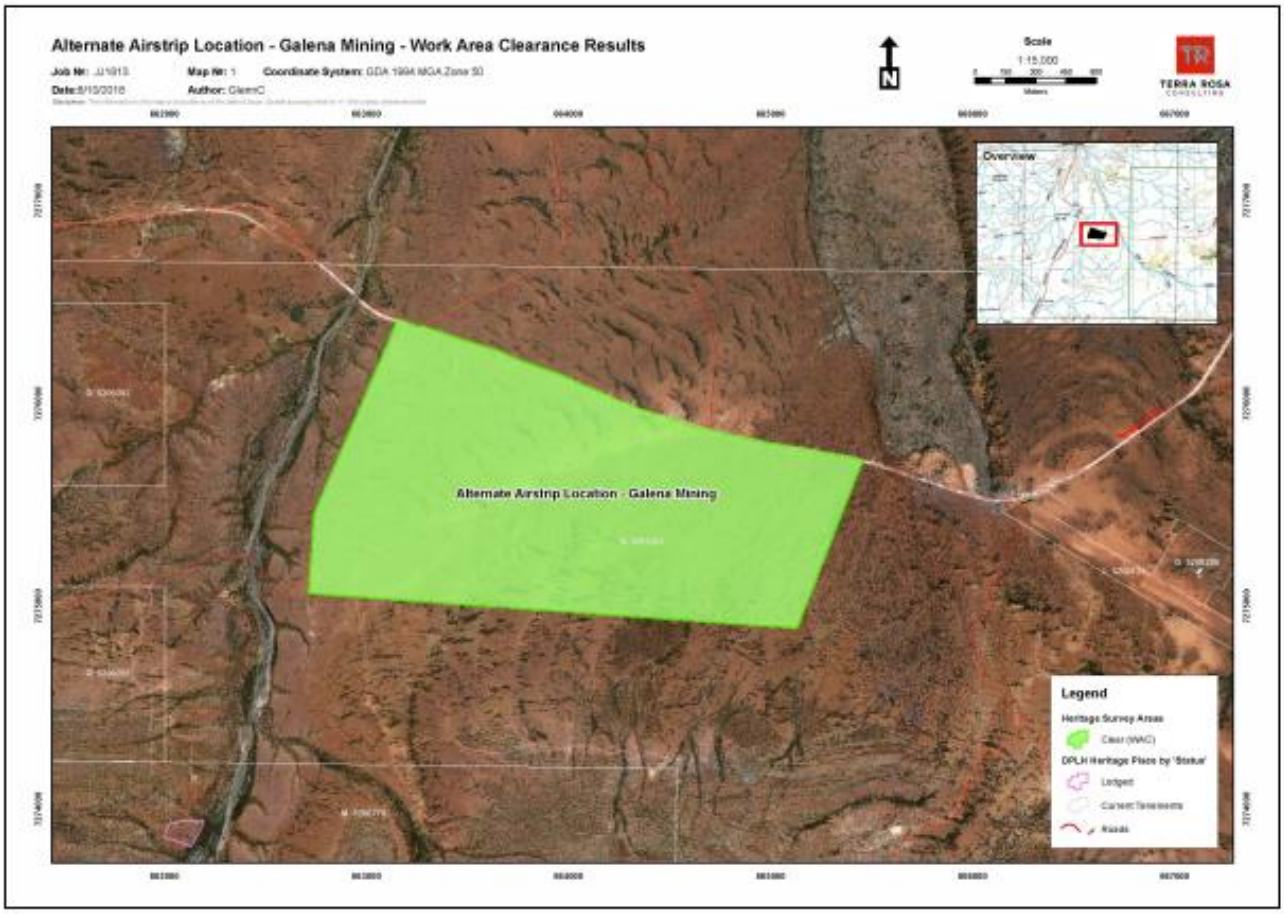

Figure 22: Heritage Survey Findings

Source Terra Rosa (2018b)

5.7 Environmental Threats Summary

From the baseline information collated in this section, AMPL consider the key environmental threats associated with the project are:

- Metals elevation in surface soils. During the life of mine, specific locations (eg; ROM & process plant) are likely to develop elevated metals concentrations (including lead) in surface soils due to placement of ore, dust fallout and minor spills and leaks over time.
- Groundwater quantity. Localised groundwater mounding associated with seepage from the TSF. The regional groundwater flow is generally north west, however, local hydraulic pressure from the TSF may produce groundwater level rise at the creekline immediately east of the project. Groundwater quality is **not** expected to be an environmental threat. Existing groundwater quality at the site is regarded as fresh, with values in the order of 500 mg/L TDS. Baseline studies on tailings material (Section **5.3.4**) indicate they are non acid forming and have very low solubility of contained metals. Tailings slurry water has an approximate TDS of 300mg/L which is comparable with the existing groundwater level. Laboratory analysis of tailings slurry water also show results of specific metals are within ANZECC stock drinking water guideline values. As any TSF seepage water will also be diluted with natural groundwater between the source (the TSF) and the closest sensitive receptor (the creekline approximately 1.2 km to the east), the concentration of specific metals and the overall TDS content is expected to be significantly lower at the receptor location than the laboratory analysis values.

6. Risk Assessment

The Australian and New Zealand Standard on Risk Management (AS/NZS 4360) defines risk as the product of the likelihood (**Table 37**)of an event occurring and the consequence (**Table 38**) of that event. AMPL has developed a risk matrix (**Table 39**) and risk ranking (**Table 40**) to assess the risk of activities undertaken in its operation.

To maximise the benefit of environmental management, it is important that manpower and other resources are allocated to issues on a priority basis. It is normally accepted that the highest risk issues receive the highest priority. Environmental management of impacts associated with this proposal is based on the following risk management process:

- Identify activities that could result in environmental impacts to key factors.
- Quantify the level of inherent risk (without control measures applied) from the activity.
- Formulate and implement control measures to reduce the inherent risk to an acceptable level (residual risk).
- Monitor the effectiveness of control measures.

A key outcome of the risk based model is to rank impacts, so specific management measures can be developed for high risk impacts, to reduce residual risk to as low as reasonably practicable (ALARP). AMPL adopts the following mitigation sequence for managing risks:

1. Avoid - avoid or eliminate the impact where possible.
2. Reduce - limit the severity of the impact.
3. Control - design or control procedure solutions to lower the risk.
4. Rectify - rehabilitate affected site as soon as possible.

As different activities differ in scale and nature of impact, control measures are tailored to ensure they are relevant and effectively mitigate the risk. Detailed management plans may be required for high risk aspects while procedures, forms and checklists are considered sufficient to adequately manage moderate or low risk aspects.

Table 36 reproduces environmental objectives listed in the mining proposal guidelines for key factors relevant to mining proposals. These environmental objectives also consider, and broadly cover, the clearing principles set out in the *Environmental Protection Act 1986* Schedule 5.

Table 36: DMP Objectives

Factor	Objective
Biodiversity/Flora/Fauna/ Ecosystem	To maintain representation, diversity, viability and ecological function at the species, population and community level.
Water resources	To maintain the hydrological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including ecosystem maintenance, are protected.
Landforms	Mining will not result in appreciable land degradation or the contamination or pollution of the land.
Mine closure	Mines are closed in a manner to make them (physically) safe to humans and animals, (geo-technically) stable, (geo-chemically) non-polluting/ non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State.

The mining proposal guidelines state that the environmental risk assessment should be used to determine which factors need to have site-specific environmental outcomes set (Section **7**). Outcomes only need to be set for aspects that present as moderate or high risk pre-treatment (inherent risks). The complete risk assessment is provided in **Table 41. Table 42** provides a summary of the inherent moderate and high risk aspects that have specific outcomes set in **Table 44**.

AMPL considers the overall level of risk is consistent with the nature and scale of the project and is informed by the results of the baseline environmental data as follows:

1. Located in an isolated area of the State with the nearest residential premise (sensitive receptor) approximately 40 kilometres from the mine and the nearest regional town 180 kilometres from the mine.
2. Relatively small scale of overall disturbance. Approximately 130 hectares in a region mostly uncleared.
3. No populations of flora or fauna unique to the project area, eliminating the risk of catastrophic or major consequences to specific significant environmental factors.
4. Vegetation communities impacted by the project are widely represented in the region.
5. Located in an arid environment (less than 300 millimetres of rainfall per year), with no permanent surface water bodies in the vicinity. This results in reduced risk of surface water contamination and no risk to wetlands.
6. No other use of shallow groundwater resources adjacent (within 10 kilometres) to the project site.
7. No other use of deep groundwater resources (300 – 500mbgl [depth of the orebody]).
8. Mining operations are restricted to underground mining. No large open pit void, large mine waste landform or residual pit void lake will be produced.
9. A significant level of mine waste re-use. Approximately one third of the total tailings produced during the life of mine will be processed in a paste plant and returned underground to backfill completed stopes. Waste rock from the boxcut and UG development will be assessed for its suitability for use as TSF embankment and capping material. This may reduce or possibly eliminate the WRD at closure.

The above points indicate most potential impacts have only a localised affect, confined to the mine boundary. In most cases these can be readily controlled or remediated.

The Registered Mine Manager has ultimate statutory responsibility for activities undertaken on the mine. Departmental Managers are responsible for their respective areas' compliance with regulatory requirements and internal company standards. AMPL environmental staff will actively assist Departmental Managers in fulfilling these responsibilities. Key site responsibilities are outlined in the EMS.

AMPL has developed an Environmental Management System (EMS) for the Abra project. The EMS includes procedures and forms to mitigate risks to as low as reasonably practicable. AMPL will implement the following commitment –

Commitment 3: to implement the EMS

Table 37: Risk likelihood

Determine the likelihood of the event occurring using the table below.

Likelihood Rating	Probability (%)	Description
Certain	>75	Is expected to occur in most circumstances - Evidence of common or repeated occurrence. Occurs more than once a year.
Likely	40-75	Will occur in most circumstances. Historical evidence of occurrence – 'It has happened'. Occurs at least once in a year
Possible	5-40	Might occur at some time. Anecdotal evidence of an occurrence – 'Remember it happening before'. May occur every 1-2 years
Unlikely	1-5	Could occur at some time, although no evidence of an occurrence – 'Heard of it happening'. May occur once in 10 years.
Rare	<1	May occur only in exceptional circumstances. Practically impossible. May occur in 25 years

Table 38: Risk consequence

Identify the credible consequence for each unwanted event using the table below.

Consequence Rating	Insignificant	Minor	Moderate	High	Extreme
Biodiversity /Ecosystem (General)	Minor localised impact. Limited damage with no long term effects.	On site impact to area of low significance – immediately contained.	Off site impact to area of high significance with longer term detrimental effects.	Off site impact with longer term detrimental effects.	Serious, long-term environmental damage – widespread effects
Flora or Fauna (Specific)	Very small number of individuals (1%) in local population of species may be affected	Small number (<10%) of individuals in the local population of species may be affected	A significant species is affected. Reversible, short term impact to <50% of individuals in the local population.	Major loss to significant species at the local level. Disturbance with long term impact to >50% of individuals at the local level.	Loss of species at a local or regional level
Water resources	Low impact to isolated area without affecting any other use of the water.	On site low impact with negligible effect on other use of the water.	Off site impact that will materially affect the immediate use of the water, but able to be rectified in the short-term.	Extensive hazardous impact requiring long-term rectification.	Extensive hazardous impact with residual effect
Landforms	Negligible impact to an isolated area.	On site low impact, not impacting on any significant environmental value.	Off site impact, able to be rectified in short-term without causing residual pollution or contamination.	Extensive hazardous impact requiring long-term rectification.	Extensive hazardous impact with residual effect
Mine closure	Site is safe, stable a non-polluting and post mining land use is not adversely affected.	The site is safe. Major landforms have stability or pollution issues that are contained and require no residual management. Post-mining land use is not adversely affected.	The site is safe. Any stability or pollution issues require minor, ongoing maintenance by end land-user	The site cannot be considered safe, stable or non-polluting without long-term management or intervention. Agreed end land-use cannot proceed without ongoing management.	The site is unsafe, unstable and/or causing pollution or contamination that will cause an ongoing residual affect. The post-mining land use cannot be achieved.

Table 39: Risk matrix

Risk priority - the lower the number, the higher the risk priority. eg; 9-H has a higher priority that 13-H

	Consequence				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**High**	**Extreme**
Certain	18	13	4	2	1
Likely	19	16	10	5	3
Possible	22	17	12	8	6
Unlikely	23	21	15	11	7
Rare	25	24	20	14	9

Table 40:Risk ranking

Extreme	Unacceptable. Major modification of proposed action required. Department manager accountability
High	Modification and / or mitigation of proposed action required. Supervisor accountability
Moderate	Some mitigation required. Documented processes in the EMS. Team leader accountability
Low	Minor mitigation required. Managed by routing procedures in the EMS. Operator accountability

Table 41: Risk Assessment

No.	Factor	Risk Pathway	Potential impacts (What)	Cause (How)	L	C	Inherent Risk	P	Control Measures (mitigation)	L	C	Residual risk	P
Construction phase													
1	Aboriginal heritage,	Over clearing and/or vehicle movement in unauthorised area	Interference to Aboriginal heritage sites	Vehicle/machine disturbance.	L	Min	Mod	16	Undertake heritage survey. Mark sites on constraints map. Implement clearing procedure. Induction.	U	Min	Low	21
2	Biodiversity, flora, fauna	Over clearing for mine activities	Vegetation loss / Loss of fauna habitat	Clearing	L	Min	Mod	16	Implement clearing procedure	U	Min	Low	21
3	Biodiversity, flora, fauna	Surface water flow diversion by roads	Drainage shadow causing vegetation loss in areas where vegetation is reliant on sheet flow	Alter natural drainage lines and divert surface water flow.	P	Mod	High	12	Install culverts under road to maintain natural flow path	U	Mod	Mod	15
4	Flora, fauna	Dust generation from site activities	Dust smothering adjacent native vegetation	Dust from dry roads	L	Min	Mod	16	Dust suppression (water carts) used to control dust emissions	U	Min	Low	21
5	Landforms, water resources	Hydrocarbon contamination in soil and water	Localised contamination of soil and surface water.	Refuelling / transferring spills. Machinery breakdown-burst hoses Pipeline joint leaks.	L	Min	Mod	16	Inspection, maintenance of equipment. Implement spill clean-up procedure Supply of bioremediation agent on site Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	U	Min	Low	21
6	Soil, surface water	Vehicle accident causing localised soil and water contamination	Spillage of hydrocarbons (diesel / oil)	Ruptured fuel tank / lines Overturned truck	U	Mod	Mod	15	Induction Speed limits on site Emergency response procedure	R	Mod	Low	20
7	Surface water	Storm water contaminated with sediment running off site.	Sedimentation of surface water channels.	Ineffective containment of materials Inefficient drainage structures	L	Mod	High	10	Designed drainage system to capture runoff from process plant	P	Min	Mod	17

No.	Factor	Risk Pathway	Potential impacts (What)	Cause (How)	L	C	Inherent Risk	P	Control Measures (mitigation)	L	C	Residual risk	P
Operation phase													
General – whole of site													
8	Biodiversity, flora, fauna	Over clearing for mine activities	Vegetation loss / Loss of fauna habitat	Clearing	L	Min	Mod	16	Implement clearing procedure	U	Min	Low	21
9	Biodiversity, flora, fauna	Fires from exhausts and hot work activities.	Bush fires	Hot work activities Hot exhausts of equipment and vehicles setting dry bush alight.	P	Min	Mod	17	Hot work permit Vehicle maintenance & inspections Emergency response	U	Min	Low	21
10	Soil, surface water	Hydrocarbon contamination in soil and water	Spillage of hydrocarbons (diesel / oil)	Refuelling / transferring spills. Machinery breakdown-burst hoses Pipeline joint leaks.	L	Min	Mod	16	Inspection, maintenance of equipment. Implement spill clean-up procedure Supply of bioremediation agent on site Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	U	Min	Low	21
Underground Mining													
11	Subterranean fauna	Lowering groundwater table	Loss of subterranean fauna	Change in groundwater levels and quality impacting subterranean fauna habitat	Un	Min	Low	21	Baseline surveys confirm the low significance of this factor. Monitor groundwater levels. Surveys show species exist beyond the project footprint	Un	I	Low	23
12	Groundwater	Dewatering and UG mining	Groundwater quantity (level) and quality changes.	Mine dewatering and change in metals, pH, TDS, etc. in groundwater from UG mining activities	C	Min	High	13	Monitor GWL and quality in shallow aquifers (<100m) to confirm parameters are within set values for sequential use.	P	Min	Mod	17
Processing – crushing, ROM stockpiles, conveyor transfer points													
13	Landform (dust), flora	Dust from crushing and stockpiles	Dust to and adjacent vegetation. Dust impacts from physical (particle size) and chemical (metals) aspects	Exposed areas, dry ROM stockpiles, transfer between conveyor belts, crusher dust	C	Min	High	13	Water sprays on active works areas. Dust extraction on conveyor systems and transfer points. Inspection and maintenance of dust extraction equipment	P	Min	Mod	17
14	Landform, water resources	Drainage off ROM entering surrounding environment	sediment impacting surrounding areas	Incorrect drainage systems causing discharge to the environment	L	Min	Mod	16	Drainage system and detention basins installed	U	I	Low	21
15	Landform, water resources	Contamination from spills of process liquor	Metals, acidity, sediment impacting surrounding areas	Incorrect drainage systems causing discharge to the environment	P	Mod	Mod	17	Drainage system and detention basins. Bunds around tanks in process area.	U	Min	Low	21
Waste Rock Dump (WRD)													
16	Landform, biodiversity, water resources	Contaminated water off WRD flowing into surrounding vegetation	Sediment in surrounding vegetation, soil and surface water systems. Visual impact	Runoff from WRD entering surrounding environment	U	Mod	Mod	16	Baseline materials characterisation studies quantify the risk of PAF material in mine waste. Install toe bund to contain water off WRD.	U	Min	Low	21
17	Visual amenity	Visual impact of WRD on the surrounding landscape.	Aesthetics	Inappropriate sighting and design of WRD	P	I	Low	22	Isolated project location, no close sensitive receptors. Revegetate WRD.	U	I	Low	23

No.	Factor	Risk Pathway	Potential impacts (What)	Cause (How)	L	C	Inherent Risk	P	Control Measures (mitigation)	L	C	Residual risk	P
Tailings Storage Facility													
18	Landform, biodiversity	Dry tailings blowing off the TSF	Contamination of surrounding land and vegetation	Dust from dry tailings containing metals, acidity etc deposited on area surrounding the TSF	C	Mod	Extreme	4	Cover tailings and revegetate at mine closure	U	Min	Low	21
19	Water resources	Rising groundwater level around the TSF	Inundation of surrounding vegetation and fauna from surface expression	Seepage from TSF causing a localised groundwater mound and rising water table.	L	Mod	High	10	Install toe drains and interception bores during mine life and after closure to reduce GWL to agreed level.	U	Min	Low	21
20	Water resources	Contamination of groundwater	Quality (metals, TDS, pH) impacting groundwater for sequential beneficial uses.	Seepage from TSF (metals, pH, TDS)	P	Mod	High	12	Baseline information indicates low risk of AMD. Tailings water within stock drinking water guidelines. Water monitoring around TSF	U	Min	Low	21
21	Fauna (livestock)	Drowning / entrapment in TSF	Death or injury to stock	Access to TSF surface	L	Min	Mod	16	Fence TSF to exclude stock	U	I	Low	23
Powerhouse													
22	Landform, water resources	Hydrocarbon spillage during fuel transfer	Contamination of soil and surface water	Leaking valve, hoses, pipelines. Spillage	L	Min	Mod	16	Concrete apron and sump on loading area to contain spills Fuel suppliers have trained operators and procedures.	U	Min	Low	21
23	Landform, water resources	Hydrocarbon leakage from storage areas, pipelines	Contamination of soil and surface water.	Leaking pipelines, flanges, valves.	P	Mod	High	12	Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	U	Min	Low	21
Workshop Facilities													
24	Landform, water resources	Hydrocarbon contamination from fuel, oil storage and work areas	Contamination of soil and surface water	Ruptured or damaged containers Spills and leaks	P	Min	Mod	17	Self bunded (double lined) storage tanks or bunded areas compliant with AS 1940:2004 Floor drainage in the workshop and other bunded areas are drained to a pit which is transferred by pump to an oil separator.	U	Min	Low	21
25	Landform, water resources	Contamination from wash down bay	Contamination of soil and surface water	Overflow of system	P	Min	Mod	17	Inspection and maintenance of system	U	Min	Low	21
Explosive Facilities													
26	Landform, water resources	Spillage of ANFO in magazine area	Contamination of soil and surface water.	Transferring product to magazine and from magazine to truck.	P	Min	Mod	17	Appropriate SDS information. prompt clean-up of spills.	U	Min	Low	21
Waste Management													
27	Landform	Litter blowing from the site into surrounding area	Windblown litter Odour Attract fauna	Inappropriate sighting and operation of landfill site. Disposal of inappropriate waste into landfill site. Not covering waste disposed to landfill	L	Min	Mod	16	Fencing around landfill site Monitoring of landfill capacity Covering of waste disposed to landfill site Pickup windblown litter	P	I	Low	22
28	Landform	Toxic fumes and soil contamination from burning tyres	Hazard in fire situation	Inappropriate disposal process for tyres	U	Mod	Mod	15	Regularly bury tyres Fire management plan to minimise the impact of a fire	R	Min	Low	24

No.	Factor	Risk Pathway	Potential impacts (What)	Cause (How)	L	C	Inherent Risk	P	Control Measures (mitigation)	L	C	Residual risk	P
29	Landform	Contaminated soil placed in inappropriate area.	Contamination of soil and surface water.	Disposal in inappropriate area.	L	Mod	High	10	Small areas of soil contamination to be remediated in situ Large volumes of contaminated soil to be removed to a dedicated bioremediation facility (if required)	U	Min	Low	21
Waste Water Treatment Plant													
30	Flora, fauna	Excess water from WWTP irrigation field	weed growth	High water and nutrient levels	P	Min	Mod	17	Implement site inspection checklist and weed procedure, if required.	U	I	Low	23
Rehabilitation													
31	Landform, biodiversity	Ineffectual rehabilitation reducing stability and ecological function of disturbed areas	Poor revegetation success Slow growth rates	Lack of rain Poor timing of rehabilitation Cyclone Use of inappropriate species.	P	Min	Mod	17	Research into appropriate species and times of the year for optimum rehabilitation results Comparison of baseline studies and similar mine site locations in the area on vegetation that has resulted in successful rehabilitation	U	Min	Low	21
32	Landform, biodiversity	Erosion on final landforms reducing stability and ecological function of disturbed areas	Sediment in surface water. Inability to stabilise landform	Lack of stormwater control systems. Lack of vegetation on slopes	P	Min	Mod	17	Interim (during construction) and final stormwater design on the waste landform Implement appropriate stormwater control design Monitoring of erosion and stability of landforms Appropriate vegetation on slope of landforms to minimise excess erosion	U	Min	Low	21
33	Landform, biodiversity	Grazing of rehabilitation by animals reducing stability and ecological function of disturbed areas	Native and feral animals grazing young rehabilitation and trampling slopes,	Inability of plants to establish. erosion on slopes	P	Min	Mod	17	Monitor extent of grazing on waste landforms Fence landforms to prevent degradation of vegetation from grazing, if required.	U	Min	Low	21

Table 42: Risk Assessment Summary

No.	Risk Pathway	Inherent Risk	Control Measures	Residual Risk	Control Documents
18	Dry tailings blowing off the TSF	Extreme	Cover tailings and revegetate at mine closure	Low	MCP - Implementation
3	Surface water flow diversion by roads	High	Install culverts under road to maintain natural flow path	Mod	Vegetation management procedure
7	Storm water contaminated with sediment running off site.	High	Designed drainage system to capture runoff from process plant	Mod	Monthly inspection of mine area Monthly inspection of contractors area
12	Dewatering and UG mining	High	Monitor GWL and quality in shallow aquifers (<100m) to confirm parameters are within set values for sequential use.	Mod	MCP - Monitoring
13	Dust from crushing and stockpiles	High	Water sprays on active works areas. Dust extraction on conveyor systems and transfer points. Inspection and maintenance of dust extraction equipment	Mod	Monthly inspection of mine area Monthly inspection of contractors area
19	Rising groundwater level around the TSF	High	Install toe drains and interception bores during mine life and after closure to reduce GWL to agreed level	Low	Water monitoring procedure
20	Contamination of groundwater	High	Baseline information indicates low risk of AMD. Tailings water within stock drinking water guidelines. Water monitoring around TSF	Low	Water monitoring procedure
23	Hydrocarbon leakage from storage areas, pipelines	High	Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	Low	Hydrocarbon and chemical procedure
29	Contaminated soil placed in inappropriate area.	High	Small areas of soil contamination to be remediated in situ Large volumes of contaminated soil to be removed to a dedicated bioremediation facility (if required)	Low	Hydrocarbon and chemical procedure
1	Over clearing and/or vehicle movement in unauthorised area	Mod	Undertake heritage survey. Mark sites on constraints map. Implement clearing procedure. Induction.	Low	Aboriginal heritage procedure Constraints map
2	Over clearing for mine activities	Mod	Implement clearing procedure	Low	Vegetation management procedure
4	Dust generation from site activities	Mod	Dust suppression (water carts) used to control dust emissions	Low	Monthly inspection of mine area Monthly inspection of contractors area

No.	Risk Pathway	Inherent Risk	Control Measures	Residual Risk	Control Documents
5	Hydrocarbon contamination in soil and water	Mod	Inspection, maintenance of equipment. Implement spill clean-up procedure Supply of bioremediation agent on site Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	Low	Monthly inspection of mine area Monthly inspection of contractors area Hydrocarbon and chemical procedure
6	Vehicle accident causing localised soil and water contamination	Mod	Induction Speed limits on site Emergency response procedure	Low	Induction. Accident/Incident Form
8	Over clearing for mine activities	Mod	Implement clearing procedure	Low	Vegetation management procedure
9	Fires from exhausts and hot work activities.	Mod	Hot work permit Vehicle maintenance & inspections Emergency response	Low	Hot work permit.
10	Hydrocarbon contamination in soil and water	Mod	Inspection, maintenance of equipment. Implement spill clean-up procedure Supply of bioremediation agent on site Bunding of bulk hydrocarbon storage areas compliant with AS 1940:2004.	Low	Hydrocarbon and chemical procedure
14	Drainage off ROM entering surrounding environment	Mod	Drainage system and detention basins installed	Low	Monthly inspection of mine area Monthly inspection of contractors area
15	Contamination from spills of process liquor	Mod	Drainage system and detention basins. Bunds around tanks in process area.	Low	Monthly inspection of mine area Monthly inspection of contractors area
16	Contaminated water off WRD flowing into surrounding vegetation	Mod	Baseline materials characterisation studies quantify the risk of PAF material in mine waste. Install toe bund to contain water off WRD.	Low	MCP - Implementation
21	Drowning / entrapment in TSF	Mod	Fence TSF to exclude stock	Low	Monthly inspection of mine area Accident/Incident Form
22	Hydrocarbon spillage during fuel transfer	Mod	Concrete apron and sump on loading area to contain spills Fuel suppliers have trained operators and procedures.	Low	Hydrocarbon and chemical procedure

No.	Risk Pathway	Inherent Risk	Control Measures	Residual Risk	Control Documents
24	Hydrocarbon contamination from fuel, oil storage and work areas	Mod	Self bunded (double lined) storage tanks or bunded areas compliant with AS 1940:2004 Floor drainage in the workshop and other bunded areas are drained to a pit which is transferred by pump to an oil separator.	Low	Monthly inspection of mine area Monthly inspection of contractors area Hydrocarbon and chemical procedure
25	Contamination from wash down bay	Mod	Inspection and maintenance of system	Low	Monthly inspection of mine area Monthly inspection of contractors area
26	Spillage of ANFO in magazine area	Mod	Appropriate SDS information. prompt clean-up of spills.	Low	Hydrocarbon and chemical procedure
27	Litter blowing from the site into surrounding area	Mod	Fencing around landfill site Monitoring of landfill capacity Covering of waste disposed to landfill site Pickup windblown litter	Low	Waste management procedure.
28	Toxic fumes and soil contamination from burning tyres	Mod	Regularly bury tyres Fire management plan to minimise the impact of a fire	Low	Waste management procedure.
30	Excess water from WWTP irrigation field	Mod	Implement site inspection checklist and weed procedure, if required.	Low	Monthly inspection of mine area
31	Ineffectual rehabilitation reducing stability and ecological function of disturbed areas	Mod	Research into appropriate species and times of the year for optimum rehabilitation results Comparison of baseline studies and similar mine site locations in the area on vegetation that has resulted in successful rehabilitation	Low	MCP - Rehabilitation
32	Erosion on final landforms reducing stability and ecological function of disturbed areas	Mod	Interim (during construction) and final stormwater design on the waste landform Implement appropriate stormwater control design Monitoring of erosion and stability of landforms Appropriate vegetation on slope of landforms to minimise excess erosion	Low	MCP - Implementation
33	Grazing of rehabilitation by animals reducing stability and ecological function of disturbed areas	Mod	Monitor extent of grazing on waste landforms Fence landforms to prevent degradation of vegetation from grazing, if required.	Low	MCP – Implementation and Monitoring

No.	Risk Pathway	Inherent Risk	Control Measures	Residual Risk	Control Documents
11	Lowering groundwater table	Low	Baseline surveys confirm the low significance of this factor. Monitor groundwater levels. Surveys show species exist beyond the project footprint	Low	NA
17	Visual impact of WRD on the surrounding landscape.	Low	Isolated project location, no close sensitive receptors. Revegetate WRD.	Low	NA

Table 43 is an extract from the EMS. It is included in this mining proposal to show how the results of the risk assessment (**Table 41** and **Table 42**) are addressed in the EMS via procedures and other documents.

Table 43: Control Documents in the EMS

Document	Control function
Standard Operating Procedure (SOP)	
Vegetation management procedure	Documents the process for vegetation clearing, topsoil management and weed control. Includes the internal clearing permit form and clearing register.
Fauna management procedure	Documents the process for fauna management. Includes fauna death or injury reporting procedure
Hydrocarbon and chemical procedure	Documents the process for hydrocarbon and chemical management. Includes the Hazardous Materials Register and the Spill Procedure
Aboriginal heritage procedure	Documents the process to identify and protect Aboriginal heritage sites.
Waste management procedure	Documents the process for waste management. Includes the spill procedure
Accident/Incident Form	Form to report accidents and incidents
Accident Incident Investigation Form	Form to investigation Significant or High risk incidents
Hot work permit	Documents the process to undertake hot work activities on site
Environmental constraints map	Records environmental / heritage sites and buffer areas.
Project Operating Procedure (POP)	
Water monitoring procedure	Documents the process for water monitoring.
Monthly inspection of contractors area	Records inspection of contractors areas and routine reporting requirements (eg NPI data; clearing reconciliation).
Monthly inspection of mine area	Records inspection of site facilities and mine features for compliance with environmental requirements.

7. Outcomes and Reporting

The mining proposal guidelines state that the purpose of setting outcomes is to provide agreement between the proponent and DMP as to the level of environmental impact that is predicted and considered acceptable. This then enables performance measures and a monitoring schedule to be established against these outcomes. The performance measures must follow the SMART principle; specific, measurable, achievable, realistic and time bound.

The environmental risk assessment should be used to determine which factors need to have site-specific environmental outcomes set. Outcomes only need to be set for aspects that present as moderate or high risk pre-treatment (inherent risks). **Table 42** - Risk Assessment Summary provides a summary of these factors.

The outcomes must also be consistent with DMP's environmental objectives. These objectives have considered, and broadly cover, the clearing principles set out in the *Environmental Protection Act 1986* (EP Act) Schedule 5. AMPL has addressed the clearing principles in Section **3.3** and **Table 23.**

The EMS contains the control documents aimed at mitigating environmental risks. These comprise of procedures, forms, checklists and maps. **Table 44** provides a summary of the outcomes and performance measures contained in the various EMS control documents, which aspects identified in the risk assessment that they address and the relevant DMP environmental factors and objectives contained in the mining proposal guidelines.

Closure outcomes are considered to be a sub-set of a project's environmental outcomes. The risk factors identified in **Table 41** and **Table 42** with controls and outcomes addressed at mine closure are included in the mine closure plan. The Mine Closure Plan contains a risk assessment addressing aspects focussed on mine closure. Environmental outcomes and performance measures in this Mining Proposal and EMS are focussed on the operational phase of the project.

7.1 Monitoring

Consistent with the SMART principle, **Table 44** also details the method and frequency of monitoring for each of the performance measures.

7.2 Reporting

Environmental performance is reported both internally and to external regulatory agencies.

1. Internal reports are prepared on a monthly, quarterly and annual basis.
2. External annual reports are prepared for DMIRS, DWER and DoH.
3. Mining proposals will be subject to a standard condition requiring proponents to notify DMP of any reportable incident within 24 hours of detection. The mining proposal guidelines define a 'reportable incident' as:
    - an incident that breaches a performance measure of the approved mining proposal;
    - an incident arising from the mining activity that has caused, or has the potential to cause, environmental harm.

Table 44: Environmental Outcomes

Factor (DMP 2016)	DMP Objective (DMP 2016)	Risk Pathway (from Table 42)	EMS Control Document	Outcomes	Performance Measure	Monitoring	Frequency
Biodiversity/Flora/Fauna/ Ecosystem	To maintain representation, diversity, viability and ecological function at the species, population and community level.	3 Access /haul roads 2 Over clearing for mine activities 8 Over clearing for mine activities	Vegetation Management Procedure	All site activities are undertaken within approved project disturbance boundaries.	Extent of site clearing is within approved limit and boundaries and recorded within 3 months of clearing	Survey pickup of cleared areas	Quarterly
				Topsoil salvaged and stored for use in rehabilitation	Survey quantity (m^3) of stockpiled topsoil within 3 months of construction	Survey pickup of stockpiles.	Quarterly
Water resources	To maintain the hydrological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including ecosystem maintenance, are protected.	19 Groundwater level 20 Groundwater quality	Water Monitoring Procedure	Comply with all licence water monitoring requirements.	All licence requirements met.	Annual compliance report containing relevant monitoring data	Annual
				Groundwater level and quality beyond the tenement boundary is maintained within the range of background levels	Groundwater level change less than 2 metres (accounting for natural variance) five years after mine closure when measured at monitoring bores established within 500 metres downstream from the tenement boundary	Mine monitoring bores and regional groundwater bores monitored quarterly during life of mine and 6 monthly after closure for 5 years	Quarterly & biannual
Landforms	Mining will not result in appreciable land degradation or the contamination or pollution of the land.	23 Hydrocarbon leakage from storage areas, pipelines 29 Disposal of contaminated soil. 10 Hydrocarbon spillages 22 Hydrocarbon spillage during fuel transfer 26 Spillage of ANFO 27 Landfill site. 28 Tyre disposal 7 Storm water contaminated with sediment running off site. 13 Dust from crushing and stockpiles 1 Over clearing and/or vehicle movement in unauthorised area 4 Vehicle movement on access/haul roads 5 Hydrocarbon spillages 14 Drainage off ROM entering surrounding environment 15 Contamination from spills of process liquor 21 Drowning / entrapment in TSF 24 Hydrocarbon contamination from fuel, oil storage and work areas	Hydrocarbon and Chemical Procedure	Integrity of hydrocarbon and chemical storage bunds and containment measures is maintained.	Any hydrocarbon spills remediated so that there is no residual impact from the spill.	Monthly record of completed inspections and remedial actions during the life of mine	Monthly
				All hydrocarbon and chemical spills identified and remediated to the agreed standard in the Contaminated Sites Act 2003	Any hydrocarbon or chemical spill is categorised as per the spill procedure (in the EMS) and actioned accordingly within 24 hours	Environmental incident report, remediation actions and audit closeout	Monthly
			Waste Management Procedure Fauna Management Procedure	No off-site pollution from mine landforms	Surface soil Pb levels within 500 metres of the tenement boundary below NEPM[1] added contaminant limits (ACL) for commercial/ industrial use.	Annual sampling of surface soils during the life of mine and continue for 5 years after mine closure	Annual
				Landform stability is appropriate for the stage of mine life.	No impacts to vegetation outside the mine disturbance boundary from unstable mine landforms.	Annual erosion and stability assessment of mine landforms.	Annual

Factor (DMP 2016)	DMP Objective (DMP 2016)	Risk Pathway (from Table 42)	EMS Control Document	Outcomes	Performance Measure	Monitoring	Frequency
		25 Contamination from wash down bay 30 WWTP irrigation field 6 Vehicle accident 9 Fires from exhausts and hot work activities.					

1. NEPM (1999). Schedule B1 – Table 1(B)4

8. Environmental Management System

The mining proposal guidelines state that a mining proposal requires proponents to demonstrate an upfront assessment and identification of risk management measures (see section **6**). Due to the long term nature of these activities and the potential for new risks to arise during operations, ongoing risk identification and monitoring the success of implemented management measures is required. Following approval of the mining proposal, DMIRS requires the risk management process to be maintained and managed throughout the life of the project via an appropriate Environmental Management System (EMS). A separate EMS is not required for each individual Environmental Group Site (EGS). Proponents can have an overarching EMS that is suitable for all of their sites provided it adequately addresses the specific procedures for the EGS associated with the Mining Proposal.

AMPL has developed an EMS to manage environmental impacts associated with its mining operations. At the present time, AMPL has only one proposed mining project, the Abra base metals mine. However, in the future, other mining projects may be developed and for minerals other than base metals. For this reason, the EMS has structured its management procedures to provide:

- Standard Operating Procedures (SOP) - to manage aspects that are common to more than one EGS.
- Project Operating Procedures (POP) – to manage aspects unique to a specific EGS (project site).

While the EMS is structured to be consistent with ISO 14001, AMPL does not intend to apply for certification under this standard. The EMS is provided with this mining proposal in **Appendix E**.

A Mine Closure Plan is attached in **Appendix H**.

9. References

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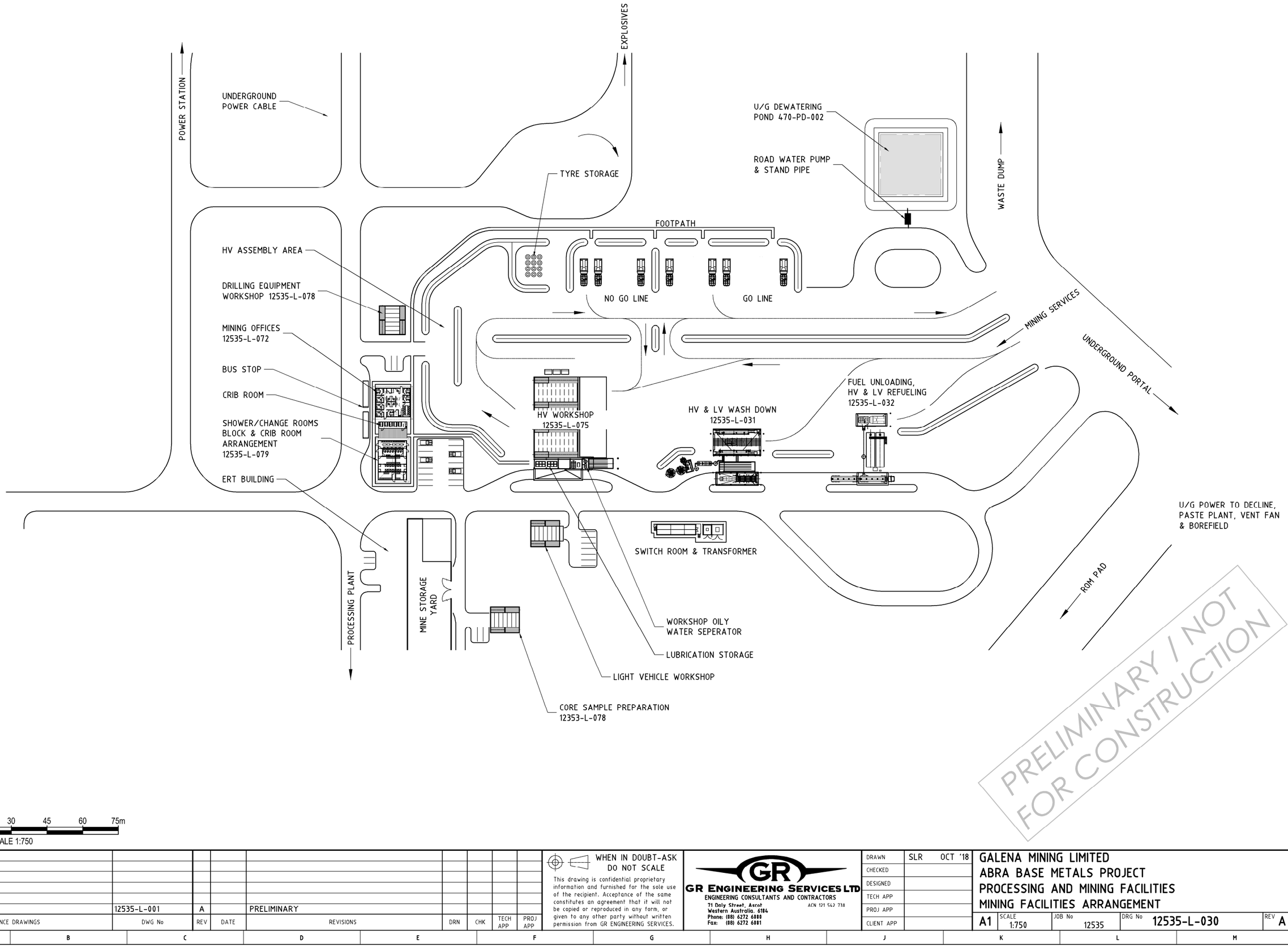
Appendix A. Process Plant Drawings

NORTH



15 0 15 30 45 60 75m

SCALE 1:750

PRELIMINARY / NOT FOR CONSTRUCTION

REFERENCE DRAWINGS	DWG No	REV	DATE	REVISIONS	DRN	CHK	TECH APP	PROJ APP
LOCATION PLAN	12535-L-001	A		PRELIMINARY				

GR ENGINEERING SERVICES LTD
ENGINEERING CONSULTANTS AND CONTRACTORS
71 Daly Street, Ascot
Western Australia. 6104
Phone: (08) 6272 6888
Fax: (08) 6272 6881
ACN 121 542 738

DRAWN	SLR	OCT '18
CHECKED		
DESIGNED		
TECH APP		
PROJ APP		
CLIENT APP		

GALENA MINING LIMITED
ABRA BASE METALS PROJECT
PROCESSING AND MINING FACILITIES
MINING FACILITIES ARRANGEMENT

A1	SCALE 1:750	JOB No 12535	DRG No 12535-L-030	REV A

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NORTH

ABLUTION BLOCK
BUS STOP
PROCESSING OFFICES
CRIB ROOM
REAGENT STORAGE
MCC/SWITCHROOM & TRANSFORMER
LIME SILO
REAGENTS
UNDERGROUND POWER CABLE
SERVICES LINES
WAREHOUSE
WORKSHOPS
CORE PROCESSING
LABORATORY & SAMPLE PREPARATION
RADIATION SOURCE STORAGE CONTAINER
PRIMARY CRUSHER
ROM PAD
TERTIARY CRUSHER
SECONDARY CRUSHER
MCC/SWITCHROOM & TRANSFORMER
DRIVE-IN SUMP
ABLUTIONS
PRODUCT SCREENING
COMPRESSORS
FLOTATION
GRINDING & FLASH FLOTATION
RAW WATER DAM
WATER SERVICES
CONCENTRATE THICKENER
TAILINGS THICKENER
FILTRATION AND CONCENTRATE LOADING
FINE ORE BIN
EMERGENCY FEED HOPPER
EMERGENCY STOCKPILE

10 0 10 20 30 40 50m
SCALE 1:500

LOCATION PLAN	12535-L-001	A		PRELIMINARY				
REFERENCE DRAWINGS	DWG No	REV	DATE	REVISIONS	DRN	CHK	TECH APP	PROJ APP

WHEN IN DOUBT-ASK DO NOT SCALE

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ENGINEERING CONSULTANTS AND CONTRACTORS
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Phone: (08) 6272 6000
Fax: (08) 6272 6001

DRAWN	SLR	DEC '18
CHECKED		
DESIGNED		
TECH APP		
PROJ APP		
CLIENT APP		

GALENA MINING LIMITED
ABRA BASE METALS PROJECT
CRUSHING AND PROCESSING ARRANGEMENT PLAN

A1	SCALE 1:500	JOB No 12535	DRG No 12535-L-006	REV A

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