GOLDER
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REPORT

Ardmore Start-Up Operation - Progressive Rehabilitation and Closure Plan

Mining Lease 5542 (Environmental Authority BRMN0037)

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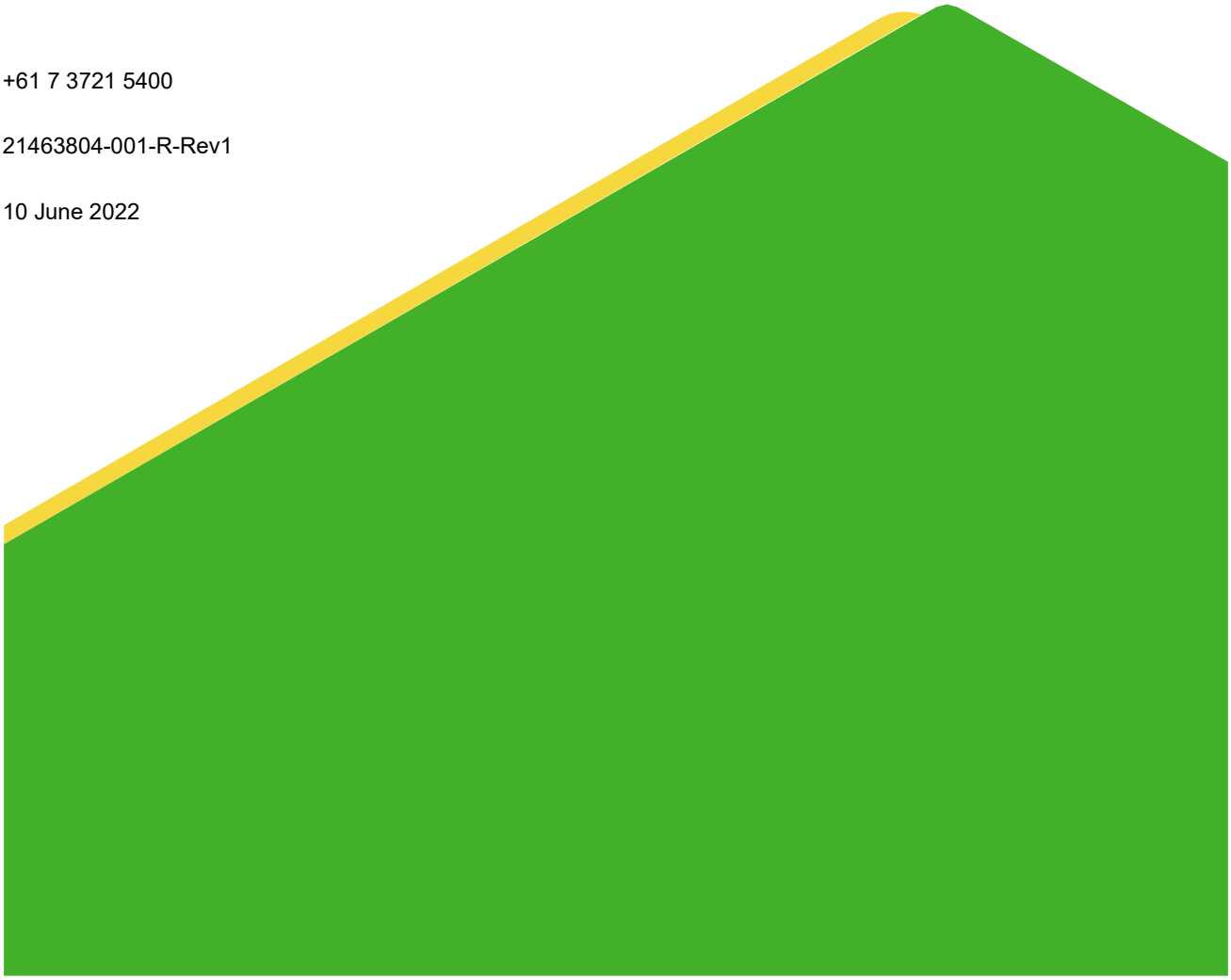
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Distribution List

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Table of Contents

1.0 INTRODUCTION 10

1.1 Mining operation summary 12

1.2 Current land outcome documents 15

2.0 PROJECT PLANNING 16

2.1 Baseline information 16

2.1.1 Topography 16

2.1.2 Climate 18

2.1.3 Geological setting 20

2.1.4 Hydrology 24

2.1.5 Hydrogeology 28

2.1.6 Soil 36

2.1.7 Land stability 39

2.1.8 Terrestrial ecology 39

2.1.9 Aquatic ecology 43

2.1.10 Weed and pest species 45

2.1.11 Pre-mining land use 46

2.1.12 Underlying landholders 48

2.2 Project description 48

2.2.1 Mining tenements 48

2.2.2 Environmentally relevant activities 49

2.2.3 Mine features 49

2.2.4 Type of mining operation 51

2.2.5 Duration 52

2.2.6 Design of mine features for closure 52

2.2.7 Progressive rehabilitation 52

2.2.8 Existing rehabilitation 53

2.2.9 Land unavailable for rehabilitation until operations cease 53

3.0 COMMUNITY CONSULTATION 53

3.1 Primary stakeholders 54

3.2 Community consultation register 54
3.3 Community consultation plan 59
3.3.1 Consultation objectives 59
3.3.2 How the community will be engaged 59
3.3.3 Consultation frequency 60
3.3.4 Information released for community consultation 60
3.3.5 How feedback and comments will be considered 60
4.0 POST-MINING LAND USE 61
4.1 Land use strategies and regional planning 61
4.2 Closure planning 62
4.3 PMLU criteria 62
4.4 Rehabilitation Areas 62
4.5 PRCP Schedule 72
4.5.1 Final site design 72
4.5.2 Rehabilitation milestones criteria 75
5.0 NON-USE MANAGEMENT AREA 75
6.0 REHABILITATION MANAGEMENT METHODOLOGY 75
6.1 Hydrogeology 78
6.2 Flooding 80
6.3 Soils and capping material assessment 90
6.4 Mine waste characterisation 91
6.4.1 Waste types 91
6.4.2 Mine waste 91
6.4.3 Use of mine waste in rehabilitation 92
6.5 Landform and cover design 92
6.6 Water management 93
6.6.1 Description of contaminants 93
6.6.2 Source, pathway, and fate of contaminants 94
6.7 Revegetation process 95
6.8 Tailings Storage Facility 96
6.8.1 TSF rehabilitation and closure methodology 97

6.8.2 Tailings characterisation 97
6.8.3 Geotechnical stability 100
6.8.4 Tailings water management and erosion protection 100
6.9 Voids 100
6.10 Underground mining 100
6.11 Built infrastructure 100
7.0 RISK ASSESSMENT 101
7.1 Methodology 101
7.2 Risk assessment findings 102
8.0 MONITORING AND MAINTENANCE 108
8.1 Monitoring schedule 108
8.2 Contingency strategies 108
8.3 Post-closure monitoring 108
8.4 Reporting 110
9.0 REFERENCE LIST 111
10.0 IMPORTANT INFORMATION 113

TABLES

Table 1: Land outcome documents used to support this PRCP 15
Table 2: Monument Airport Station maximum and lowest maximum temperatures (2000 to 2021) 18
Table 3: Geological stratigraphy 21
Table 4: Site catchments 26
Table 5: Summary of registered bores within 11 km from the Project Area 28
Table 6: TP04, TP05, TP09, and TP10 lithology 36
Table 7: TP02, TP03, TP06, and TP07 lithology 37
Table 8: TP01 and TP08 lithology 37
Table 9: Environmentally Relevant Activities 49
Table 10: Area of disturbance – Phase 2 50
Table 11: Coordinates of approved production wells 51
Table 13: Community consultation register 56
Table 14: Rehabilitation Area (RA1) – pits and borrow pits 65
Table 15: Rehabilitation Area (RA2) - tailings storage facility 67
Table 16: Rehabilitation Area (RA3) - overburden storage facility and ROM 68

Table 17: Rehabilitation Area (RA4) - mine infrastructure areas....70
Table 18: Calculated Drawdowns after 90 Days of Pumping (15 L/s)....78
Table 19: Indicative revegetation species list and sowing rate....95
Table 20: Qualitative criteria for likelihood....101
Table 21: Qualitative criteria for consequence....101
Table 22: Qualitative risk assessment matrix....102
Table 23: Risk assessment findings....103
Table 24: Proposed reference sites....109

Figure 1: Project location....11
Figure 2: Mining Lease area layout....13
Figure 3: Start-up Operation layout....14
Figure 4: Topography....17
Figure 5: Rainfall statistics - BOM Monument Airport Station....19
Figure 6: Mean temperature for annual season (based on 1986 to 2005 reference period)....19
Figure 7: Maximum 1-day precipitation for annual season (based on 1986 to 2005 reference period)....20
Figure 8: Surface geology....23
Figure 9: Receiving water monitoring points....25
Figure 10: Site drainage basins....27
Figure 11: Regional hydrogeological setting....29
Figure 12: Groundwater elevation in the Northern zone....31
Figure 13: Piper diagram, November 2017....32
Figure 14: Conceptual hydrogeological cross section northern part of ML (N-S)....33
Figure 15: Conceptual hydrogeological cross section southern part of ML (W-E)....33
Figure 16: Groundwater monitoring bores location map....35
Figure 17: Soil types within the Project Area....38
Figure 18: Typical ground cover and vegetation....39
Figure 19: Regional Ecosystems....41
Figure 20: Registered bores and groundwater dependant ecosystems....44
Figure 21: RE1.3.7b River Red Gum (*E. camaldulensis*) Fringing Open Woodland....45
Figure 22: Narrow RE1.3.7b Riparian Community with Buffel Grass invasion....46
Figure 23: Pre-mining land use ROM pad area....47
Figure 24: Pre-mining land use processing plant area....48
Figure 25: Processing plant area....51
Figure 26: Reference map indicating the Rehabilitation Areas (whole of ML)....63

Figure 27: Reference map indicating the Rehabilitation Areas 64
Figure 28: Final site design and conceptual PMLU (whole of ML) 73
Figure 29: Final site design and conceptual PMLU (close up) 74
Figure 30: Cross section of the site at closure 77
Figure 31: Potential GDEs and drawdown contours 79
Figure 32: 1% AEP event maximum flood depth 81
Figure 33: 0.1% AEP event maximum flood depth 82
Figure 34: PMP event maximum flood depth 83
Figure 35: 1% AEP event maximum flood velocity 84
Figure 36: 0.1% AEP event maximum flood velocity 85
Figure 37: PMP event maximum flood velocity 86
Figure 38: 1% AEP event flood severity 87
Figure 39: 0.1% AEP event flood severity 88
Figure 40: PMP event flood severity 89
Figure 41: Generic moisture density curve at zero air voids for 800 ktpa 99

FIGURES

Figure 1: Project location 11
Figure 2: Mining Lease area layout 13
Figure 3: Start-up Operation layout 14
Figure 4: Topography 17
Figure 5: Rainfall statistics - BOM Monument Airport Station 19
Figure 6: Mean temperature for annual season (based on 1986 to 2005 reference period) 19
Figure 7: Maximum 1-day precipitation for annual season (based on 1986 to 2005 reference period) 20
Figure 8: Surface geology 23
Figure 9: Receiving water monitoring points 25
Figure 10: Site drainage basins 27
Figure 11: Regional hydrogeological setting 29
Figure 12: Groundwater elevation in the Northern zone 31
Figure 13: Piper diagram, November 2017 32
Figure 14: Conceptual hydrogeological cross section northern part of ML (N-S) 33
Figure 15: Conceptual hydrogeological cross section southern part of ML (W-E) 33
Figure 16: Groundwater monitoring bores location map 35
Figure 17: Soil types within the Project Area 38
Figure 18: Typical ground cover and vegetation 39

Figure 19: Regional Ecosystems 41
Figure 20: Registered bores and groundwater dependant ecosystems 44
Figure 21: RE1.3.7b River Red Gum (*E. camaldulensis*) Fringing Open Woodland 45
Figure 22: Narrow RE1.3.7b Riparian Community with Buffel Grass invasion 46
Figure 23: Pre-mining land use ROM pad area 47
Figure 24: Pre-mining land use processing plant area 48
Figure 25: Processing plant area 51
Figure 26: Reference map indicating the Rehabilitation Areas (whole of ML) 63
Figure 27: Reference map indicating the Rehabilitation Areas 64
Figure 28: Final site design and conceptual PMLU (whole of ML) 73
Figure 29: Final site design and conceptual PMLU (close up) 74
Figure 30: Cross section of the site at closure 77
Figure 31: Potential GDEs and drawdown contours 79
Figure 32: 1% AEP event maximum flood depth 81
Figure 33: 0.1% AEP event maximum flood depth 82
Figure 34: PMP event maximum flood depth 83
Figure 35: 1% AEP event maximum flood velocity 84
Figure 36: 0.1% AEP event maximum flood velocity 85
Figure 37: PMP event maximum flood velocity 86
Figure 38: 1% AEP event flood severity 87
Figure 39: 0.1% AEP event flood severity 88
Figure 40: PMP event flood severity 89
Figure 41: Generic moisture density curve at zero air voids for 800 ktpa 99

Figure 1: Project location 11
Figure 2: Mining Lease area layout 13
Figure 3: Start-up Operation layout 14
Figure 4: Topography 17
Figure 5: Rainfall statistics - BOM Monument Airport Station 19
Figure 6: Mean temperature for annual season (based on 1986 to 2005 reference period) 19
Figure 7: Maximum 1-day precipitation for annual season (based on 1986 to 2005 reference period) 20
Figure 8: Surface geology 23
Figure 9: Receiving water monitoring points 25
Figure 10: Site drainage basins 27
Figure 11: Regional hydrogeological setting 29

Figure 12: Groundwater elevation in the Northern zone 31
Figure 13: Piper diagram, November 2017 32
Figure 14: Conceptual hydrogeological cross section northern part of ML (N-S) 33
Figure 15: Conceptual hydrogeological cross section southern part of ML (W-E) 33
Figure 16: Groundwater monitoring bores location map 35
Figure 17: Soil types within the Project Area 38
Figure 18: Typical ground cover and vegetation 39
Figure 19: Regional Ecosystems 41
Figure 20: Registered bores and groundwater dependant ecosystems 44
Figure 21: RE1.3.7b River Red Gum (*E. camaldulensis*) Fringing Open Woodland 45
Figure 22: Narrow RE1.3.7b Riparian Community with Buffel Grass invasion 46
Figure 23: Pre-mining land use ROM pad area 47
Figure 24: Pre-mining land use processing plant area 48
Figure 25: Processing plant area 51
Figure 26: Reference map indicating the Rehabilitation Areas (whole of ML) 63
Figure 27: Reference map indicating the Rehabilitation Areas 64
Figure 28: Final site design and conceptual PMLU (whole of ML) 73
Figure 29: Final site design and conceptual PMLU (close up) 74
Figure 30: Cross section of the site at closure 77
Figure 31: Potential GDEs and drawdown contours 79
Figure 32: 1% AEP event maximum flood depth 81
Figure 33: 0.1% AEP event maximum flood depth 82
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Figure 36: 0.1% AEP event maximum flood velocity 85
Figure 37: PMP event maximum flood velocity 86
Figure 38: 1% AEP event flood severity 87
Figure 39: 0.1% AEP event flood severity 88
Figure 40: PMP event flood severity 89
Figure 41: Generic moisture density curve at zero air voids for 800 ktpa 99

APPENDICES

APPENDIX A
PRCP checklist

APPENDIX B
EA amendment application supporting information report

APPENDIX C
Tailings Storage Facility – Preliminary conceptual design (Start-up Operation)

APPENDIX D
Tailings testwork

APPENDIX E
Important information

1.0 INTRODUCTION

Agriflex (Agriflex Pty Ltd) is required to submit a Progressive Rehabilitation and Closure Plan (PRCP) for its mining operations in Queensland (Qld) due to the recent rehabilitation reforms and amendments to the *Environmental Protection Act 1994* (EP Act). The PRCP is required for the operations on Mining Lease ML5542 (Environmental Authority (EA) BRMN0037).

The Project approved under the EA is for a small-scale Start-up Operation in the Southern zone of ML5542, will extract phosphate ore using shallow open-cut strip mining. The proposed larger operation (not yet approved) is referred to as the Ardmore Phosphate Rock Project.

The Department of Environment and Science (DES) Guideline: Progressive Rehabilitation and Closure Plans (ESR/2019/4964 Version 2.00: March 2021) (referred to herein as the PRCP Guideline) provides the information to assist companies in complying with the amendments to the EP Act and the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (Qld) (MERFP Act). It also contains information for existing EA holders for transitioning their mining activity to the PRCP framework. The PRCP Guideline has been used in the preparation of this PRCP, and a checklist as per Section 6 of the DES Submission of a Progressive Rehabilitation and Closure plan application form (ESR/2019/4957 Version 3.00: Feb 2021) has been provided in Appendix A.

The two components of the PRCP are:

- PRCP planning component (this report) which provides the background information to the PRCP Schedule.
- PRCP Schedule which includes the development of management milestones and criteria and the timing for each rehabilitation milestone (RM) to be achieved. The PRCP Schedule is provided as a separate standalone spreadsheet (ESR/2019/5103.xls) for DES.

The main purpose of the PRCP is for the EA holder to plan how and where activities will be carried out on land in a way that maximises the progressive rehabilitation to a stable condition. It also provides the information on the condition to which the EA holder must rehabilitate the land before the EA is surrendered.

The Project is located 128 km south of the city of Mount Isa and 23 km west of the town of Dajarra in Northwest Queensland (Figure 1) (ABS, 2016). The high-grade phosphate rock deposit was previously drilled out from 1968 through to 1980 at the same time as the discovery of the Duchess Phosphate Rock Mine, which provides feed to the Phosphate Hill ammonium phosphate fertiliser plant.

The ML5542 for the Ardmore Phosphate Rock Project was granted in 1975 and it has been held under common ownership with the Duchess Mine since that time, until being transferred to Agriflex in June 2017.

The ML5542 encompasses 2,209 hectares, with the target high-grade phosphorite deposit occurring as a single, essentially flat lying unit within two separate areas, the “Northern zone” with a strike extent of approximately 4.0 km (N-S) and the “Southern zone” with a strike extent of approximately 1.6 km (E-W). The target phosphorite unit is shallow dipping, with the average depths of the hanging wall and footwall contacts being 8.3 m and 12.0 m respectively based on drilling to date.

Technical information to support this PRCP are provided in the EA Amendment Application – Supporting Report (2018), and the appendices within that report (Appendix B).

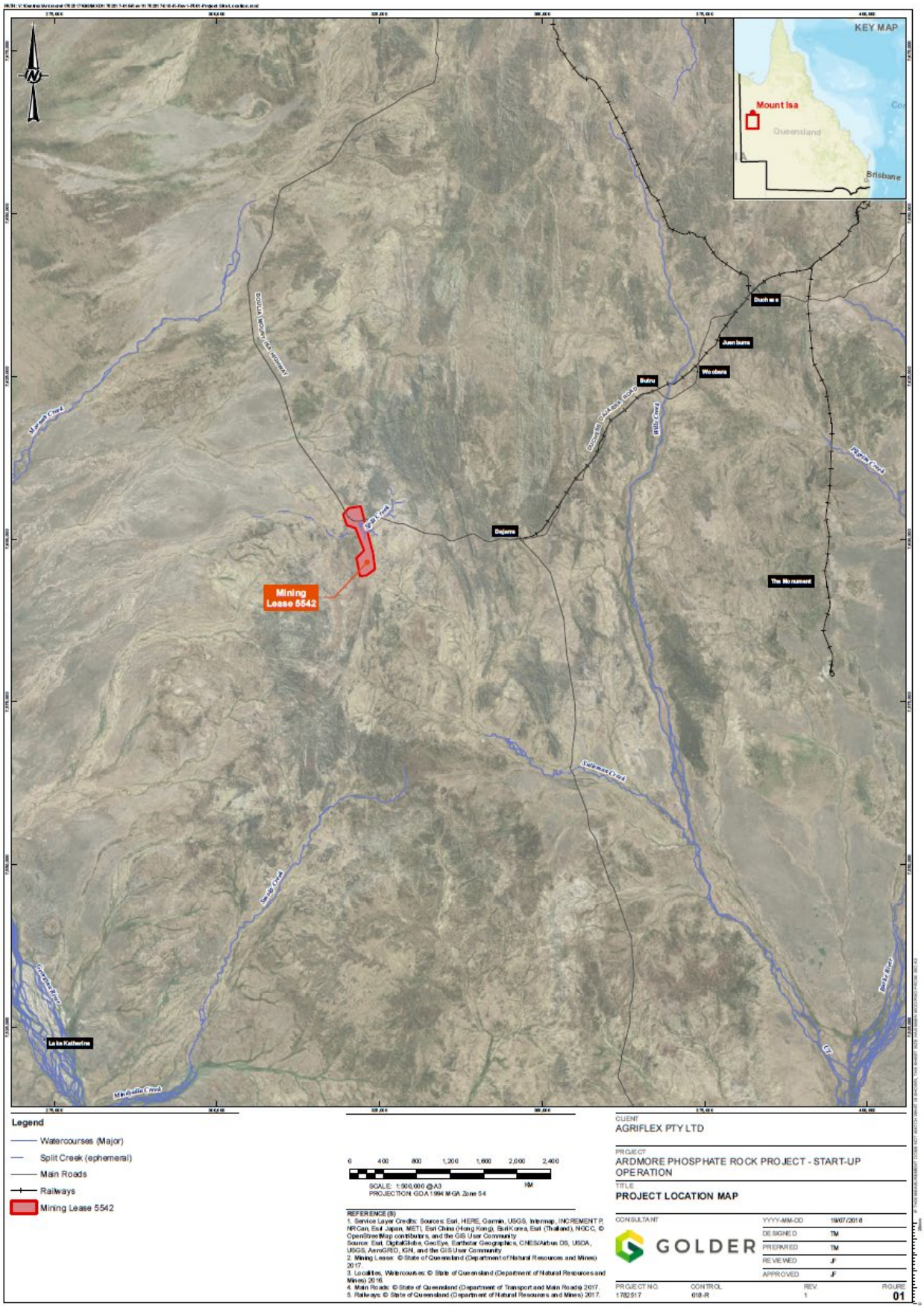


Figure 1: Project location

1.6 Mining operation summary

The high-grade phosphorite deposit on the ML is located within two separate areas, the ‘Northern zone’ and the ‘Southern zone’. Agriflex propose to undertake preliminary, small-scale mining and processing operations (Start-up Operation) in the ‘Southern zone’ prior to a decision to develop a full-scale operation.

The Start-up Operation in the Southern zone of ML ML5542 will extract ore using shallow open-cut strip mining. Mining will include removal of overburden and shallow phosphate rock at shallow depths and will not reach the water table during mining operations.

ROM ore will be processed in the demonstration plant. The concentrate will be loaded in containers and transported to an existing rail siding at Mount Isa. It will then be railed to the Port of Townsville and shipped to potential customers for independent testing through their facilities. At the completion of the Start-up Operation, the viability and economic merits of the Project will be considered by Agriflex to determine whether to expand the operation to a Full-scale Operation in the future. The aim of the mining operation is to supply phosphate rock concentrate to fertiliser plants in Australia (which are currently reliant on imported phosphate) and export throughout the region.

The Project will disturb a total area of approximately 22.95 ha in total. This includes a 1.97 ha pit area, a 1.71 north pit area, 2.93 ha TSF and TSF fence area, 1.10 ha for borrow pits, 3.24 ha ROM area, 7.42 ha for roads and tracks, 1.54 ha for mine infrastructure, and 3 ha of exploration activities.

A 5 m wide corridor approximately 8.5 km in length will accommodate an 80 mm diameter water pipeline from two bores in the north of the ML to the processing facilities and an accompanying single vehicle access track for pipeline maintenance (4.3 ha). The pipeline will be temporarily laid on the surface along a route from the north to the south of the ML as shown in Figure 2 and Figure 3.

An existing station road will be used for access and temporary haulage along a 11 km distance from the processing plant to the highway (1 km from the processing plant to the ML boundary).



Figure 2: Mining Lease area layout

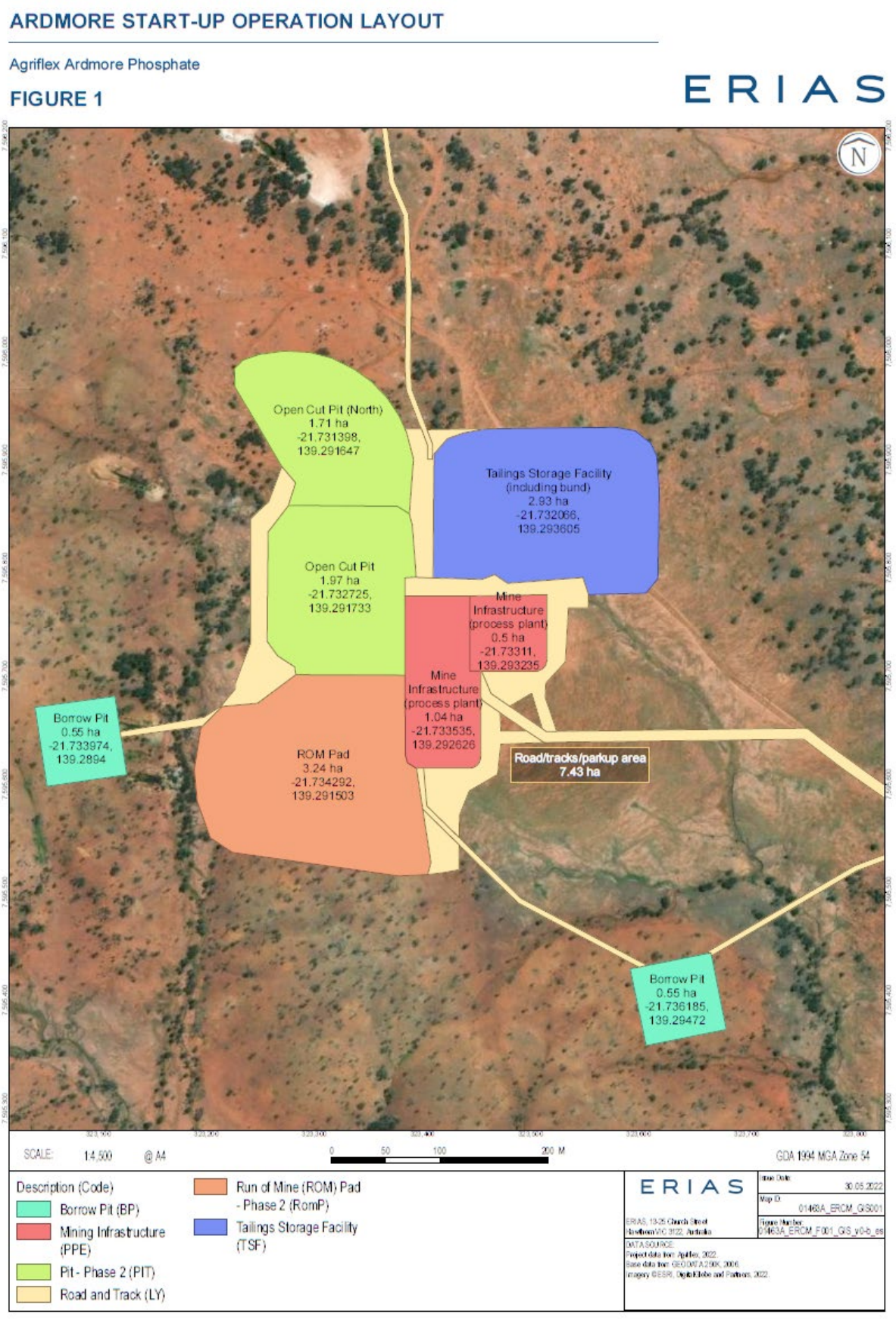


Figure 3: Start-up Operation layout

1.7 Current land outcome documents

As the Project is a transitional PRCP, the current land outcome documents have been used to populate this PRCP where relevant are provided in Table 1.

Table 1: Land outcome documents used to support this PRCP

Type	Document number	Document name
Environmental Authority	EA BRMN0037	Environmental Authority EA BRMN0037
Required under EA condition C2	1782517-016-R-Rev3	Groundwater Monitoring Program
Required under EA condition C9	1782517-016-R-Rev3	Erosion and Sediment Control Plan
Required under EA condition C10	1782517-016-R-Rev3	Receiving Environment Monitoring Program (REMP)
Required under EA condition F8	1782517-048-R-Rev0	Waste Rock and Spoil Disposal Plan
Required under EA condition F11	1782517-049-R-Rev0	Tailings Procedures
Required under EA condition G2	1782517-033-R-Rev1	Plan of Operations

2.0 PROJECT PLANNING

The Project consists of a demonstration processing plant and a small-scale open pit within the Southern Zone of the ML. The aim of the operation is to supply phosphate rock concentrate for testing, to fertiliser plants in Australia (which are currently reliant on imported phosphate) and elsewhere throughout the region.

2.1 Baseline information

This baseline information section comprises the characteristics that existed prior to mining, which may influence the rehabilitation and closure planning process. Appendix B, Appendix C, and Appendix D provide all the technical reports to support this PRCP.

2.1.1 Topography

The Project lies within range country on the eastern margin of the Barkly Tableland. Relief throughout the area is low, though rugged with nearby hills being up to 50 m above the valley bases. The surface overlying both the north and south deposits is relatively flat with the highest point of 350 m Australian Height Datum (AHD) being in the southern area and the lowest 310 m AHD in the north. The site topography is presented in Figure 4.

The deposit is split into two lodes, known as the Northern and Southern zones. Split Creek (a dry creek, 30 m to 40 m wide) splits the two zones and drains westward towards the Georgina River.



Figure 4: Topography

2.1.2 Climate

The Start-up Operation is situated near Dajarra and the closest Bureau of Meteorology (BOM) station is the Monument Airport Station (ID: 037034), located approximately 65 km east of the project site and is used to describe the local climate (BOM, 2021).

The climate is characterised as hot, semi-arid with a pronounced wet season from December to March. This coincides with very high temperatures with maximums averaging 36.5°C and very high potential evapotranspiration. Minimal rain falls from June to September while daytime maximum temperatures remain moderate at an average 24.3°C and potential evapotranspiration drops significantly.

The BOM identifies this seasonality as three main seasons experienced in Mount Isa.

- Hot temperatures with high humidity (January to April).
- Mild temperatures with low humidity (May to August).
- Hot temperatures with low humidity (September to December).

Average annual potential evaporation (3041 mm) far exceeds average annual rainfall (464 mm) recorded at Mount Isa Aero (ID 029127), located 128 km north from the site.

Mean maximum and lowest maximum temperatures from the Monument Airport Station are presented in Table 2 (BOM, 2021). Over the sampled period, spanning from 2000 to 2021 June is the month with the lowest maximum temperature with 7.7 °C. Over the same period, December is the hottest month, with mean maximum temperature reaching 38.3 °C. The annual mean maximum temperature is 32.4 °C.

Table 2: Monument Airport Station maximum and lowest maximum temperatures (2000 to 2021)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	37.9	37.1	35.7	32.7	27.8	24.1	24.4	26.9	31.6	35.4	37.5	38.3	32.4
Lowest maximum temperature (°C)	20.8	22.5	22.9	17.3	15.8	7.7	9.6	14.9	12.6	20.2	18.3	22.3	7.7

The mean rainfall data obtained from the Monument Airport Station over 19 years of measurement indicates that the heaviest rainfalls have occurred between November and March of each year. February has the highest mean rainfall, with 71.2 mm. The mean annual rainfall is 319.4 mm, predominantly in summer (Figure 5).

April through to September have consistently low rainfall across the sampled period, with each of these months recording a mean monthly rainfall around the 10 mm mark. The lowest mean rainfall month was August with 3.2 mm.

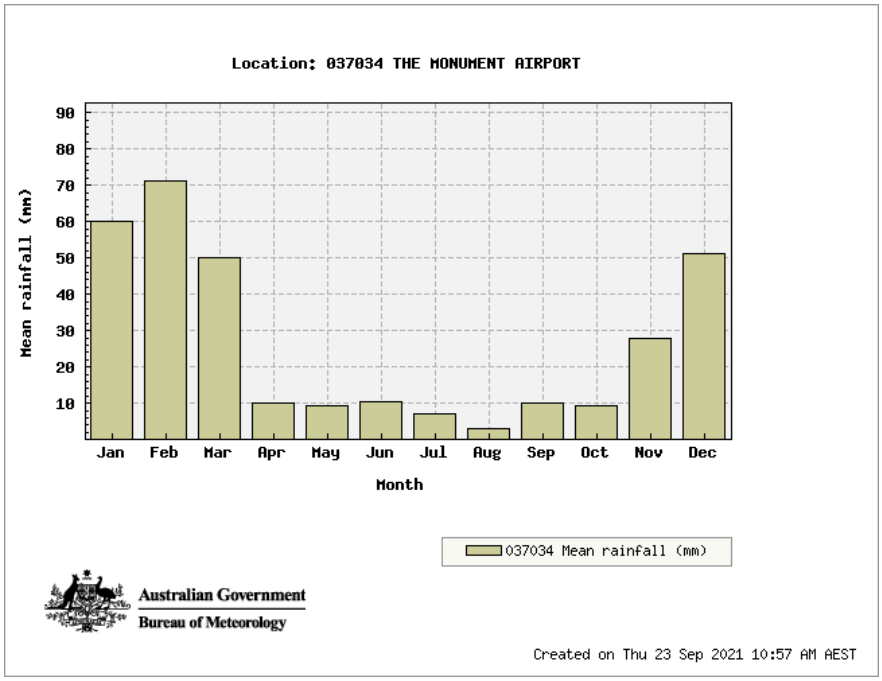


Figure 5: Rainfall statistics - BOM Monument Airport Station

2.1.2.1 Long-term climate projections

The long-term climate projections are important to understand when planning for mine closure. The Queensland Government has published projections regarding climate change in the region, which are summarised in this section (Queensland Government, 2021).

The Project Area is located on the border between the Cloncurry and Boulia Local Government Areas (LGA) For the Cloncurry LGA (used for the purposes of this baseline), the mean annual temperature is predicted to rise by approximately 1.1°C by 2030 and by approximately 4.6 °C by 2090, as illustrated in Figure 6.

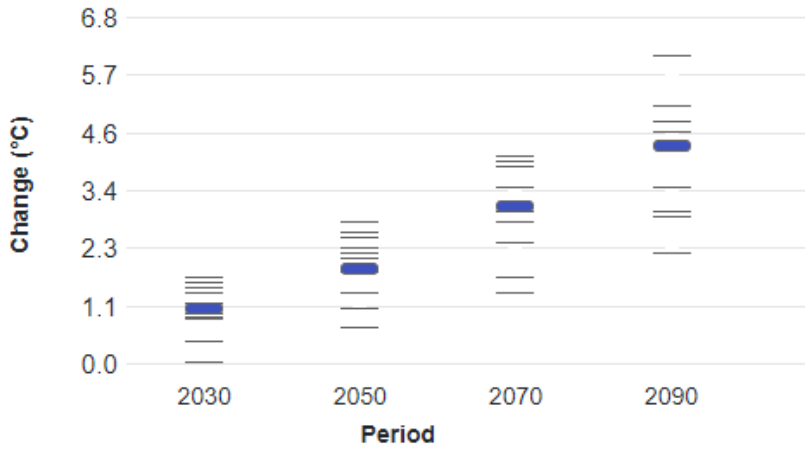


Figure 6: Mean temperature for annual season (based on 1986 to 2005 reference period)

For the same area, high climate variability is to remain a major factor influencing rainfall changes over the next few decades. Rainfall changes over 2090 continue to show a large amount of variability intensity, with the intensity of heavy rainfall events likely to increase. Overall, a reduction in the maximum 1-day precipitation is predicted, as shown in Figure 7.

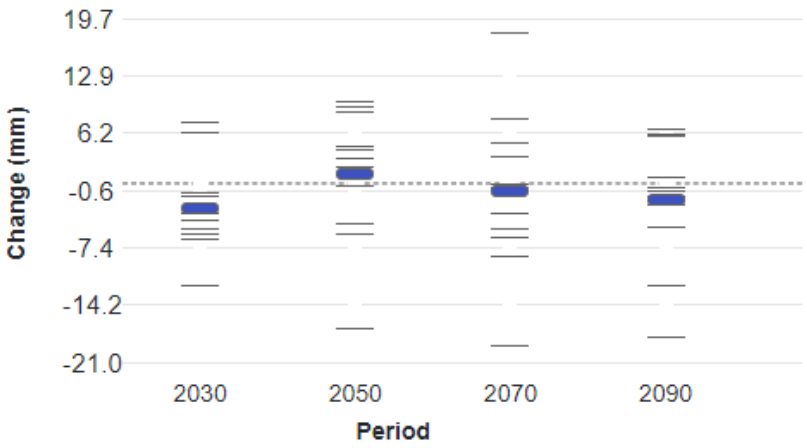


Figure 7: Maximum 1-day precipitation for annual season (based on 1986 to 2005 reference period)

The Fifth IPCC assessment report on climate change predicts a sea level rise of 0.28 to 0.61 m by 2100 (Church et al 2013). Due to its location and distance from the sea, sea level rise would not impact the Project.

2.1.3 Geological setting

2.1.3.1 Regional geological setting

The Ardmore deposit is an outlier of the Georgina Basin sedimentary rocks on the Mt Isa Block. The Georgina Basin is a large basin lying across the Queensland and Northern Territory border flanking the western and south western margins of the Mount Isa Province. It occupies an area of approximately 325,000 km^2 and is prospective for phosphate, petroleum, lead, zinc and copper.

The basin fill consists mainly of Cambrian to Middle Ordovician marine sedimentary rocks with the Cambrian and Early Ordovician rocks essentially being marine carbonate rocks with minor sandstone and siltstone, and the Middle Ordovician rocks dominated by siltstone and sandstone. Silurian to Devonian freshwater sandstone and Permian boulder beds overlie the early Palaeozoic Georgina Basin succession and are thought to represent younger successions laid down in superimposed basins. The basin was deformed by minor to moderate folding and faulting throughout, and over thrusting along the southern margin

The stratigraphic sequence is well-defined and includes a stable Precambrian basement. The two major Precambrian units within the study area are the Eastern Creek Volcanics and the Sybella Granite. These form a basement of crystalline rocks around the outlier and by interference, underlie the younger sediments (MEPL, 1977).

The basal sedimentary unit overlying the Precambrian basement is the Riversdale Formation that has been stated to be from the Upper Proterozoic to Lower Cambrian (MEPL, 1977). The Thorntonia Limestone conformably overlies the Riversdale formation with a gradational contact. This unit is overlain conformably by the Beetle Creek Formation (BCF) which is the significant phosphate containing unit in north-west Queensland.

The Blazan Shale is the uppermost formation preserved within the Ardmore outlier and is a thinly interbedded, siliceous shale, siltstone, and chert.

2.1.3.2 Project geological setting

The Project lies within range country on the eastern margin of the Barkly Tableland.

The recent investigations carried out at Ardmore have only fully penetrated the Blazan Shale and BCF and partially penetrated the Thorntonia Limestone. In the area of the ML the BCF is comprised of three members.

The Basal Phosphorite member is a phosphatic siltstone and chert member that is overlain by the lower siltstone member. This member comprises the majority of the BCF at Ardmore and is differentiated from the lower Basal Phosphorite Member by the lower grades of phosphate. The Simpson Creek Phosphorite Member overlies the Lower Siltstone Member. This is a high-grade phosphate unit that is the target unit for the Start-up Operation.

The geological setting of the Project area is a small downfaulted block of Cambrian sediments approximately 10 km long and 2 km wide with a constricted central portion. Its long axis bears north by north-west. The northern zone consists of a broad synclinal nose with the sediments dipping in towards the centre. It plunges toward the east into a boundary fault (MEPL, 1977).

The 1:100,000 Ardmore geology map (Australia 1:100,000 geological series, Sheet Number 6754) indicates that there are a number of surface geological units present within the mining lease comprising the following;

- Alluvium (Quaternary): Clay, silt, sand, gravel; flood-plain alluvium
- Blazen Shale (Middle Cambrian): Siliceous shale, chert, siltstone, fine arenite, conglomerate, dolomitic and bituminous limestone, phosphorate
- Beetle Creek Formation (Cambrian): Chert, siliceous shale with trilobite fossils, basal conglomerate
- Thorntonia Limestone (Middle Cambrian): Grey crystalline limestone
- Riversdale Formation (Early Cambrian): Conglomerate, arenite, arkose, shale, mudstone, dolomite
- Sulieman Gneiss (Palaeo Proterozoic): Felsic gneiss, augen gneiss, hornblende schist, amphibolite, quartzite.

These units form a syncline that plunges to the east where it is truncated by a north-south trending fault. Previous hydrogeological studies suggest the presence of a potentially water bearing zone within the Beetle Creek Formation and the underlying Thorntonia Limestone.

The geochemical properties of the rock to be disturbed have been assessed and there are no predicted problems such as acid mine drainage from the storage of overburden over the life of the mine or post closure.

The surface geology and structural map of the mining lease area, extracted from the 1:100,000 Ardmore geology map (Australia 1:100,000 geological series, Sheet Number 6754) indicates that there are a number of surface geological units present within the mining lease and a brief description of the geological units, from the youngest to the oldest, is presented in Table 3. Surface geology of the Mining Lease area is provided in Figure 8.

Table 3: Geological stratigraphy

Age	Unit	Description
Quaternary	Alluvium	Clay, silt, sand, gravel; flood-plain alluvium.
Middle Cambrian	Blazan Shale	The uppermost formation preserved within the Ardmore Outlier. Siliceous shale, chert, siltstone, fine arenite, conglomerate, dolomitic and bituminous limestone, phosphorite.
Cambrian	Beetle Creek Formation (Sub units: Basal Phosphorite Member, Chert Member,	The significant phosphate containing unit within the Outlier. Chert, siliceous shale with trilobite fossils, basal conglomerate.

Age	Unit	Description
	Simpson Creek Phosphorite Member)	
Thorntonia Limestone	Middle Cambrian	Lithologically it is a thinly to thickly bedded limestone or dolomitic limestone, with grey vuggy chert occurring as beds and nodules throughout the formation. This material underlies the phosphate ore.
Early Cambrian	Riversdale Formation	The basal sedimentary unit within the Ardmore Outlier and rests unconformably on the Precambrian basement. Underlies the Thorntonia Limestone. Conglomerate, arenite, arkose, shale, mudstone, dolomite.
Palaeo Proterozoic	Sulieman Gneiss	Felsic gneiss, augen gneiss, hornblende schist, amphibolite, quartzite.

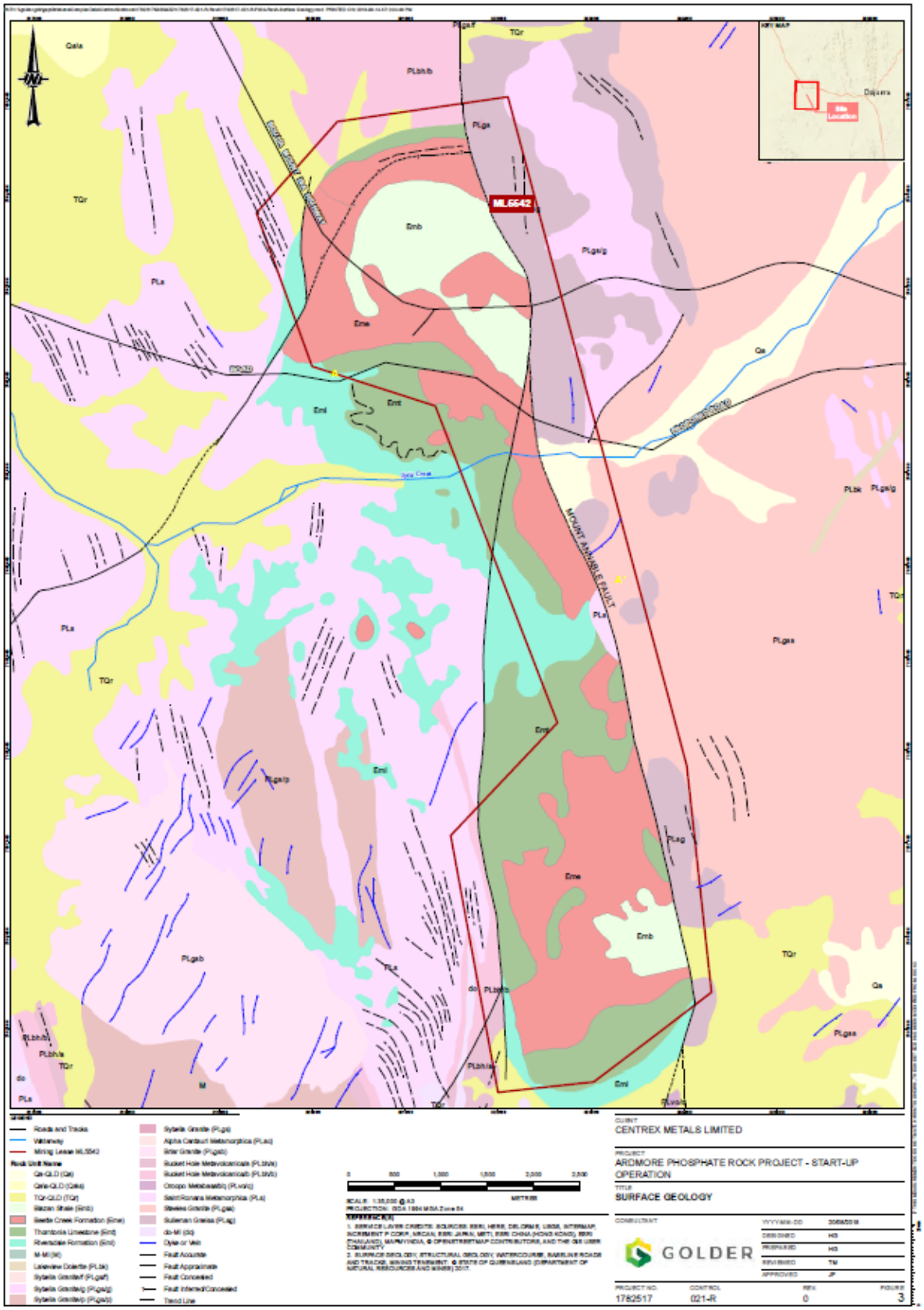


Figure 8: Surface geology

2.1.4 Hydrology

The Project is situated in the Georgina River Basin, which is based around the Georgina, Burke, and Hamilton Rivers. The basin is approximately 325,000 km^2 in area and extends from north-western Queensland and into the Northern Territory. The main surface water resource of the Georgina River Basin is the Georgina River. Split Creek, a tributary of Georgina River, flows east to west through the centre of the ML, and within the ML, a smaller drainage line flows southward from the southern catchment which flows into Sulieman Creek, into the Burke River, and eventually into the Georgina River.

Due to the pronounced wet and dry seasons the majority of streamflow occurs in the summer months often associated with monsoonal activity. For runoff to occur the precipitation needs to be significant or prolonged enough to fill the soil surface stores and generate runoff. A significant amount of this runoff will also then infiltrate to the alluvium of the ephemeral streams.

The site is located within a flat area with no significant water courses. Watercourses are ephemeral and only flow after heavy rainfall which also causes local flooding (Figure 10).

Peak event modelling uses design rainfalls, topography, and catchment development to simulate catchment runoff for Annual Exceedance Probability (AEP) 1%, 0.1% and Probable Maximum Precipitation (PMP).

The mine design and infrastructure layout has been designed to avoid surface water drainage lines and minimise potential for adverse impacts to mine infrastructure and to downstream watercourses. This is further detailed in Section 6.2.

NRC (2018a) completed a baseline wet season receiving environmental monitoring program (REMP) within the ML. This consisted of surface water quality sampling at three sites, as well as stream sediment quality sampling at 11 sites (Figure 9). Note that due to the intermittent nature of flow on the site, only one round of surface water samples was collected. Only three of the eleven sites had sufficient water for surface water quality sampling. Sites with water were included and there were two on Split Creek (ARD4 and ARD6), and one on its tributaries (ARD5). A summary of surface water quality results is presented below.

- pH was above the ANZECC trigger values for toxicants for the protection of slightly to moderately disturbed systems (pH 6.0 – 7.5) at ARD4 (pH 7.6).
- Electrical Conductivity (EC) was above the QWQG salinity guideline (200 µS/cm) at ARD4 (398 µS/cm).
- Dissolved Oxygen (DO) was below ANZECC guideline range (90 – 120 %saturation) at all sites sampled (69.1, 6.8, 20.9 %saturation at ARD4, ARD5, ARD6 respectively).
- Filterable reactive phosphorus (FRP) was above the ANZECC guideline (0.005 mg/L) at all of the sites sampled (0.016, 0.049, 0.015 mg/L at ARD4, ARD5, ARD6 respectively).
- Total aluminium concentration was elevated above the guideline value (0.055 mg/L) at ARD5 (0.15 mg/L).
- Total and dissolved uranium concentrations were below the LOR at all sites; however, the LOR (1 µm/L) was higher than the relevant guideline value (0.5 µm/L).
- All other physico-chemical parameters and metal concentrations were below published guideline values.

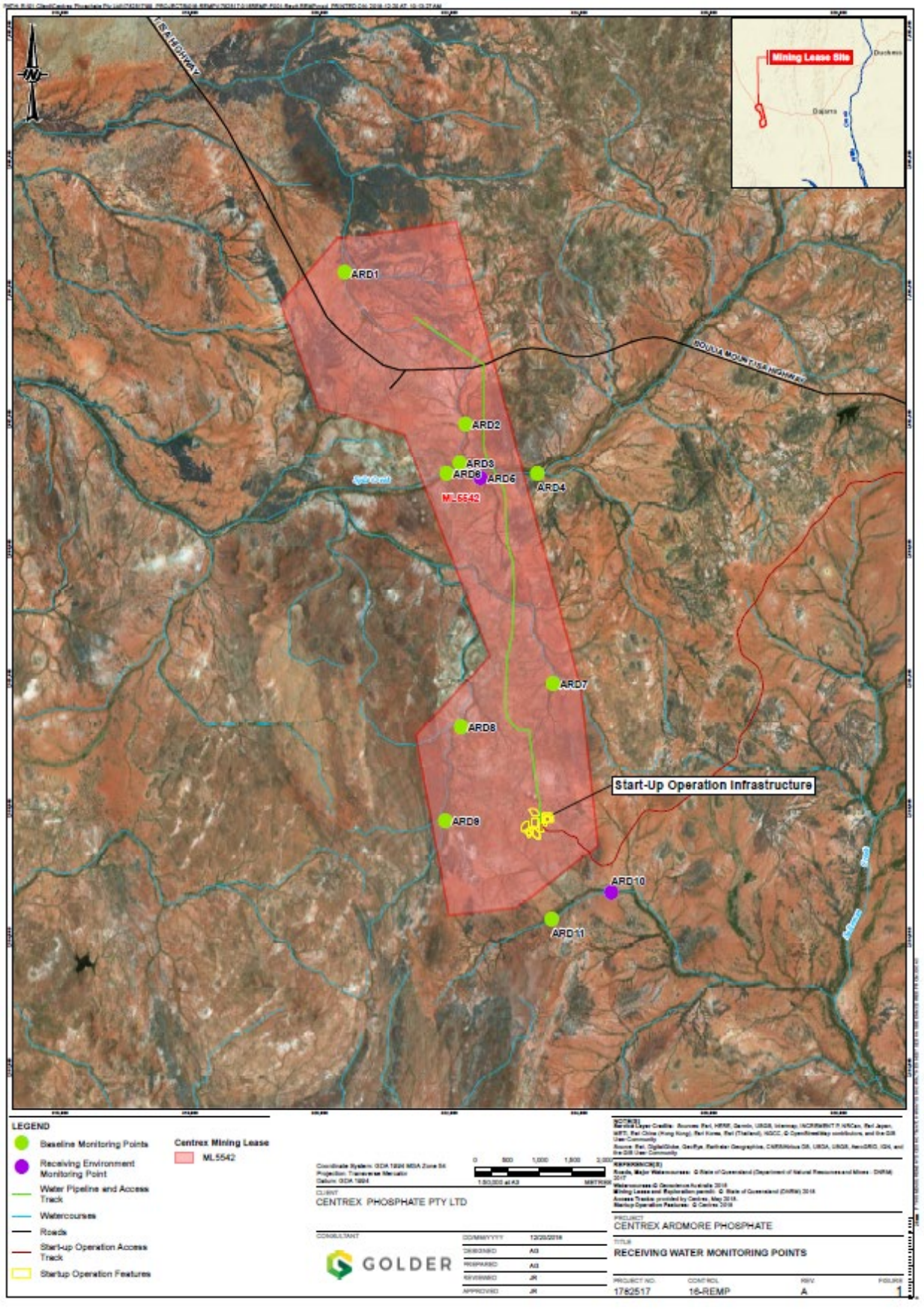


Figure 9: Receiving water monitoring points

The Environmental Protection (Water) Policy 2009 (EPP Water) defines the environmental values and water quality objectives for the surface water environment in Queensland. The Project tenure is situated in the Georgina River Basin. There are no water quality objectives prescribed in the EPP Water for the Georgina River Basin.

In accordance with the EPP Water, if there are no prescribed specific environmental values or water quality objectives for the waters on, or adjacent to, the site, then the water quality objectives are the set of water quality objectives that will protect all environmental values for the water. These are, in order of preference: site specific documents for the water, any Queensland water quality guidelines or any Australian water quality guidelines. Local water quality objectives can also be derived using the Queensland water quality guidelines procedures.

For the purposes of determining the individual site catchments an extracted Digital Elevation Model (DEM) was accessed from Geoscience Australia. This provided the spatial coverage to include the full extent of the site catchments. Using ARC GIS spatial analysis tools, the DEM was used to delineate the catchments to a set of fixed points on watercourse lines at catchment outlets (Figure 10).

The largest site catchment has been labelled as Catchment A and is on Split Creek. Catchment B has been defined from the confluence of 2 watercourses downstream of the Start-up Operation location. Catchments C and D will join at a point just to the west of the mining lease while Catchment E has been identified at the existing northern farm dam. Catchment F is further north of Catchment E and within the mining lease area. The area of each defined catchment is provided in Table 4.

Table 4: Site catchments

Catchment	Area (km2)
A	78.1
B	8.6
C	7.0
D	7.3
E	1.8
F	4.6

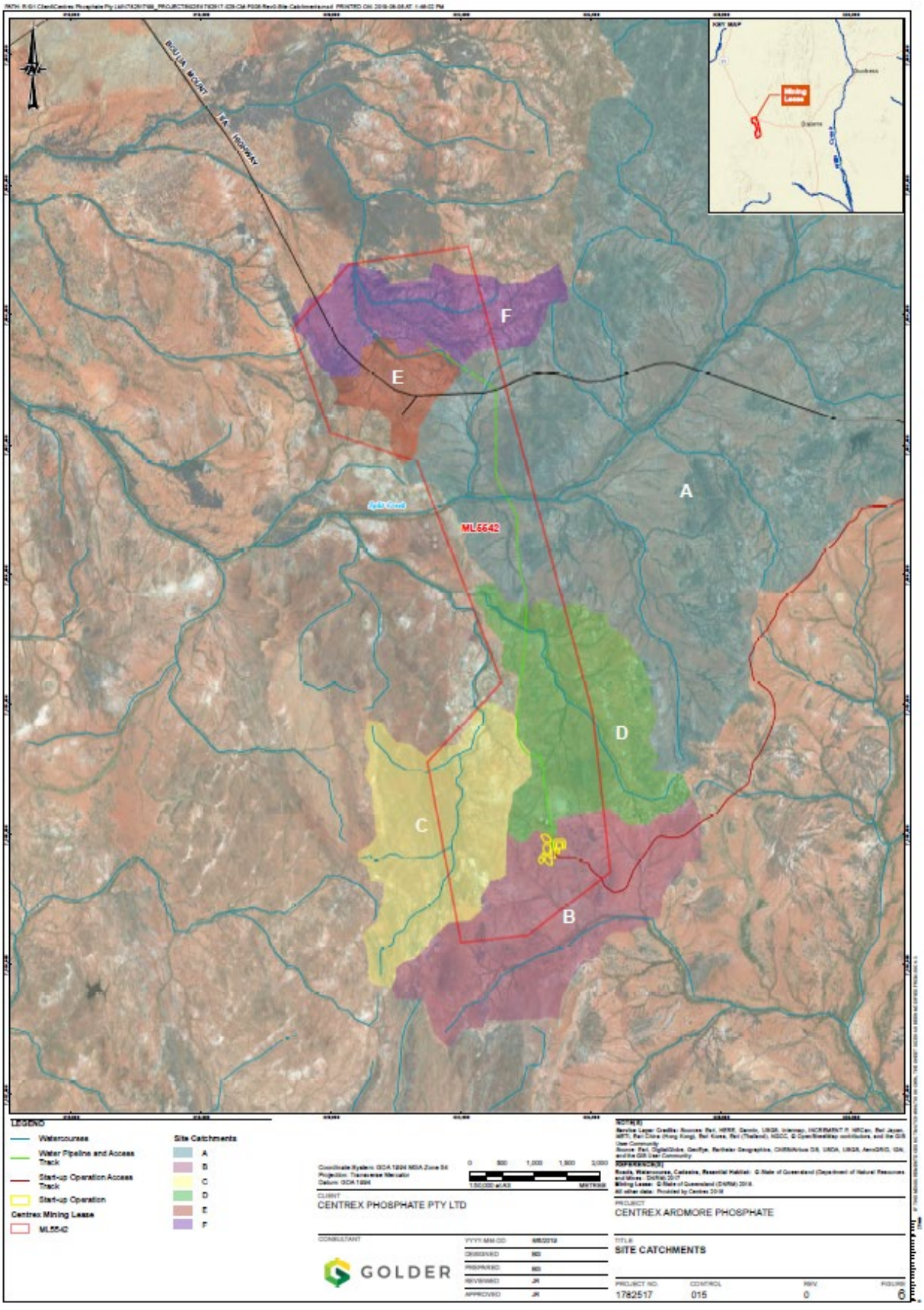


Figure 10: Site drainage basins

2.1.5 Hydrogeology

The ML is located within an outlier the Georgina Basin which extends across the Queensland - Northern Territory border as presented in Figure 11. This basin is described as a large northwest-southeast trending extensional sedimentary basin and contains mainly Cambrian-Ordovician dolomite and limestone aquifers, and some sandstone aquifers around the southern margin. Tertiary aquifers occur in small overlying basins. Groundwater flow is partly northwest to an internal drainage basin and partly southeast down the Georgina Valley and ultimately beneath the Great Artesian Basin. There are no artesian aquifers in the ML or in the ML area.

The Queensland Globe database shows 510 registered bores within 75 km of the Project, including 266 yielding bores. The majority of the high yielding bores are located in close proximity to the Phosphate Hill Mine Site, approximately 75 km from the ML. The nearest third-party production bore (Ardmore bore, RN5496) is located outside of the search area, about 11 km northwest of the project area. The drilling and installation of the bore was conducted early 1919 and the bore depth is 186.5 m below ground level.

Seven bores were identified within 11 km of the proposed mine site. A summary of the registered bores is presented in Table 5.

The use of the BCF aquifer for farming provides an unreliable water supply (flow and/or water quality are very poor) in the region. There are no known uses of this aquifer for farming in the project vicinity.

Table 5: Summary of registered bores within 11 km from the Project Area

Bore ID	Distance from groundwater extraction (km)	Bore Depth (m)	Drilled Date	Easting (m)	Northing (m)	Yield information	Status
5189	10	Unknown	Unknown	327677	7593150	No yield information	Decommissioned
5188	10	Unknown	30/09/1943	331373	7600251	No yield information	Decommissioned
5495A	1.5	29	10/07/1950	320024	7602481	No yield information	Abandoned. Bore does not exist / not located on the ground
5496 (Ardmore Homestead bore)	8	186.5	1919	312280	7603476	No yield information	Functional
8404	11	28	1916	332451	7602826	No yield information	Unknown
118041A (Frank's bore)	5	30	10/09/2002	315702	7603000	0.5 L/s	Functional
17915 (Sulieman's bore)	12	33.5	14/04/1968	333112	7601953	1.8 L/s	Functional

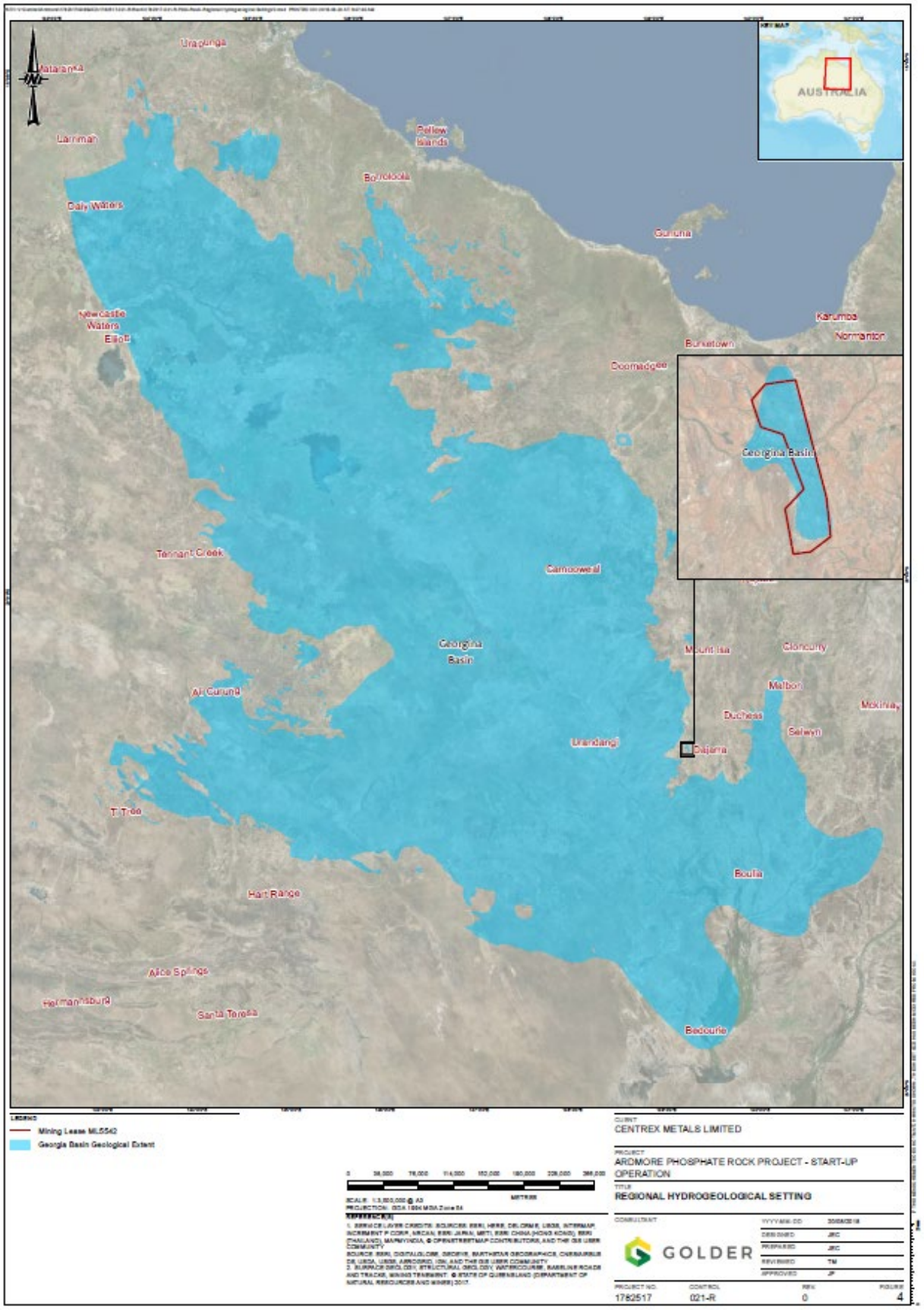


Figure 11: Regional hydrogeological setting

Exploration drilling by Agriflex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 meters below ground level (mbgl). A groundwater elevation map for the Northern zone of the ML was created based on the stabilised water levels measured in 2017 monitoring event presented in Figure 12.

Groundwater levels measured in the monitoring bores screened in the BCF show an elevation between 301.1 and 301.6 m AHD. Groundwater levels measured in the open boreholes show slightly lower groundwater elevations between 300.9 and 301.6 m AHD. The water table in the BCF in the northern part of the ML is essentially horizontal with very low hydraulic gradients.

In the southern part of the ML, the only monitoring bore screened in the BCF is dry at 324 m AHD (9.1 mbgl) (Figure 16). Based on exploration boreholes, moist ground conditions were encountered between 30 and 40 mbgl. A groundwater elevation map for this area is not provided.

Groundwater quality was assessed based on the results of two sampling rounds carried out in the monitoring bores installed in 2017 as well as in the landowner bore (Frank's bore). Field and laboratory analysis suggest that groundwater in the fractured rock aquifer of the BCF in the northern portion of ML5542 is generally brackish to saline, with laboratory Electrical Conductivity measurements ranging between 5,800 µS/cm to 22,500 µS/cm. The groundwater in this formation is generally neutral to slightly basic and is typically sodium-chloride dominant. Small concentrations of some metals, including As, Cd, Cu, Ni, Pb, and V, as well as TRH were found.

Field analysis collected during the development of monitoring bore MB03 indicate that groundwater in the Thorntonia Limestone formation in the vicinity of this monitoring bore is neutral with a pH value of 7.47 to 7.64 and highly saline with laboratory Electrical Conductivity measurements ranging between 16,500 to 16,800 µS/cm. The groundwater in this formation is generally neutral to slightly basic and is typically sodium-chloride dominant.

The concentration in major ions as presented in the Piper Diagram (Figure 13) suggest that the water contained in the Beetle Creek formation and the Thorntonia Limestone are from a same origin and possibly hydraulically connected.

Water sampled from Frank's bore was generally fresh, with laboratory EC measurements less than 1 000 µS/cm and basic pH ranging of 8.55. The dominant cation is Sodium and the dominant anion is Bicarbonate.

The concentration in major ions as presented in the Piper Diagram suggest that the water sampled from Frank's Bore is chemically different to the groundwater sampled in the northern part of the ML.

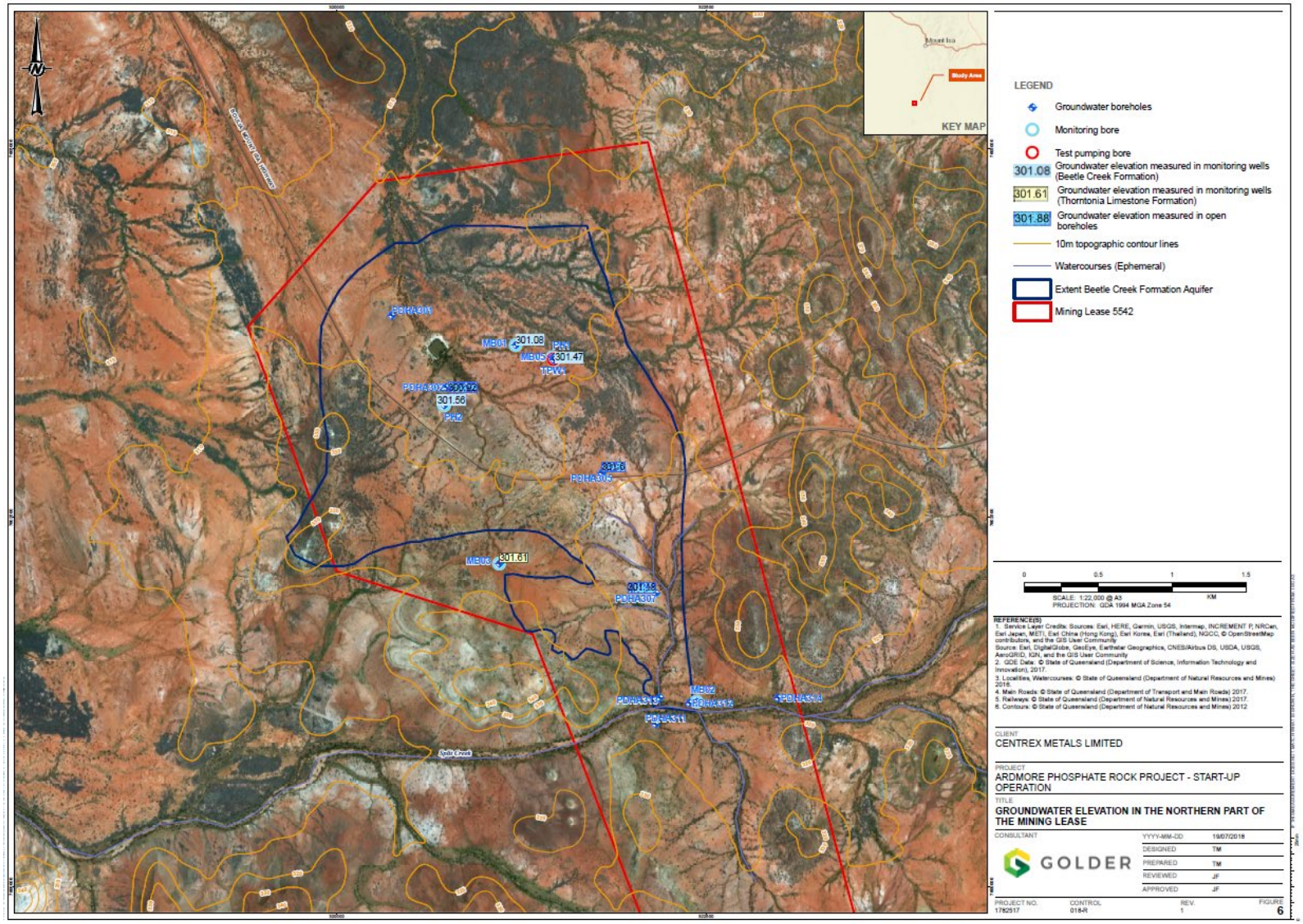


Figure 12: Groundwater elevation in the Northern zone

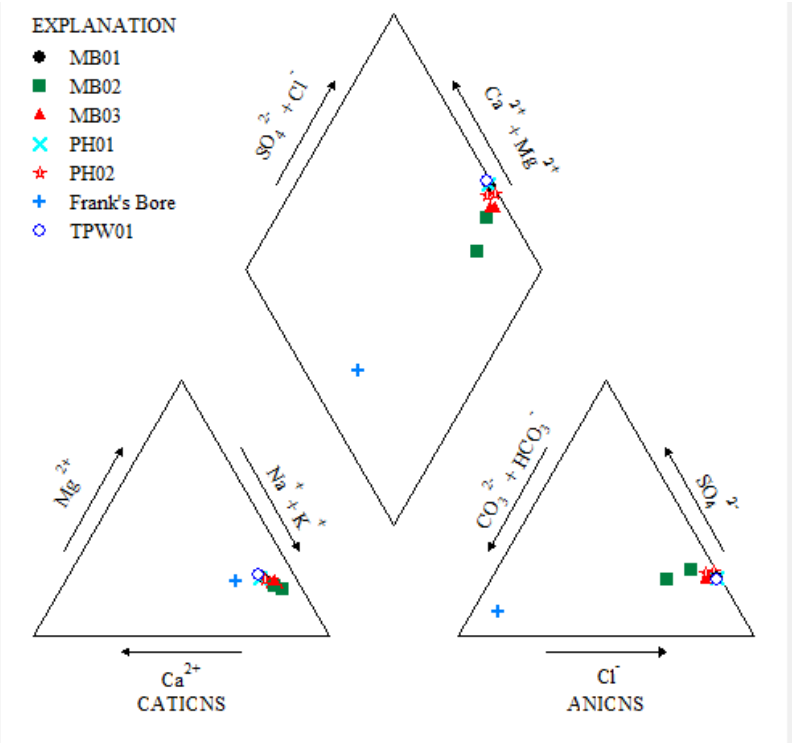


Figure 13: Piper diagram, November 2017

2.1.5.1 Hydrogeological Conceptual Model (HCM)

The description of groundwater conditions and the HCM has been developed for the ML, with a particular focus on the Northern zone (Figure 14) as this is where groundwater extraction activities will take place during the Full-scale Operation and it is where the groundwater exists beneath the ML. A HCM is provided for the Southern Zone in Figure 15, where the Start-up Operation will occur.

This section describes the capacity of the hydrostratigraphic units with respect to groundwater.

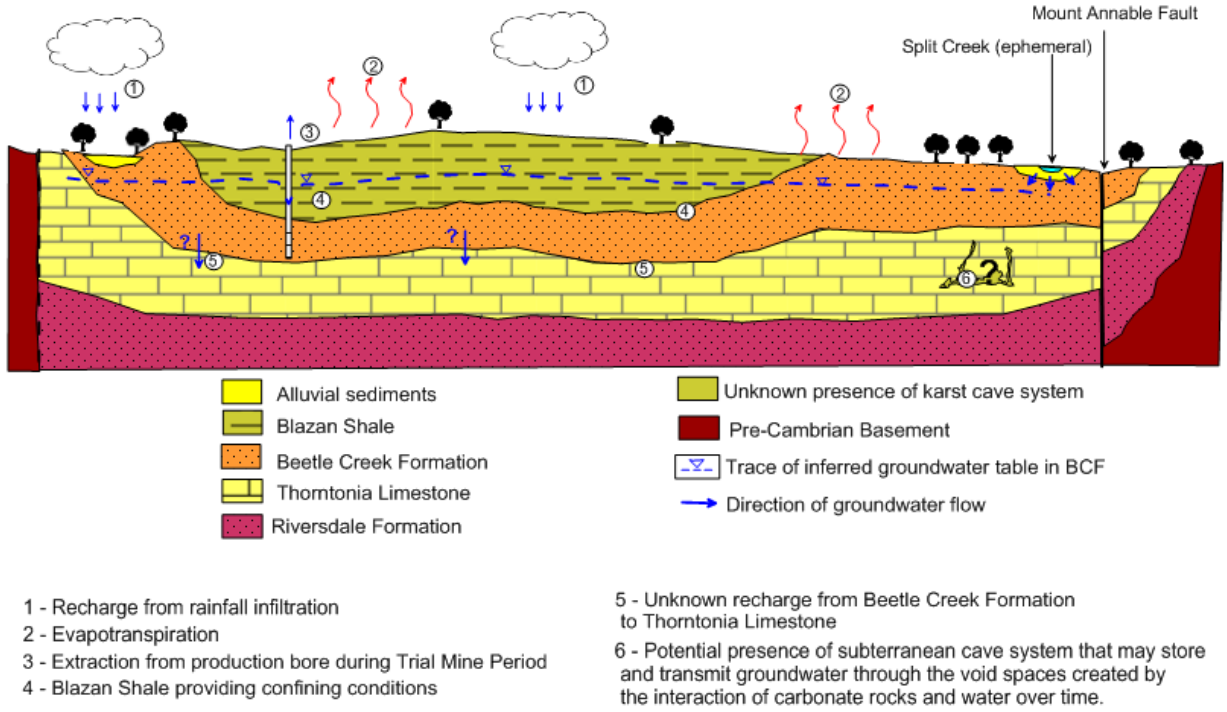


Figure 14: Conceptual hydrogeological cross section northern part of ML (N-S)

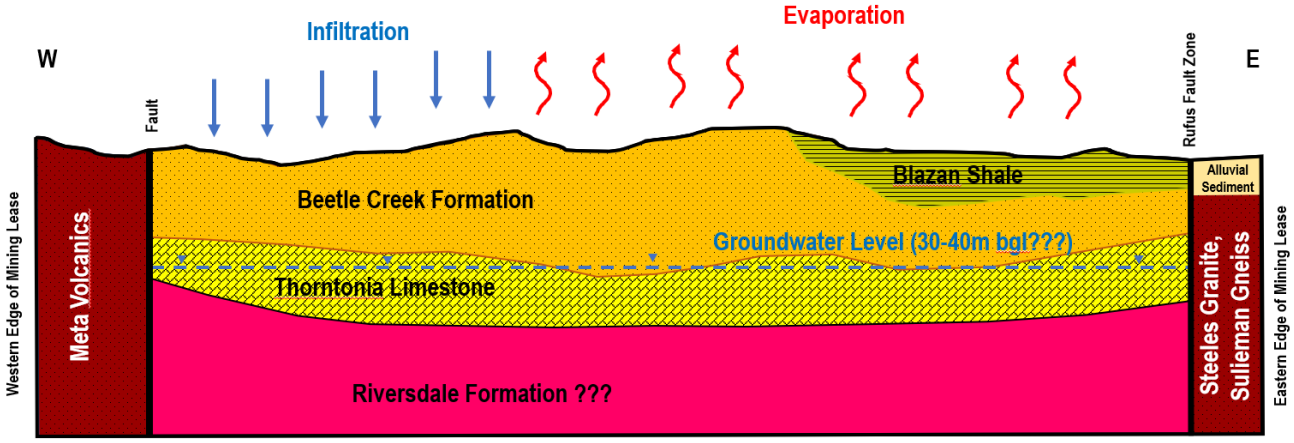


Figure 15: Conceptual hydrogeological cross section southern part of ML (W-E)

Blazan Shale – confining unit

The Blazan Shale conformably overlies the BCF and acts as an aquitard and locally confining unit to the underlying shallow groundwater aquifer. According to the exploration drilling carried out to date, the Blazan Shale has a thickness of up to 53 m locally.

As shown in Figure 8, in the Northern zone outcrops of the Blazan shale are limited in extent to the central part of the Northern zone. Near the edges, the shallow aquifer likely transitions from locally confined to an unconfined state.

The Blazan Shale unit is unsaturated and to date hydraulic properties have not been measured.

Beetle Creek Formation – shallow aquifer unit

The BCF is the major water bearing geological unit underlying the Project. This hydrostratigraphic unit is comprised of siltstone, shale and chert as well as some collophane mudstone in the upper member. The extent and thickness of this unit has been characterized through more than 300 exploration boreholes, several monitoring bores, and a geophysical survey. Based on the geophysical survey information the base of the BCF varies from 251 m AHD at the eastern part where it is truncated by the unnamed north south fault and 334 m AHD in the western area. This unit is estimated to have a maximum thickness of up to 34 m approximately 1500 m north of Split Creek on the western side of the Rufus Fault Zone.

In the Southern zone monitoring bore MB04 was drilled targeting this unit where only the lower part of this formation remains. No water was encountered during drilling of this well and during the three monitoring events carried out onsite, this well was found dry. The exploration drilling that targeted the BCF encountered moist ground conditions between 30 and 40 meters below ground level in a few drillholes below the proposed maximum depth of the Southern Pit. In the southern zone the BCF is believed to be dry.

The Transmissivity (T) obtained for the Beetle Creek Aquifer in the vicinity of TPW01 ranges between 950 and 1760 m^2/day with an overall geometric mean value of 1348 m^2/day. Based on a saturated thickness of 20 m at TPW01 the hydraulic conductivity (K) value of the BCF is 47-88 m/day with a mean of approximately 67 m/day. The BCF Storativity (S) values obtained from pumping tests are in the range of 2.82E-05 to 9.79E-03, which is consistent with published values for confined aquifers (Freeze, 1979).

Thorntonia Limestone – shallow aquifer unit

The Thorntonia Limestone has been described as light yellow, thin to thickly bedded dolomite and minor limestone with fossils throughout. In the northern part of the ML all boreholes drilled during the recent hydrogeological investigation have reached this unit, but a monitoring well has only been installed in the Thorntonia Limestone at MB03.

The Thorntonia Limestone is water bearing in the north and based on water chemistry is likely in hydraulic connection with the overlying BCF, forming part of the shallow aquifer.

The hydraulic conductivity estimated by the slug test in MB03 was 25-62 m/day, similar to values from tests in the BCF. This range is reflective of the fractured nature of the limestone encountered during installation of MB03. However, as MB03 it is the only onsite bore installed in the Thorntonia Limestone, it is not clear if the degree of fracturing and resulting hydraulic conductivity values are typical for this formation in other parts of the site, and at present the BCF is considered the main water-bearing unit of the shallow aquifer.

Riversdale Formation – aquitard

Underlying the Throntonia Limestone is the Riversdale Formation (RF), which outcrops along the western and southern margins of the ML5542.

Descriptions of this formation (MEPL, 1977) indicate that the upper part of the formation contains finer clastics and chemical sediments. Based on these descriptions and the lack of groundwater in the Southern zone, it is assumed that this unit is lower permeability than the BCF and may be functionally acting as a local aquitard.

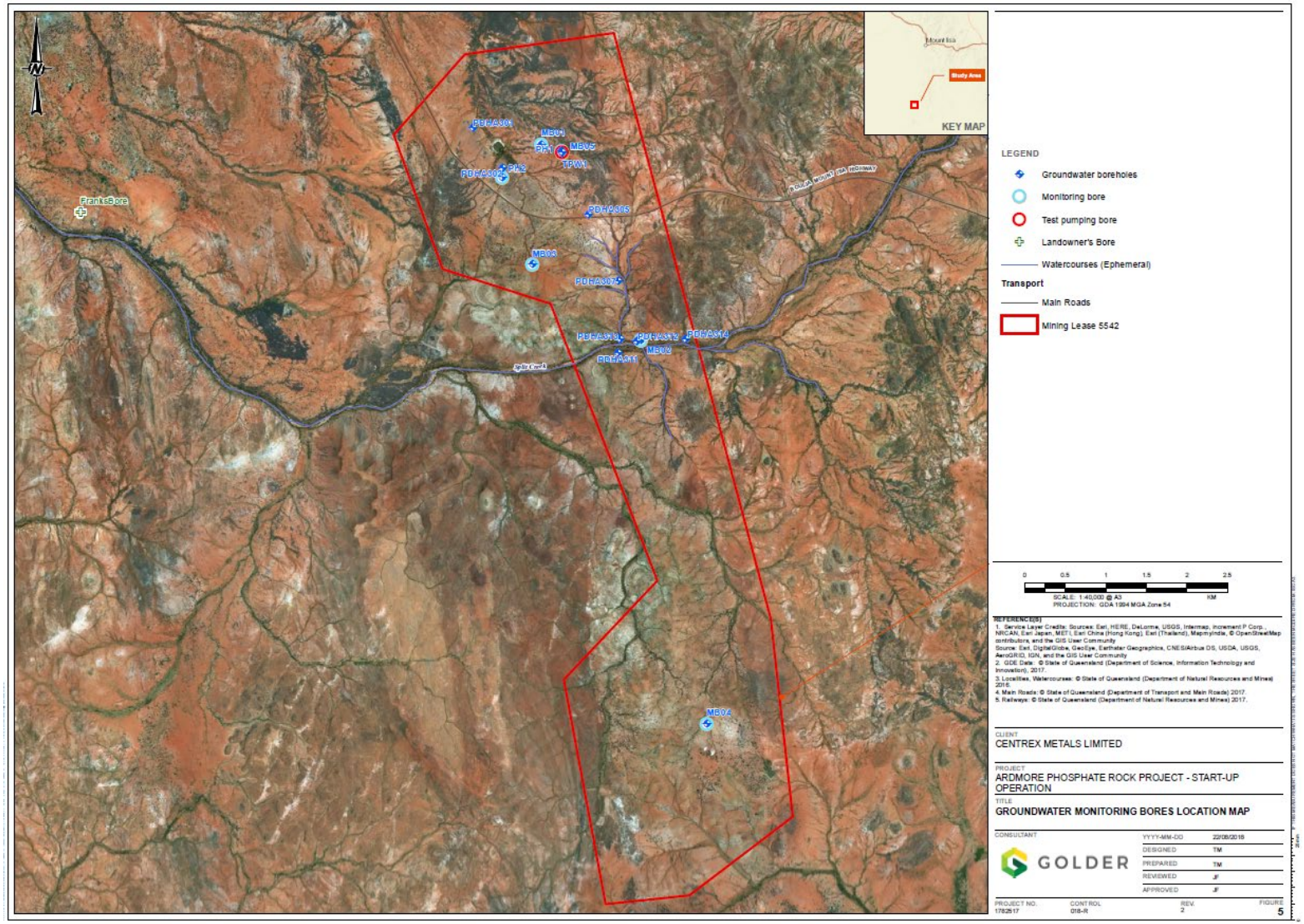


Figure 16: Groundwater monitoring bores location map

2.1.6 Soil

The existing soil in the area is mainly chromosols and kandosols, with the Project area dominated by chromosol soils. This soil is characterised as saline with high electrical conductivity and elevated concentrations of chloride. The topsoil layer is either not existent or very thin (<10 cm) with limited humus organic matter present. Two of the three soil test pit sites had high concentrations of sulphates in the subsoils, with gypsum the likely source at these locations.

Topsoil is thin to non-existent at the site however where it is recoverable, it will be stockpiled separately for use in rehabilitation activities. It will be stored no higher than 2 m and will be formed in shapes that aid the capture of incident rainfall and encourage continuing biological activity within the soil.

Observations of on-site water infiltration noted in previous investigations indicate that the site is very well drained, however some areas are known to pond with water during heavy downpours, likely due to the clay content in near-surface subsoils. A thin topsoil layer (<10 cm) comprising silty sand has been observed, during previous studies, across the majority of the site. Clay/sandy silt/gravelly deposits are red/orange in the southern section of the site with a contrast to a yellow colour in the Northern zone. Rock outcrops are observed scattered throughout the ML.

The soil supports ecosystems by providing a suitable growth medium for vegetation (good quality soil which remain stable in-situ). Impairment of either soil availability (quantity) or quality as a result of mining activities may impact terrestrial and aquatic ecosystems, and surface water quality. The environmental value for soil is therefore the provision of good quality soil of a suitable quantity for vegetation growth. For the project area the naturally saline soils supports little vegetation. The retention of soils in-situ (non-erosive) is also important to prevent adverse impacts to aquatic ecosystems and surface water quality.

Ten soil test pit locations (TP01 – TP10) were chosen based on those areas within the Project mining disturbance area, and the future potential Full-scale Operation area. A total of 29 soil samples from the ten test pits were collected for analysis. The test pit sites (Figure 17) varied in depth from 0 to 1.2 meters below ground level (bgl). To assess the onsite soil type and quality, the soil was analysed for the particle size distribution (PSD) and Emerson classification. The samples were also analysed included pH, EC, exchangeable cations, major cations, chloride, Total Kjeldahl Nitrogen (TKN), total phosphorus (P), total potassium (K), sulphur (S), total organic carbon (TOC), sodium adsorption ratio (SAR).

The soil at each site was also logged for the nature and condition of encountered lithology according to the Australian Soil Classification System (ASCS).

The soil lithology is variable on site depending on where the test pit was advanced in the site landform.

At locations TP04, TP05, TP09 and TP10, the test pits showed similar lithologies which were generally described in Table 6.

Table 6: TP04, TP05, TP09, and TP10 lithology

Depth	Lithology
0.0 - 0.3 m bgl	Sandy Loam to Light Clay, low plasticity, red to dark red, with plenty of silt, fine to medium sand and gravels, granular to blocky structure
0.3 - 0.6 m bgl	Sandy Clay Loam to Light Clay, low plasticity, dark red, with decreasing clay and silt content, plenty of fine to medium sand and gravels, massive structure.
0.6 -1.2 m bgl	Clayey Gravel, fine to coarse sub-rounded to angular gravel, dark red, with low to medium plasticity clay, plenty of sand, massive structure
	Weathered bed rock was intercepted at the bottom of test pits TP04 and TP05

At locations TP02, TP03, TP06 and TP07 the Blazen Shale formation was intercepted at shallow depths and pits were limited to 1 m depth. The general lithology at these locations is provided in Table 7.

Table 7: TP02, TP03, TP06, and TP07 lithology

Depth	Lithology
0.0 - 0.3 m bgl	Silty Loam to Clayey Gravel, low plasticity, dark red, fine to coarse sub-rounded to angular gravel. with some slit and fine sand.
0.3 - 0.98 m bgl	Sandy Loam to Sandy Clay Loam, low plasticity, dark red to orangish red, with many fine to coarse sub-rounded to angular gravels and cobbles.

At locations TP01 and TP08, thicker alluvium was encountered, and the Blazen Shale parent material was not intercepted. The general lithology at TP01 and TP08 is provided in Table 8.

Table 8: TP01 and TP08 lithology

Depth	Lithology
0.0 - 1.45 m bgl	Medium Clay, low to medium plasticity, dark red, with some silt and fine sand.

At TP01, crystalline inclusions were noted to be possibly gypsum. At TP08 white calcareous segregations were observed below 0.5 m bgl.

Across the ML there were areas of observed bedrock exposure. The Beetle Creek and Blazen Shale formations were observed near the northern portion of the lease area. Areas of exposed shale were observed in creek beds and erosion channels. There was also an area of granitic bedrock exposed near the middle of the lease area.

TP08 is the only test pit location within the Start-up Operation footprint area.

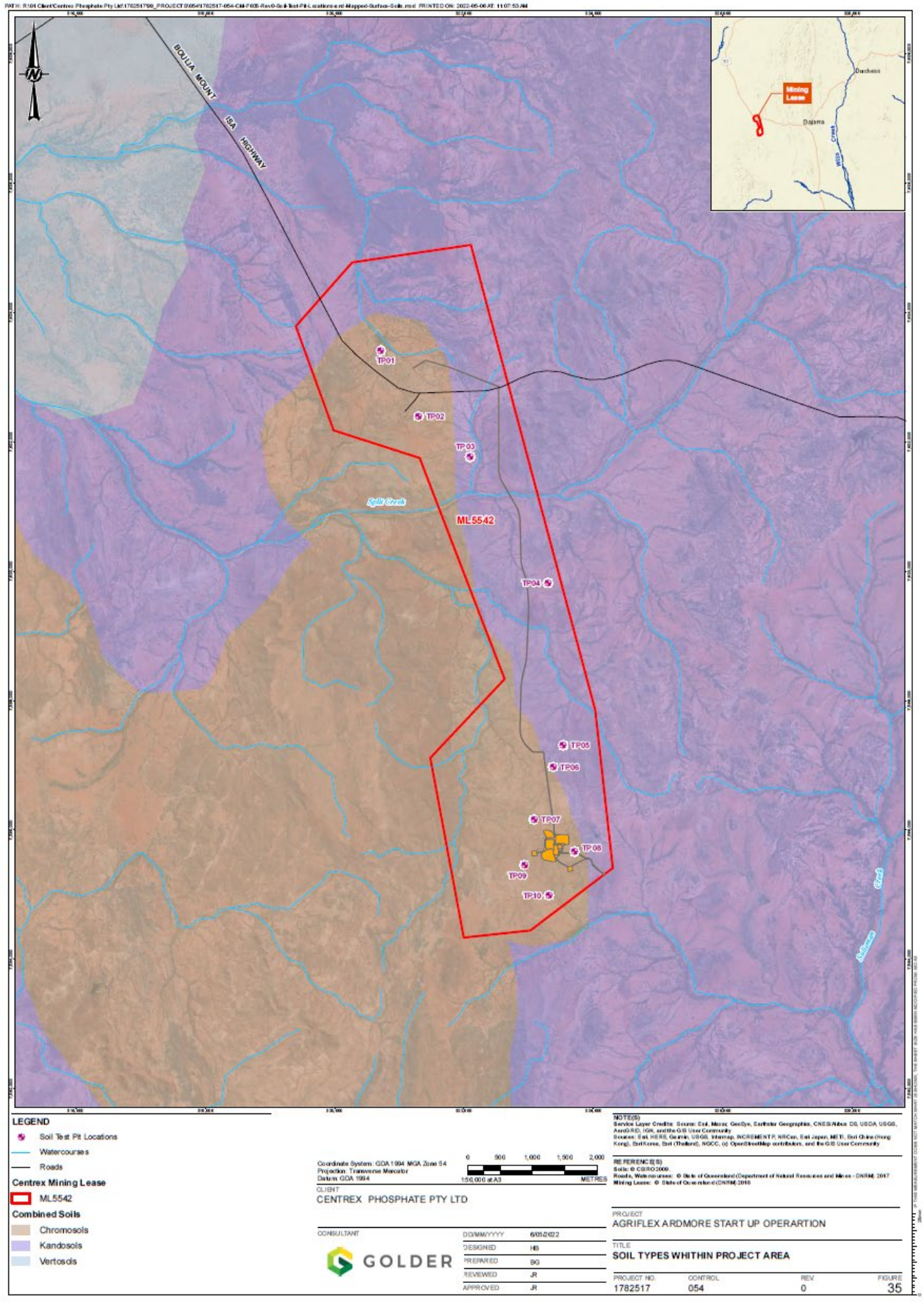


Figure 17: Soil types within the Project Area

2.1.7 Land stability

The Start-up Operation will be in the southern catchment of the ML. In this area, runoff is expected to be in the form of overland flow to the south east until reaching a natural drainage line which flows east until the confluence with the Sulieman Creek, a point about 6 km downstream of the Start-up Operation.

The area around the Start-up Operation generally slopes to the south east at around 1.4 degrees (°) and generally flattens towards the alluvial plans.

Surface soils in the Start-up Operation area have been sampled and identified as sandy clay loam. Surface soils have been found to be largely benign, though local overburden materials in some areas consist of elevated calcium, phosphorus and EC (RGS, 2018).

The ground cover generally consists of grasses and shrubbery and intermittent trees. Figure 18 shows typical ground cover and vegetation present on the project site. The local area is generally degraded by long term stock grazing. Clearing of land, as well as continued physical damage to waterways from stock movement contributes to erosion and sedimentation within waterways.



Figure 18: Typical ground cover and vegetation

2.1.8 Terrestrial ecology

The region is best described as sparsely vegetated with low, very open woodland on gravelly plains and slightly undulating areas primarily around rock outcrops. Denser vegetation occurs along ephemeral

watercourses however all areas have been significantly impacted by cattle grazing and pest plant species invasion is evident, particularly throughout all riparian areas.

NRC (2017, 2018a and 2018b) undertook two flora and fauna field surveys coinciding with timing for an early dry season survey between 31 May – 6 June 2017 and wet season survey between 19 – 23 March 2018. Aside from Regional Ecosystem (RE) 1.3.7b, all other REs recorded and mapped within the ML have a 'least concern' status under the VM Act, and a 'no concern at present' biodiversity status. The RE 1.3.7b (the River Red Gum (*Eucalyptus camaldulensis*) fringing woodland on Split Creek and some other watercourses and margins) has an endangered biodiversity status, and, therefore, is an ESA and Matter of State Environmental Significance (MSES) under the EP Reg.

Although no areas of regrowth or non-remnant vegetation are mapped within the mining lease, small areas have been cleared and modified to create stock-water dams for cattle. Similarly, small, isolated areas of disturbance, from historical and recent exploration activities, are present within the vicinity of the Project area. Essential habitat for the Purple-necked Rock Wallaby is mapped within the ML.

Cattle grazing has greatly reduced the biodiversity of the ground layer of most of the REs through direct grazing, and the introduction of pest plants. The introduced pasture grass, Buffel Grass (*Cenchrus ciliaris*) has invaded all riparian areas within ML5542, and this competition with native species has greatly reduced the biodiversity values of the riparian communities, particularly RE 1.3.7b.

The environmental values present within the direct vicinity of the proposed Start-up Operation location were predominately very sparse with limited to no habitat values, on RE 14.9.12x4a/4.9.10b.

The key environmental values of the area are summarised below:

- Remnant vegetation associated with a state-mapping defined watercourse or drainage feature is classified as a MSES.
- The RE 1.3.7b, a Category B Environmentally Sensitive Areas (ESA) was confirmed within the ML (29.2 ha), has an endangered biodiversity status, therefore is an ESA under the EP Reg.
- Split Creek which supports a substantial River Red Gum community, and more distinct riparian habitat values, including hollow-bearing River Red Gums is the only watercourse feature considered large enough to provide corridor connectivity values at the local scale within the ML.
- Threatened fauna and habitat for the State-listed vulnerable Purple-necked Rock-wallaby. While mapped Essential habitat is located in one area to the north-east of the ML (34.8 ha within the ML boundary), field-based assessment confirmed a lack of essential shelter habitat factors. Suitable habitat features were identified outside the ML to the east and south that may provide shelter and breeding habitat for the Purple-necked Rock-wallaby. A population was recorded 1.8 km to the northwest of the Project area in an area consisting of outcropping limestone, watercourse and spinifex grasslands, a preferred food source of this species.

Eight REs were identified during vegetation ground-truthing, none of which are threatened ecological communities (TECs) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) (NRC, 2017). Aside from RE 1.3.7b, all other REs recorded and mapped within the ML have a 'least concern' status under the VM Act, and a 'no concern at present' biodiversity status. The RE 1.3.7b has an endangered biodiversity status, and, therefore, is an ESA under the EP Reg. Although no areas of regrowth or non-remnant vegetation are mapped within the mining lease, small areas have been cleared and modified to create stock-water dams for cattle. Similarly, small, isolated areas of disturbance, from historical exploration activities, are present within the vicinity of the Project area (Figure 19).

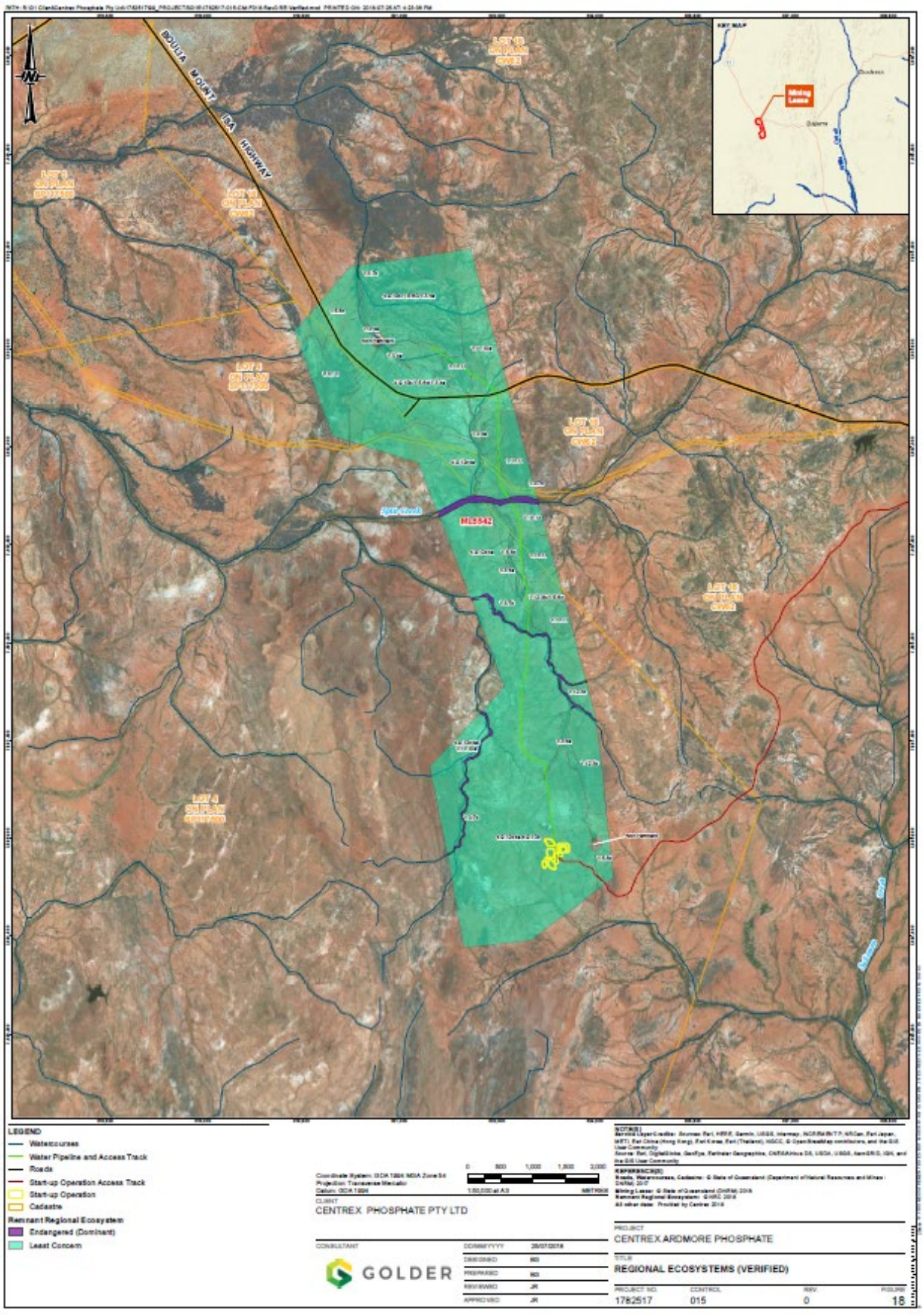


Figure 19: Regional Ecosystems

2.1.8.1 Flora

The region is best described as sparsely vegetated with low, very open woodland on gravelly plains and slightly undulating areas primarily around rock outcrops. Denser vegetation occurs along ephemeral watercourses however all areas have been significantly impacted by cattle grazing and pest plant species invasion is evident, particularly throughout all riparian areas.

Although no areas of regrowth or non-remnant vegetation are mapped within the ML, small areas have been cleared and modified to create stock-water dams for cattle. Similarly, small, isolated areas of disturbance, from historical and recent exploration activities, are present within the vicinity of the Project Area. Essential habitat for the Purple-necked Rock Wallaby is mapped within the ML.

Cattle grazing has greatly reduced the biodiversity of the ground layer of most of the REs through direct grazing, and the introduction of pest plants. The introduced pasture grass, Buffel Grass (*Cenchrus ciliaris*) has invaded all riparian areas within ML5542, and this competition with native species has greatly reduced the biodiversity values of the riparian communities, particularly RE 1.3.7b.

Eighty-one flora species, representing 31 families, are recorded within ML5542, none of which are listed under either the EPBC Act, or the *Nature Conservation Act 1992* (Qld) (NC Act). All the species recorded are common and widespread throughout the region. The vegetation diversity is reflective of the influences of cattle grazing.

Habitat values for most faunal groups were relatively low and sparsely distributed throughout ML5542. Connectivity values are limited given that the vegetation within the mining lease is part of a broader landscape. Limited microhabitat features, except in areas of rock outcrops and riparian communities, occur. Rocky outcrop features primarily occurred on the eastern and western borders of the mining lease where areas of eroded limestone or low outcropping hills were present. Small areas of limestone outcrops (typically less than 0.1 ha) occurred sporadically in the southern portion of the mining lease and provide some refugia for small fauna species in areas that were otherwise sparse and provided very limited fauna habitat. Distinct habitat features are associated with Split Creek, which has a large sandy bed, with mounds of woody debris collected in some areas and mature hollow-bearing River Red Gums. The only permanent water sources were the two stock water dams located in the north and south sections. Indeed, given the distinct seasonality of the rainfall, it can be expected that highly mobile species, in particular birds and bats, could move through the area during favourable times.

2.1.8.2 Fauna

A desktop assessment identified eight listed fauna species and six migratory fauna species with potential relevance to the ML. The desktop assessment identified that no threatened ecological communities (TEC) could potentially be within the ML, or within a 25 km radius of the ML. Two flora and fauna survey events were undertaken, coinciding with timing for an early dry season survey between 31 May – 6 June 2017 and wet season survey between 19 – 23 March 2018.

One threatened species of fauna was confirmed on the western edge of the ML - the State listed vulnerable Purple-necked Rock-wallaby. A population was recorded in an area consisting of outcropping limestone, watercourse and spinifex grasslands, a preferred food source of this species. A 34.8 ha area of essential habitat is mapped in the north-east of the ML boundary, with two observation records from 1976 and 1985 are associated with this area, however the ground-truthing of this area undertaken by NRC concluded the mapped essential habitat was considered marginal (NRC, 2018b).

Given their habitat requirements, the environmental values within the ML have a moderate or high likelihood of supporting an additional seven threatened species:

- Night Parrot
- Red Goshawk
- Painted Honeyeater
- Carpentarian Antechinus
- Plains Death Adder
- Grey Falcon
- Northern Leaf-nosed Bat.

The desktop assessment identified a further six migratory fauna which could utilise the environmental values of the ML. None of these species were recorded during field assessments, and all are considered to have a low likelihood of occurrence as it was determined The ML supports very few resources that would be important to the migratory species.

The paucity in habitat diversity is reflected in the fauna species recorded. Twenty species of mammals from ten families, 23 species of reptiles from eight families, three species of amphibian from two families, and 64 species of birds were recorded.

2.1.9 Aquatic ecology

The aquatic Groundwater Dependent Ecosystem (GDE) dataset expresses the potential for groundwater interaction for rivers, springs, and wetland ecosystems across Australia. It shows the ecosystems that rely on groundwater that has been discharged to the surface, for example, as baseflow or spring flow.

The GDEs identified with the Australian GDE Atlas are shown to potentially be located in the western and southern parts of the mining lease and are generally of Aquatic, Subterranean and Terrestrial type. GDE locations and the identified local registered groundwater bores are presented together in Figure 20.

The desktop search from Atlas GDE identified Split Creek as being an aquatic GDE. The field activities carried out onsite included a walkover of the entire site and the drilling of a monitoring bore close to split Creek (MB002). Split Creek has been identified as an ephemeral creek and a recharge area for the aquifer, with the water table within the BCF in the vicinity of Split Creek is 8 mbgl. Drawdowns in the groundwater levels in the BCF in the area of Split Creek will not impact the creek.

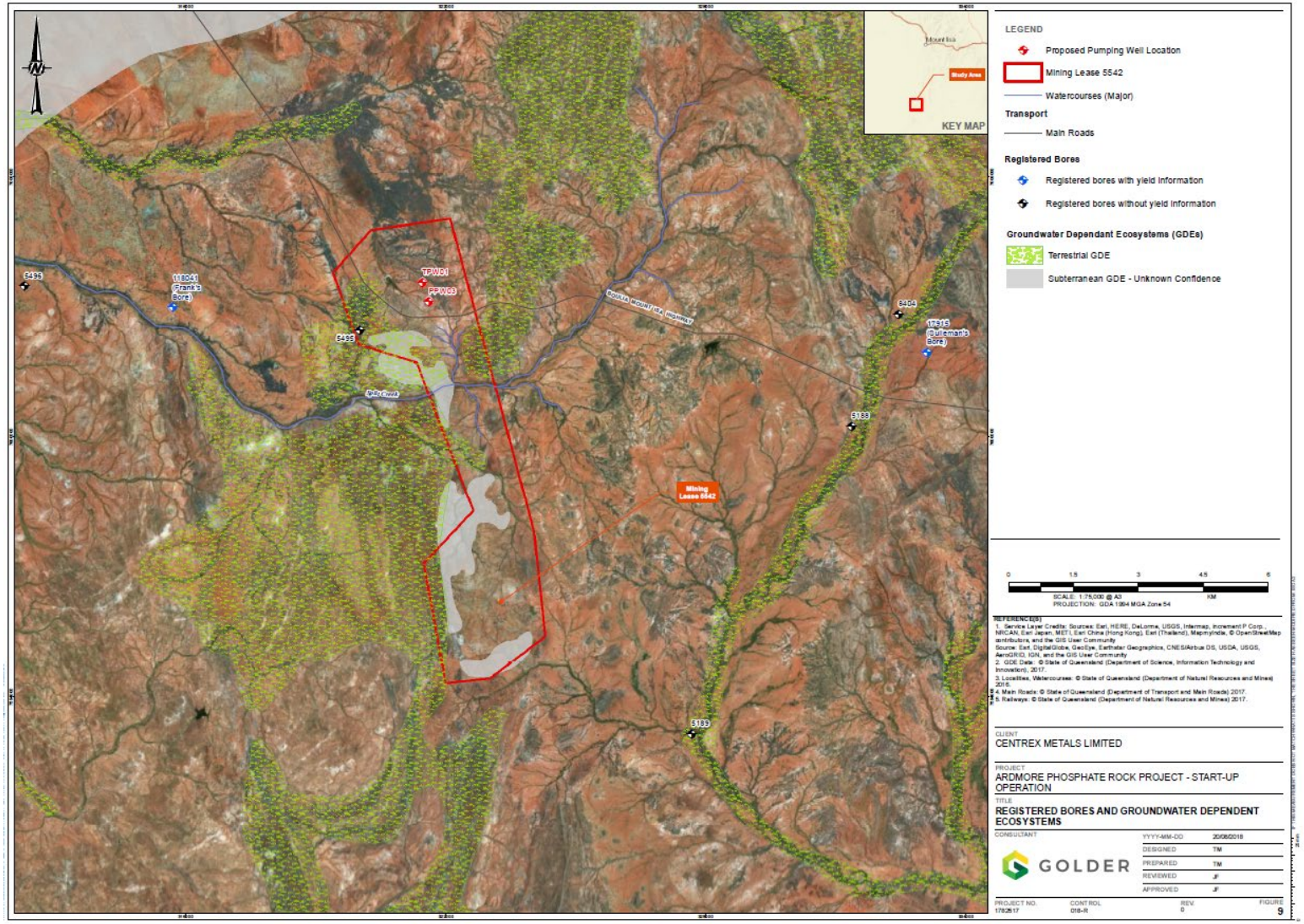


Figure 20: Registered bores and groundwater dependant ecosystems

2.1.10 Weed and pest species

Cattle grazing has greatly reduced the biodiversity of the ground layer of most of the REs through direct grazing, and the introduction of pest plants.

The introduced pasture grass, Buffel Grass (*Cenchrus ciliaris*) has invaded all riparian areas within ML5542, and this competition with native species has greatly reduced the biodiversity values of the riparian communities, particularly RE 1.3.7b (see Figure 21 and Figure 22). The invasive Mimosa Bush (*Vachellia farnesiana**) is commonly present in the shrub layer on the margins of riparian areas. Like Buffel Grass, Mimosa Bush is not a prohibited or restricted invasive plant in Queensland under the Biosecurity Act 2014, nor is it a declared weed within the Cloncurry Shire. While the canopy of the riparian community remains relatively intact, the biodiversity values of the understorey layers are severely degraded. Similarly, the REs away from the watercourses exhibit similar, albeit lesser, levels of degradation.



Figure 21: RE1.3.7b River Red Gum (*E. camaldulensis*) Fringing Open Woodland



Figure 22: Narrow RE1.3.7b Riparian Community with Buffel Grass invasion

2.1.11 Pre-mining land use

This section outlines the historical Indigenous and European land uses for the area.

2.1.11.1 Historical Indigenous land uses

A search of the Department of Aboriginal and Torres Strait Island Partnerships (DATSIP) Cultural Heritage Register of the ML area did not identify any Aboriginal cultural heritage sites. As ML5542 is “pre-1996 grant”, the lease area is not subject to matters related to the Native Title (Queensland) Act 1993. The determination recognised the rights and interests of the holders of ML5542 as falling predominantly within the 2014 determined Bularnu Waluwarra and Wangkayujuru People (BWW) Native Title area. Approximately 99 ha of the lower southern portion of the ML extends into an area not covered by currently registered or determined native title claims. Consultation with Queensland South Native Title Services (QSNTS) legal officers identified the last registered claim on this area being from the Kalkadoon people (RBC Environmental, 2017).

No non-indigenous recorded/protected historical sites or places were identified within the ML. The Moonah Creek ‘Hanging Tree’, a tree with historical significance for encounters between indigenous and non-indigenous peoples in the 1870s-1890s, is identified on the Queensland Heritage Register as being located within the Ardmore Station property, however it does not fall within the ML boundary (DES, 2016).

An aboriginal cultural and historic heritage assessment of the lease area was undertaken by RBC Environmental together with traditional owner representatives on behalf of Agriflex in June 2017, in accordance with the *Queensland Heritage Act 1992* and *Aboriginal Cultural Heritage Act 2003* (ACHA) Duty of Care guidelines.

While some areas of the site were found to be highly disturbed, the ground surveys have identified Aboriginal archaeological sites consisting of a series of knapping and ‘assaying’ sites associated with outcropping chert and/or exposed nodules. Though many of these artefacts are largely considered to be of low significance

given the type and abundance of isolated artefacts throughout the area. There was one high significance artefact site location within the wider area, however this is outside of the area of disturbance for the Start-up Operation.

An additional targeted field survey was conducted in August 2017 over the Project area. Two artefact sites from the earlier survey were found to be within proximity to the Project's area of disturbance – a chert knapping and worked silcrete outcrop. No areas or sites of historical significance were identified during field assessments.

2.1.11.2 Historical European land uses

Established in the early 20th century, Dajarra began as a railway construction camp for the Great Western Railway, extending the train line from Cloncurry in the 1920s. Being the most western-point of the Queensland rail system, it rapidly became strategically significant as one of the world's largest cattle-trucking depots, as it provided access to the east coast markets and ports for international export (RBC Environmental, 2017; O'Rourke, 2011). No areas or sites of historical significance were identified during field assessments.

2.1.11.3 Land system mapping

The land systems of the regional area have been mapped by the CSIRO (1954). The land system mapping considers the topography and land forms, soils, vegetation, and climate and categorise the land suitability. The Project Area is mapped as 'Pasture land – native pastures', which is in line with what the land is currently used for. The current land use surrounding the Start-up Operation is grazing and native vegetation which is mostly and rocky in places (Figure 23 and Figure 24).



Figure 23: Pre-mining land use ROM pad area



Figure 24: Pre-mining land use processing plant area

2.1.12 Underlying landholders

The ML is within two (2) land tenure parcels; Lot 16 CW62 and Lot 4 SP117500 (both Lands Lease) within the Cloncurry Shire local government area across the north-eastern corner, and Lot 4 on SP117500 within the Boulia Shire Council local government area for the remainder of the Project site.

The underlying landholder of the Corella Park Station is the McMillan Pastoral Company Pty Ltd.

The landowner intends to keep ownership of the land post mining (as pastoral lease tenure). The proposed post-mining land use will be the same as the pre-mining land use; grazing on native pastures.

2.2 Project description

The Start-up Operation will process ore on a small scale to obtain phosphate rock concentrate samples for marketing, optimising plant configuration, developing design parameters and enhancing recovery. The Operation will extract ore using shallow open-cut strip mining.

Mining involves removal of overburden and shallow phosphate rock at shallow depths and will not reach the water table during mining operations.

The Start-up Operation will require approximately 12 people to be employed on a short-term basis. Concentrate will be loaded onto containers and trucked to Cloncurry for export by rail to Townsville.

The extent of mining is shown in Figure 3.

2.2.1 Mining tenements

ML5542 encompasses 2,209 hectares (ha), with the target high-grade phosphorite deposit occurring as a single, essentially flat lying unit within two separate areas, the “Northern zone” with a strike extent of approximately 4.0 km (N-S) and the “Southern zone” with a strike extent of approximately 1.6 km (E-W). The

target phosphorite unit is shallow dipping, with the average depths of the hanging wall and footwall contacts being 8.3 m and 12.0 m respectively based on drilling to date.

Mining is only occurring in the southern portion of the lease, as shown in Figure 2 and Figure 3.

The EA for the Project permits a maximum disturbance area of 22.92 ha for mining (including mining infrastructure, pit, TSF, as well as water infrastructure disturbance).

ML5542 encompasses two land parcel tenures across two council shires:

- Lot 16 on CW62 within the Cloncurry Shire local government area across the north-eastern corner of the ML.
- Lot 4 on SP117500 within the Boulia Shire Council local government area for the remainder of the ML.

The current land use is low intensity grazing and with native grasses and vegetation in the general area.

2.2.2 Environmentally relevant activities

Environmentally relevant activities, as listed in Schedule 2 of the *Environmental Protection Regulation 2008* are being sought under this application. These are listed in Table 9 below.

In accordance with section 19A of the EP Act, activities listed in Schedule 2 of the EP Regulation are referred to as ancillary activities as they form part of the recourse activity as a single integrated operation on-tenure.

Table 9: Environmentally Relevant Activities

Environmentally Relevant Activity (Ancillary Activity)	Threshold	AES Score
21 (Resource)	A mining activity that is an ineligible ERA, other than a mining activity mentioned in items 9 to 20	136
31(2)(a) – Mineral Processing	Washing, leaching, classifying, mixing and concentrating mineral products (between 1,000t to 100,000t)	179
33 – Crushing, Milling, Grinding or Screening	Crushing, grinding, milling or screening more than 5,000t of material in a year	No score

Note: ***screening*** includes washing, crushing, grinding, milling, sizing or separating material.

2.2.3 Mine features

The layout of the mine features for the Start-up Operation is shown in Figure 3. The features consist of a south and north pit, overburden storage facility and ROM pad, processing plant and tailing storage facility (TSF) including an earthen bund.

The Project consists of a demonstration processing plant (Figure 25) and a small-scale open pit to be constructed within the Southern zone of the ML.

The Project will disturb a total area of approximately 22.92 ha in total. This includes (for Phase 2): a 1.97 ha pit area, a 1.71 north pit area, 2.93 ha TSF and TSF fence area, 1.10 ha for borrow pits, 3.24 ha ROM area, 7.42 ha for roads and tracks, 1.54 ha for mine infrastructure, and 3 ha of exploration activities.

A 5 m wide corridor approximately 8.5 km in length will accommodate an 80 mm diameter water pipeline from two bores in the north of the ML to the processing facilities and an accompanying single vehicle access track

for pipeline maintenance (4.3 ha). The pipeline will be temporarily laid on the surface along a route from the north to the south of the ML as shown in Figure 3.

Mining is currently occurring in a pit in the southern area of the 'Mine Area'. During this stage, the overburden is stored in the area adjacent the pit and then backfilled. The next phase will involve mining in the area just to the north of the current pit (previously designated as the ROM pad) referred to as the northern pit. The area previously mined will be backfilled and then used as the ROM pad area. The approved area of disturbance for Phase 2 (maximum area of disturbance) is provided in Table 10.

Table 10: Area of disturbance – Phase 2

Disturbance area				
Mine Domain	**Mine Feature Name**	**Map Reference (GDA94 MGA zone 54)**		**Maximum Area of Disturbance (ha)**
		Easting	**Northing**	
Mine infrastructure area (MIA)	Process plant and infrastructure	323414	7595704	1.54
Run of mine (ROM)	ROM Pad	323301	7595606	3.24
Pit	Open-cut pit (including ramps and bunds)	323323	7595780	1.97
	Open-cut pit north (including ramps and bunds)	323313	7595927	1.71
Tailings storage facility (TSF)	TSF and TSF bund	323516	7595855	2.93
Borrow areas	Borrow pit 1	323083	7595639	1.1
	Borrow pit 2	323636	7595401	
Roads and Tracks	Roads/tracks and park-up area	Linear features		7.43
Exploration	Exploration activities	Costeans, drill holes and associated exploration disturbance		3.00
Total				**22.92**

An existing station road will be used for access and temporary haulage along a 11 km distance from the processing plant to the highway (1 km from the processing plant to the ML boundary).



Figure 25: Processing plant area

The operation also includes two borrow pits, each be approximately 70 m x 70 m x 3 m depth, which includes an allocation for bunds, ramps and soil stockpiles. Subsoil and topsoil will be removed and stockpiled prior to mining. A leased, containerised diesel genset and distribution board provides power to the Project, supplying 415 V, 50 Hz. The distribution board will feed through to both individual small power users and the main process plant board.

Agriflex has approval to extract water from the Northern zone of the ML from two production wells located in the BCF. The approved extraction bores coordinates are presented in Table 11.

Table 11: Coordinates of approved production wells

Extraction well ID	Easting (m)	Northing (m)	Yield (L/s)
TPW01	321468	7603572	7.5 L/s
PPW03	321625	7603123	7.5 L/s

The Project will store approximately 40,000 litres of diesel during site operations. The diesel will be stored in specialised fuel tanks with built-in bunding and spill protection measures compliant with Australian Standard 1940: 2017. The storage and handling of flammable and combustible liquids. Chemicals used on site will include a flocculant for the ore processing, and oils for machinery and vehicle maintenance such as engine and hydraulic oils.

2.2.4 Type of mining operation

The Start-up Operation consists of a demonstration processing plant and small-scale open pits to be constructed within the Southern zone of the ML. The Project will extract ore using shallow open-cut strip mining.

The target phosphorite unit is shallow dipping and outcropping in many areas with the average depths of the hanging wall and footwall contacts being between 8.3 m and 12.0 m. Excavations and dozer stripping trials of

the overburden undertaken by Agriflex to date indicate that mining will be possible by free-digging, with no blasting required. Agriflex propose to mine the deposit with eight separate cuts.

Dozers will remove the topsoil and place it in stockpiles for later use in rehabilitation. The shale overburden will then be removed and placed within the overburden storage facility. A truck and shovel will then extract the ore placing it on the ROM ore stockpile.

ROM ore will be processed in the demonstration plant to produce concentrate.

The aim of the mining operation is to supply phosphate rock concentrate to fertiliser plants in Australia (which are currently reliant on imported phosphate) and export throughout the region.

2.2.5 Duration

The Start-up Operation is a small-scale operation and will extract ore over a 6-month period.

More specifically, the life of the operation is broken down into the following elements:

- Plant erection and commissioning: 4-6 weeks
- Mining construction: 2-3 weeks
- Mining: 6-8 weeks
- Processing: 7-20 weeks.

Mined ore will be stockpiled on the ROM pad until the process plant construction is complete.

2.2.6 Design of mine features for closure

By its nature, the Start-up Operation's closure will either constitute a transition into the Full-scale Operations or go through a closure process is the venture is deemed non-viable. The mine has been designed to manage overburden, topsoil, subsoil to enable rehabilitation should the Full-scale Operation not proceed.

If Full-scale Operations are to proceed on the ML, the pit void created by Start-up Operation will become part of the southern pit and progressively backfilled with overburden. Processing equipment will be re-located to the Full-scale process plant location to the north of the southern pit. The contents of the Start-up Operation's tailings dam will be pumped to the Full-scale Operation TSF and the pond liner recovered. A separate, more detailed PRCP relating to the updated EA would be developed for this in the future, if the Full-scale Operation proceeds. If the decision is made for the Full-scale Operation not to proceed then the mine closure and rehabilitation plan provided in this PRCP for the Start-up Operation will be implemented.

Following completion of the mining, the pits will be backfilled with overburden and material from the ROM and the process plant and associated infrastructure will be de-commissioned. A significant portion of the infrastructure will be leased equipment which will be removed from site and returned to the rental companies.

The total area that will be disturbed by the Project is approximately 22.92 ha. The landowner intends to keep ownership of the land post mining (as pastoral lease tenure). The proposed post-mining land use will be the same as the pre-mining land use; grazing on native pastures.

2.2.7 Progressive rehabilitation

As further described in Section 2.2.9, the ROM pad area will be mined before mining migrates north to the pit area (Figure 3). Once the ROM pad area is mined, the void area will be backfilled with materials which were stored directly to the north. Progressive rehabilitation will occur on areas of the progressively backfilled pit.

The mine closure process begins with planning during the design, assessment and permitting phases of the Project prior to its construction and continues throughout the life of the Project. Closure planning aims to reduce the residual liability and risk of a project. The aim of closure planning is to have a structured and systematic mine closure and completion process to:

- Achieve acceptable environmental outcomes.
- Reduce the financial burden of mine closure and rehabilitation.
- Avoid the site becoming hazardous and a source of pollution for legacy in the future.

This mine closure concept has been developed to demonstrate that the Project can be adequately closed and the plan is technically, economically and socially feasible.

2.2.8 Existing rehabilitation

No significant rehabilitation has been undertaken yet at the Start-up Operation.

2.2.9 Land unavailable for rehabilitation until operations cease

Mining is currently occurring in a pit in the southern area of the 'Mine Area' (Figure 3). During this stage, the overburden is stored in the area adjacent the pit and then backfilled. The next phase will involve mining in the area just to the north of the current pit. The area previously mined will be backfilled and then used as the ROM pad area.

The mining areas (pit, overburden, ROM) will be rehabilitated as the project progresses. The processing plant and TSF will remain until the decision is made on the Full-scale operation. The roads and bores will remain for the landholder at mine completion.

The ‘Mine Infrastructure Area’ will contain the processing plant which will remain in place until the decision is made on the Full-scale operation. This is in line with Section 126D of the EP Act, where the processing plant will be used as operating infrastructure.

The land surrounding the Start-up Operation has probable and proved ore reserves that are planned to be mined within 10 years. It is one of the few remaining undeveloped high-grade phosphate rock deposits with an estimated 16.2 million tonne of phosphorite Mineral Resources (incorporating Joint Ore Reserves Committee (JORC)-defined Measured, Indicated and Inferred categories) at 27.8% P_2O_5, using a 16% P_2O_5 cut-off grade (Centrex Metals, 2018).

The TSF for the Start-up Operation is within the footprint of the Southern Ore zone (where ‘proved’ ore reserves exist). If the Full-scale operation proceeds the tailings contents will be extracted and placed into the larger Full-scale TSF. The Start-up Operation TSF as outlined in the PRCP and the approved EA, will remain in place (not rehabilitated until the decision is made not to proceed with the Full-scale operation. If the decision is not to proceed, then the TSF will be rehabilitated.

As such, there will be a disturbance area of 4.47 ha (TSF and the processing plant area) (which will be unavailable for rehabilitation until operations cease or until the decision is made whether Agriflex will proceed with the Full-scale Operation.

3.0 COMMUNITY CONSULTATION

Agriflex is committed to developing and maintaining a mutually beneficial relationship with the local community. Consultation activities by Agriflex for the Project commenced in 2017 and has been ongoing throughout the life of the Project. Agriflex has in place a Community and Landowner Liaison Program (CLLP) that provides a roadmap for:

- Identifying which stakeholders may be affected by the mining activities.
- Identifying the potential benefits to the local community from the Project.
- Ensuring the relevant stakeholders are fully informed of the proposed activities and that Agriflex is engaged with the community concerns and issues.

It is Agriflex's commitment that all stakeholders must be provided with, and encouraged to take, the opportunity to communicate any concerns or interests that they may have on the Project.

3.1 Primary stakeholders

Agriflex has established a project database of affected and interested stakeholders for reference during the Project. It lists the latest stakeholder and property owner contact information, acts as a central repository for all highlighted issues during the consultation process and summarises the response to all received submissions.

The project's key stakeholders are categorised in Table 12.

Landholders and property managers have been provided with information on the Project and have been briefed on Project outcomes, timelines, and proposed activities within their respective properties.

Agriflex continues to maintain regular contact with landholders and property managers via letters, emails, phone conversations, and face-to-face discussions.

3.2 Community consultation register

Two community information sessions have been held for the Project on Tuesday 15th May 2018 and Tuesday 4th December 2018 at the Jimberella Hall, Dajarra, where provisions were made for interested stakeholders to attend a 'walk-in' consultation session. The purpose of the community information session was to generate awareness and provide a platform to discuss the Project in detail (including discussion on the rehabilitation and closure), encouraging a mechanism to engage key stakeholders and incorporate community input into the Project.

The May information session was conducted over four hours and attended by approximately 35-40 local representatives, while the session conducted in December was held over two hours with approximately 25-30 attendees. At both sessions, three (3) Agriflex and at least one (1) Golder representatives were available to discuss the Project with attendees. Attendee numbers are approximate as it was not mandatory for attendees to record their names with Agriflex. Accordingly, the proportion of new stakeholders in attendance at the December session is unknown.

Stakeholders comprised of Dajarra local community members (e.g., residents, local business owners, emergency services representatives, local school and health clinic personnel) and representatives from the wider community, including the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), State Member of Parliament (MP) Robert Katter, Boulia and Cloncurry Shire Councils and regional business owners.

Through this community engagement session, feedback obtained from key stakeholders and members of the community about the intended project was positive, and outlined three core themes:

- Employment and other potential benefits to the community
- Road traffic (dust, noise, and safety)
- Water availability and quality.

There were no particular issues or concerns raised relating to mine closure or rehabilitation.

The community indicated high levels of unemployment is an issue for the town and expressed an interest in the potential for employment and business opportunities for their community, and a willingness to be recruited and trained for positions with lower to mid-level skill sets.

Increased road traffic between the mine and Duchess was discussed, with acknowledgement that the traffic increase would require increased road maintenance. Increased dust, noise and road safety were also concerns raised, as well as the availability and quality of water required by the Full-scale mine and water for road works on the Dajarra – Duchess Road. Water is considered a scarce resource in the region of which the quality is considered very poor.

Other feedback from the community identified increased pressures on community emergency services and incident response planning, and a desire for community support programs and initiatives (e.g., community bus upgrades/maintenance, improved water quality at primary school, etc.). The community also expressed a desire for continued consultation throughout progression of the Project.

The community consultation register is provided in Table 12.

Table 12: Community consultation register

Consultation date	Stakeholder /Community member	Consultation type	Information provided and issues discussed	Issues raised by community and how issues were considered	Decisions/Outcomes	Commitments
Ongoing	Directly and indirectly affected landholders	▪ Direct conversations	▪ Discussions on mining operation progress ▪ Activities within and adjacent to their property ▪ Identification of concerns and interests ▪ Rehabilitation of Start-up Operation components	▪ There were no particular issues or concerns raised relating to mine closure or rehabilitation	▪ Continue engagement and discussions with landholders	▪ Continue engagement and discussions with landholders ▪ Discuss specifics of rehabilitation and closure activities and timing
18 March 2021 and December 2022	Regulatory bodies	▪ Pre-lodgment meeting and PRCP planning with DES	▪ Requirements of PRCP and submission date	▪ Discussions over the level of information available in existing land outcome documents and how these would be used in the PRCP	▪ Submit PRCP by 29 October 2021 ▪ Submit updated PRCP by June 2022	▪ Agriflex submitted draft PRCP on 29 October 2021 ▪ Agriflex to submit final PRCP by June 2022
Ongoing 2017- 2022	Directly and indirectly affected landholders	▪ Discussions on mining assessment/approval progress ▪ Discussions on mining operation progress ▪ Mine closure and rehabilitation components of the EA application/approval	▪ Project schedule and progress ▪ Economic and social benefits of Project ▪ Activities within and adjacent to their property ▪ Identification of concerns and interests ▪ Potential impacts and mitigation measures and	▪ There were no particular issues or concerns raised relating to mine closure or rehabilitation.	▪ Continue engagement and discussions with landholders	▪ Continue engagement and discussions with landholders ▪ Discuss specifics of rehabilitation and closure activities and timing

Consultation date	Stakeholder /Community member	Consultation type	Information provided and issues discussed	Issues raised by community and how issues were considered	Decisions/Outcomes	Commitments
			▪ Mechanisms for feedback, involvement and advocacy.			
2019 - 2021	Regulatory bodies	▪ EA application for Full-scale Operation ▪ Annual reporting requirements discussions ▪ ERC meetings with DES	▪ Introduction to Project; ▪ Provide personal contact for Project duration and ability for direct contact ▪ Project schedule and progress ▪ Identification of concerns and interests ▪ Potential impacts (beneficial and adverse) of the Project infrastructure ▪ Provide information and mechanisms for public discussion ▪ Short term and long-term impacts, economic and social benefits ▪ Mechanisms for feedback, involvement and advocacy. ▪ ERC calculations and closure requirements	▪ Discussed ERC calculations and transition from Financial Assurance framework	▪ Project to transition to PRCP framework ▪ ERC calculations	▪ Agriflex to transition to PRCP and is able to operate with an ‘expired Plan of Operations’ during the transition to PRCP

Consultation date	Stakeholder /Community member	Consultation type	Information provided and issues discussed	Issues raised by community and how issues were considered	Decisions/Outcomes	Commitments

15 May 2018 and 4 December 2018	Residents and businesses at Dajarra	▪ Community hall presentation and open discussions	▪ Project schedule and progress
			▪ Identification of concerns and interests
			▪ Potential impacts and mitigation measures
			▪ Mechanisms for feedback, involvement and advocacy.
				▪ There were no particular issues or concerns raised relating to mine closure or rehabilitation.
				▪ The three core themes discussed were:
				  ▪ Employment and other potential benefits to the community
				  ▪ Road traffic (dust, noise, and safety)
				  ▪ Water availability and quality
					▪ Continue engagement and discussions with community	▪ Additional engagement and discussions to occur prior to Full-scale Operation application and Full-scale PRCP

3.3 Community consultation plan

Agriflex is committed to developing and maintaining a mutually beneficial relationship with the local community. This section describes the strategy for future engagement. Agriflex has in place a CLLP that provides a roadmap for:

- Identifying which stakeholders may be affected by the mining activities (including rehabilitation and closure).
- Identifying the potential benefits to the local community from the Project.
- Ensuring the relevant stakeholders are fully informed of the proposed activities and that Agriflex is engaged with the community concerns and issues.

It is Agriflex's commitment that all stakeholders must be provided with and encouraged to take the opportunity to communicate any concerns or interests that they may have on the Project.

In-line with PRCP guideline requirements, Agriflex has developed this community consultation plan which outlines future commitments to consult regarding rehabilitation activities.

3.3.1 Consultation objectives

The objectives of the stakeholder consultation process are to inform key stakeholders of the proposed Project activities, to provide an overview of potential socioeconomic and environmental impacts, and to provide the community a platform by which to voice their interests and concerns. Therefore, in conformance with the CLLP, the objectives of the ongoing consultation process are to:

- Identify all relevant stakeholders and establish and maintain relationships with interested parties.
- Provide regular information about proposed activities in an open and transparent manner.
- Document, understand, and respond to stakeholder key issues and interests.
- Develop and implement strategies to address identified issues, interests and benefits.
- Provide opportunities for stakeholders input into the Project development.
- As a minimum, comply with the legislative mandatory requirements relating to community engagement.

It is incumbent on Agriflex to respond to all concerns and depending on the stage of the activities to communicate those concerns in person, community meetings, focus groups and newsletters.

3.3.2 How the community will be engaged

Agriflex initiated contact with directly affected landholders and property managers during the initial exploratory phase of the Project. Landholders and property managers were provided with information on the Project and have been briefed on Project outcomes, timelines, and proposed activities within their respective properties. Agriflex continues to maintain regular contact with landholders and property managers via letters, emails, phone conversations, and face-to-face discussions.

The Start-up Operation is a very short-term project designed to support bulk sampling of phosphate. Future engagement will include discussions on the scheduling of progressive rehabilitation activities for the Start-up Operation and also on next phase of the Project; the Full-scale Operation or additional interim phases of further test pits or bulk samples. Details of how the community will be engaged are provided below.

3.3.2.1 Contact with directly affected landholders

Agriflex initiated contact with directly affected landholders and property managers during the initial exploratory phase of the Project. Landholders and property managers were provided with information on the Project and have been briefed on Project outcomes, timelines, and proposed activities within their respective properties during the EA application process. Agriflex continues to maintain regular contact with landholders and property managers via letters, emails, phone conversations, and face-to-face discussions. These discussions also include planned rehabilitation activities.

3.3.2.2 Community information sessions

During the EA application process there were a series of community information sessions held at the Jimberella Hall, Dajarra.

There are no plans for specific community information sessions for the rehabilitation and closure of the Start-up Operation, however the future engagement regarding the Full-scale Operation will include discussion of the existing operation and the work to date on rehabilitation. Agriflex held a community engagement meeting in Dajarra on the 4th September 2019 outlining the Project as a whole. A Community Engagement meeting was also held in Dajarra on the 17th February 2022 which outlined plans for a mining camp in Dajarra and a brief outline of the of the Full-scale operation as a whole.

3.3.2.3 Meetings with regulatory agencies

Meetings with regulatory agencies will be held to discuss the future phases of the project and the rehabilitation and closure activities of the Start-up Operation where relevant.

3.3.3 Consultation frequency

Consultation with the community regarding the progressive rehabilitation and closure aspects of the Start-up Operation, will occur as needed during the regular discussions with the landholder. These general discussions occur approximately every 3-6 months.

Consultation will also occur prior to any progress with the Full-scale Operation and the related PRCP development, or if there are any proposed PRCP Schedule amendments that have potential to impact the community.

3.3.4 Information released for community consultation

As part of the overarching community consultation, the information released to the community includes general information on the current work program and future activities. During these engagement sessions information relating to rehabilitation, the PMLU, closure and decommissioning was undertaken at a high level.

3.3.5 How feedback and comments will be considered

Agriflex continues to maintain regular contact with landholders and property managers via letters, emails, phone conversations, and face-to-face discussions. This provides the opportunity for the stakeholder to provide comments and Agriflex will respond to the feedback via the same channel (e.g., email, phone call, face-to face).

Stakeholders can communicate with Agriflex to make inquiries, raise complaints, or to express grievances via the website, email or via direct phone conversations.

Agriflex will record environmental feedback or complaints received in relation to the Ardmore operation. Records will include complainant contact information, the reason of the complaint, the investigations undertaken and the conclusions formed, the actions taken and abatement measures implemented, as well as the person responsible for complaint resolution.

4.0 POST-MINING LAND USE

The mine has been designed to manage overburden, topsoil, subsoil to enable rehabilitation should the Full-scale Operation not proceed. The total area that will be disturbed by the Project is approximately 18.50 ha, with approximately 3 ha for exploration activities. The landowner intends to keep ownership of the land post mining (as pastoral lease tenure). The proposed post-mining land use (PMLU) will be the same as the pre-mining land use; grazing on native pastures.

4.1 Land use strategies and regional planning

The land systems of the regional area have been mapped by the CSIRO (1954). The land system mapping considers the topography and land forms, soils, vegetation, and climate and categorise the land suitability. The Project Area is mapped as 'Pasture land – native pastures', which is in line with what the land has been used for pre-mining and with the proposed PMLU. The current land use is grazing and native vegetation.

The Queensland Land Use Mapping Program (QLUMP) maps and assesses patterns of land use and land use change across the state at catchment scale, in accordance with the national standard for land use classification. A review of the QLUMP for Lot 4, SP117500 (the parcel of land which the Project is located) indicates that the site is not mapped as a Priority Agricultural Area, Strategic Environmental Area or Strategic Cropping Land under the Regional Planning and Interests Act 2014.

The Cloncurry Shire Planning Scheme 2016 (Version 2) commenced on 15 February 2016 (updated 04 July 2017), prepared as framework for management of development and sets Council's intention for future development in the Shire for the next 10 to 15 years. The current Boulia Shire Planning Scheme (2020-2040) was originally adopted in July 2020.

A number of values identified within both council planning schemes aim to achieve the following overall outcomes related to extractive industries, including:

- Extractive industries are established in locations that are adequately separated from sensitive land uses and do not have significant ecological, landscape or rural value.
- The industries are located so as not to detract, or diminish the scenic amenity of the surrounding area, landmarks or vistas.
- A separation area is established to maintain a buffer between the extractive industry and existing and future sensitive land uses.
- External impacts associated with extractive industry operations, e.g., haulage, do not impact on the scenic amenity and well-being of the community.
- Extractive industry sites are progressively rehabilitated including the achievement of a stable landform that is safe and suitable for other appropriate uses and prevent ongoing risk of adverse impacts of the environment.
- Are designed and operated so that the safety of persons and property is not compromised.
- Land that contains extractive industry uses are protected, so that such resources can be extracted, when needed, in an environmentally acceptable manner.

The planning schemes of both Cloncurry Shire Council and Boulia Shire Council have been reviewed and considered in conjunction with this application, and where achievable, measures have been included to assimilate local council values.

The proposed PMLU of grazing on native pastures is consistent with how the land was used before mining was carried out and it is consistent with the local council planning schemes.

4.2 Closure planning

The mine closure process begins with planning during the design, assessment and permitting phases of the Project prior to its construction and continues throughout the life of the Project. Closure planning aims to reduce the residual liability and risk of a project. The aim of closure planning is to have a structured and systematic mine closure and completion process to:

- Achieve acceptable environmental outcomes.
- Reduce the financial burden of mine closure and rehabilitation.
- Avoid the site becoming hazardous and a source of pollution for legacy in the future.

This mine closure concept has been developed to demonstrate that the Project can be adequately closed and the plan is technically, economically and socially feasible.

The goal of mine closure for the Project is to prevent and minimise adverse long-term impacts from mining and to create a self-sustaining natural ecosystem or alternate land use based on an agreed set of objectives. Closure of the mine will ensure that the site is:

- Safe to humans and wildlife;
- Non-polluting;
- Stable; and
- Able to sustain a post mining land use.

These overarching goals have been considered when planning the decommissioning and closure of the mine. Both progressive rehabilitation during the mining operations and final rehabilitation will meet the closure and rehabilitation goals.

4.3 PMLU criteria

The PMLU criteria are the basis on which successful rehabilitation and mine completion is determined. It provides for a broad agreement on final land use outcomes and a basis for measuring the achievement of that outcome. The criteria are designed to be flexible enough to adapt to changing circumstances without compromising the end outcome. DES will use the Rehabilitation Milestone (RM) criteria to assess whether the site has been adequately rehabilitated or closed. The proposed criteria for each Rehabilitation Area (RA) are provided in Table 13 to Table 16.

4.4 Rehabilitation Areas

Rehabilitation Areas are used to dissect the site into like areas and plan for rehabilitation and closure. Rehabilitation Areas (Figure 26 and Figure **27**) for the Project are:

- Open cut pits and borrow pits (Table 13).
- Tailings Storage Facility and bund (Table 14).
- Overburden storage facility, indurated storage facility and ROM (Table 15).
- Mine infrastructure areas (processing plant, access roads, and exploration areas (Table 16)).

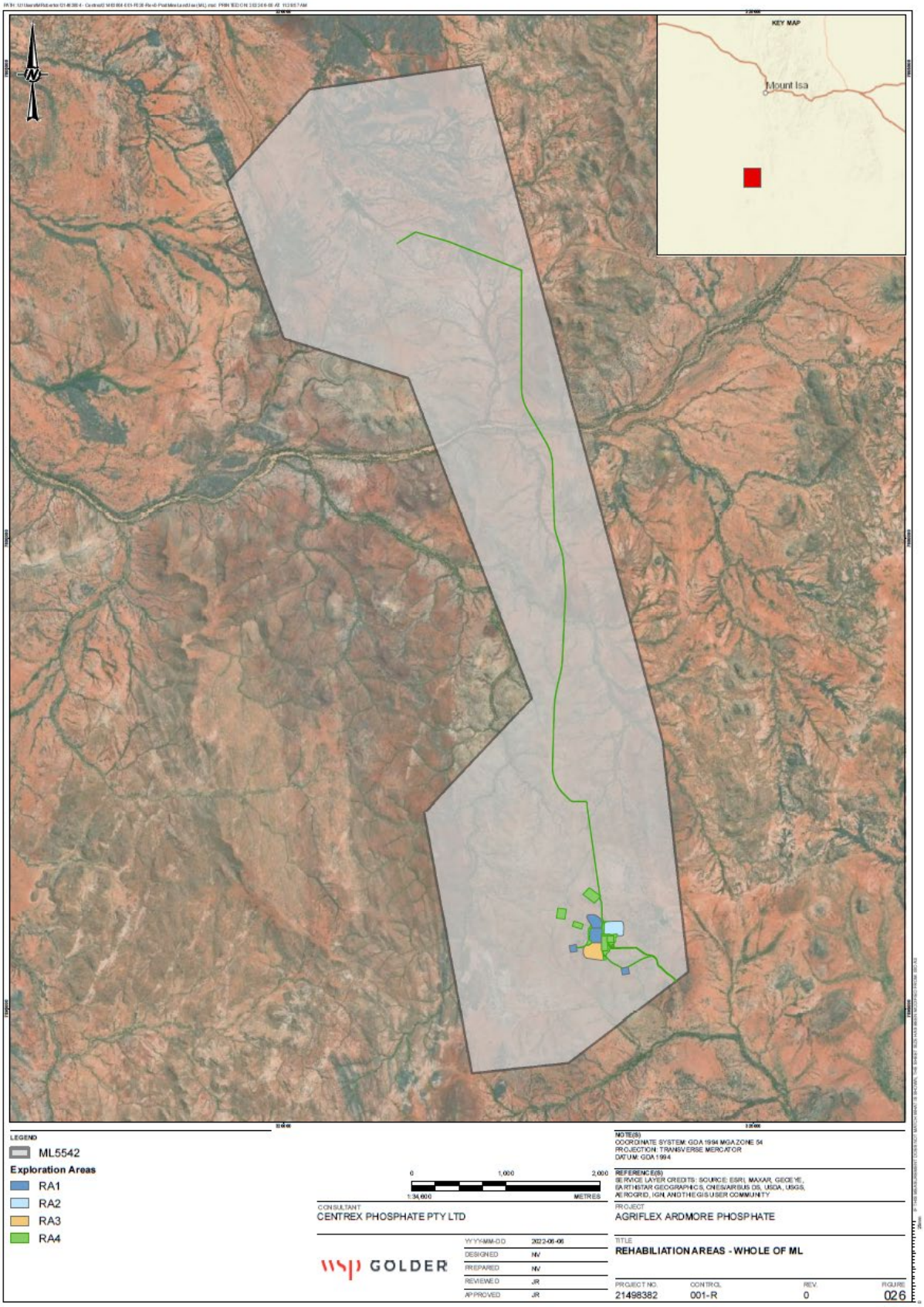


Figure 26: Reference map indicating the Rehabilitation Areas (whole of ML)

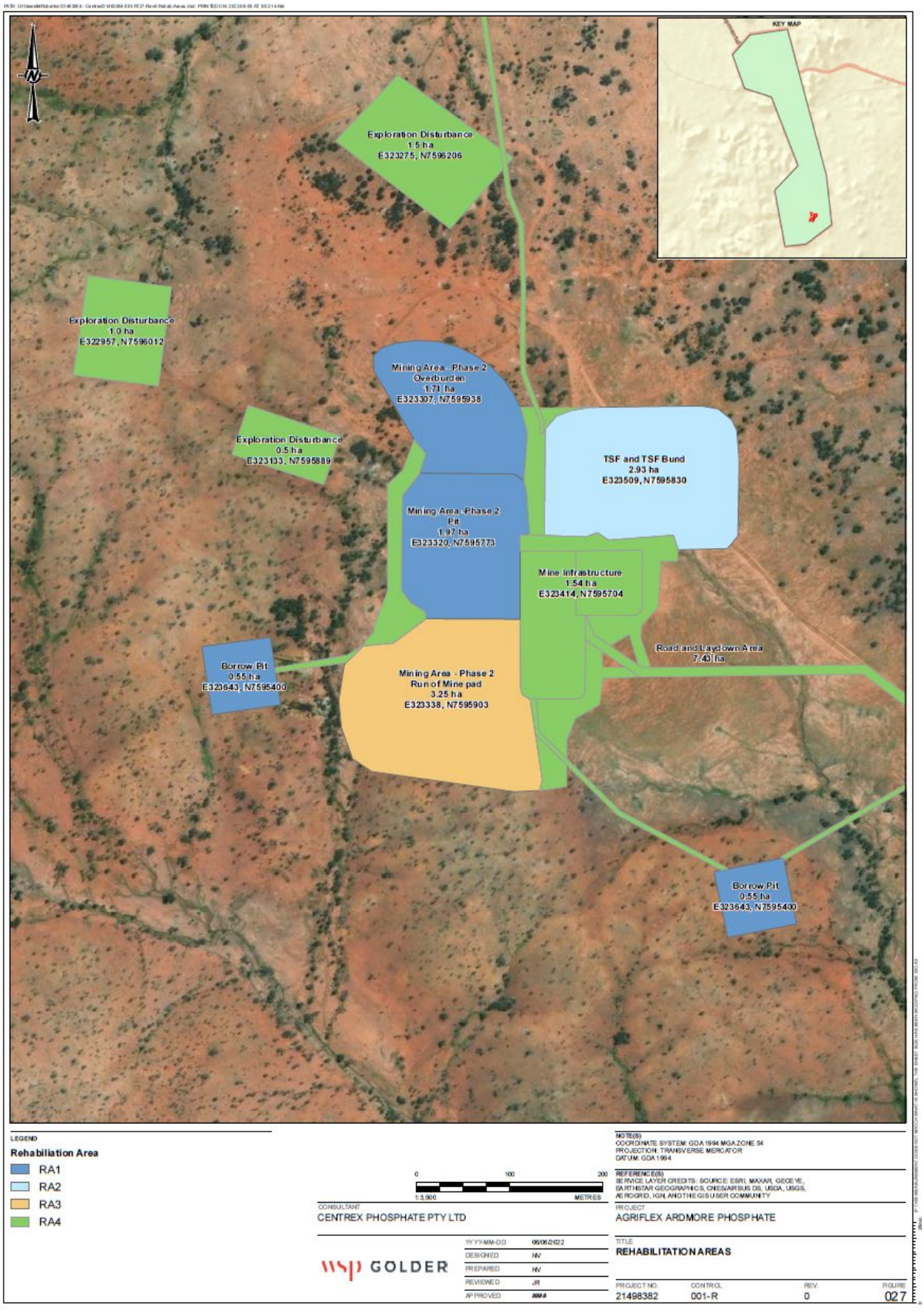


Figure 27: Reference map indicating the Rehabilitation Areas

Table 13: Rehabilitation Area (RA1) – pits and borrow pits

Item	Description	
Description	South pit area corresponds to 1.97 ha and North pit area to 1.71 ha. Disturbance for borrow pits equates to 1.1 ha.	
Duration	Mining will be over a 2 to 3-month period Rehabilitation will occur over a 6-month period	
Area of disturbance (ha)	Direct disturbance of the pit is 1.97 ha (South) and 1.71 ha (North), including a buffer area distance of 10 m surrounding the pit. Disturbance for borrow pits (rock and sand) is approximately 1.1 ha. **Total area in PRCP Schedule = 4.78 ha**	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision. The PRCP Schedule indicates that this will be completed by 2034.	
Decommissioning activities	The pits will be backfilled with overburden material to ground level. They will have a slightly concave top which will retain water and assist in natural vegetation growth. The pits will be covered with a thin layer of topsoil (0.10 m), as available and subsoil if required. Soil will be ripped or scarified to aid water retention and seed capture. Borrow pits used to extract rock will be re-spread with subsoil or topsoil. The borrow pit for sand will be contoured to a similar profile to the pre-disturbance condition.	
Infrastructure to be retained	The existing access track to the pit will be retained and the access track constructed along the water supply pipeline from the pit to the groundwater supply bores	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Rehabilitation milestones**	**Milestone criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future. **Non-polluting:** No groundwater or surface water contamination post closure (no connection to groundwater systems). **Stable landform:** Pits backfilled and stable, with no benches or high walls remaining. **Sustains agreed land use:** Pre-mining land use of grazing and limited native grasses re-instated.	Infrastructure decommissioning and removal (RM1)	a) Removal of infrastructure b) Landowner agreement for retained assets (tracks, haul roads, etc)

Item	Description	
	Landform development and reshaping / re-profiling (RM3)	a) All major earthworks completed with evidence (e.g., photographs and surveys) b) Evidence (e.g., photographs, construction design and surveys) that the backfilled material is re-instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition c) Evidence (e.g., photographs and surveys) of landshaping that incorporates drainage where relevant to reinstate pre-mining drainage paths
	Revegetation (grazing) (RM5)	a) Completed seeding of target species at <1 - 4kg/ha depending on species b) Identification and establishment of reference monitoring sites
	Achievement of surface requirements (grazing) (RM6)	a) Revegetation is comparable to reference sites for ground cover biomass b) Revegetation is comparable to reference sites for weed and pest species presence
	Achievement of post-mining land use to stable condition (grazing) (RM7)	a) A contaminated land survey carried out by an appropriately qualified person indicates that no contamination unsuitable for the post-mining land use is occurring. b) Post mining survey by appropriately qualified person indicates no active areas of rill or gully erosion and drainage follows appropriate drainage paths c) Certification of rehabilitated areas that weed and pest species abundance is no greater than at reference sites.
Closure material sources	Overburden dump (63,000 m^3) and ROM (55,300 m^3). A thin layer of topsoil between zero (gravel / rocks at surface) and 10 cm.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure)	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The likelihood of the failure depends upon the future grazing regime and timeframe between adequate rainfall. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	

Item	Description
Closure control strategies to lower residual risk	A slightly concave structure on the backfilled pits will assist in retaining rainfall to aid in some vegetation growth.

Table 14: Rehabilitation Area (RA2) - tailings storage facility

Item	Description	
Description	A geofabric-co-polymer lined Tailings Storage Facility 90 m x 90 m x 5 m deep. The TSF, TSF bund correspond to 2.93 ha.	
Duration	Mining will be over a 2 to 3-month period Rehabilitation will occur over a 6-month period	
Area of disturbance (ha)	Direct disturbance of the TSF is 0.79 ha, with the bund area 1.38 ha surrounding the TSF and 0.76 ha of disturbance. **Total area in PRCP Schedule = 2.93 ha**	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision. The PRCP Schedule indicates that this will be completed by 2034.	
Decommissioning activities	The TSF will be backfilled with material from the TSF bund. The 1 m freeboard, maintained during operations, will be backfilled with material from the TSF bund and/or low permeability soils with a high clay content (soils from the areas of TP07 and TP09, as required) back to pre-mining topography. Backfilling will create a cap of at least 1 m thickness over the TSF. A slightly concave structure on the backfilled TSF will assist in retaining rainfall to aid in vegetation growth. The initial backfill is likely to be convex due to the reduction in void volume by tailings. The lining will be left in-situ and the surface will be rehabilitated with stockpiled sub soil and topsoil. Capping on the TSF will be slightly concave to retain rainfall and aid vegetation growth.	
Infrastructure to be retained	The TSF liner will remain in-situ. The liner is UV stable, non-toxic and non-leaching.	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Rehabilitation milestones**	**Milestone criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future. **Non-polluting:** Rainfall retained on the TSF to aid vegetation growth and surface water runoff limited. Runoff will be unlikely to affect known environmental values.	Contaminant remediation (RM2)	a) If contamination exists, remediation has been undertaken b) Contaminated Land audit of site has been undertaken and either the site is suitable for its PMLU, or a Site Management Plan has been developed
	Landform development and reshaping / re-profiling (RM3)	a) All major earthworks completed with evidence (e.g., photographs and surveys) b) Evidence (e.g., photographs, construction design and surveys) that the backfilled material is re-

Item	Description	
Stable landform: TSF backfilled and physically and chemically stable. **Sustains agreed land use:** Pre-mining land use of grazing and limited native grasses re-instated.		instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition c) Evidence (e.g., photographs and surveys) of landshaping that incorporates drainage where relevant to reinstate pre-mining drainage paths d) Evidence that soils with higher clay content and low permeability is used for the TSF cap (TSF only)
Closure material sources	The TSF bund (43,000 m^3) will be used to backfill the TSF. As necessary, low permeability and high clay content soils from other locations will be employed to ensure cap integrity.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure)	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	
Closure control strategies to lower residual risk	A slightly concave structure on the backfilled TSF will assist in retaining rainfall to aid in vegetation growth. The initial backfill is likely to be convex due to the reduction in void volume by tailings but the remaining overburden could be used in the pits to ensure a concave landform.	

Table 15: Rehabilitation Area (RA3) - overburden storage facility and ROM

Item	Description
Description	Overburden storage facility and ROM.
Duration	Mining will be over a 2 to 3-month period Rehabilitation will occur over a 6-month period
Area of disturbance (ha)	Consists of approximately 3.24 ha for the ROM area. **Total area in PRCP Schedule = 3.24 ha**
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision. The PRCP Schedule indicates that this will be completed by 2034.
Decommissioning activities	Overburden material will be used to backfill the open pits. The surfaces will be returned to the original topographic level and it will be spread with topsoil and direct seeded to encourage revegetation with native species of local provenance. The ROM pad will be built with overburden so the pad can be removed and used to fill the pits.

Item	Description	
Infrastructure to be retained	Nil	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Rehabilitation milestones**	**Milestone criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future. **Non-polluting:** No groundwater or surface water contamination post closure (no connection to groundwater systems). Limited vegetation cover is present and land formed to minimise erosion. **Stable landform:** Material is used to backfill the pits leaving a relatively flat post-mining landscape. **Sustains agreed land use:** Pre-mining land use of grazing and limited native grasses re-instated.	Contaminant remediation (RM2)	a) If contamination exists, remediation has been undertaken b) Contaminated Land audit of site has been undertaken and either the site is suitable for its PMLU, or a Site Management Plan has been developed
	Landform development and reshaping / re-profiling (RM3)	a) All major earthworks completed with evidence (e.g., photographs and surveys) b) Evidence (e.g., photographs, construction design and surveys) that the backfilled material is re-instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition c) Evidence (e.g., photographs and surveys) of landshaping that incorporates drainage where relevant to reinstate pre-mining drainage paths
	Revegetation (grazing) (RM5)	a) Completed seeding of target species at <1 - 4kg/ha depending on species b) Identification and establishment of reference monitoring sites
	Achievement of surface requirements (grazing) (RM6)	a) Revegetation is comparable to reference sites for ground cover biomass b) Revegetation is comparable to reference sites for weed and pest species presence
	Achievement of post-mining land use to stable condition (grazing) (RM7)	a) A contaminated land survey carried out by an appropriately qualified person indicates that no contamination unsuitable for the post-mining land use is occurring. b) Post mining survey by appropriately qualified person indicates no active areas of rill or gully erosion and drainage follows appropriate drainage paths

Item	Description	
		c) Certification of rehabilitated areas that weed and pest species abundance is no greater than at reference sites.
Closure material sources	Topsoil and subsoil stockpiled from initial pre-stripping. Vegetation originally cleared and stored with topsoil and seeds of local species.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure)	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	
Closure control strategies to lower residual risk	Ripping or scarifying of the land during rehabilitation will encourage water capture.	

Table 16: Rehabilitation Area (RA4) - mine infrastructure areas

Item	Description	
Description	Mine infrastructure areas (processing plant, access roads and exploration).	
Duration	Mining will be over a 2 to 3-month period Rehabilitation will occur over a 6-month period	
Area of disturbance (ha)	Includes processing plant (1.54 ha), road, tracks and park up (7.43 ha), and exploration (3.0 ha). **Total area in PRCP Schedule = 11.97 ha**	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision.	
Decommissioning activities	The demonstration plant and infrastructure will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated and the areas will then be revegetated with native species. The access tracks and haul roads will remain in place post mining with agreement from the landowner.	
Infrastructure to be retained	An access track will remain to enable future maintenance access to the land.	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Rehabilitation milestones**	**Milestone criteria**
	Contaminant remediation (RM2)	a) If contamination exists, remediation has been undertaken

Item	Description	
Safe: Site is safe for humans and animals now and in the foreseeable future. **Non-polluting:** After removal of infrastructure - runoff and seepage will be good quality water that is unlikely to affect known environmental values. **Stable landform:** Remove infrastructure and establish a stable landform. **Sustains agreed land use:** Pre-mining land use of grazing and limited native grasses re-instated.		b) Contaminated Land audit of site has been undertaken and either the site is suitable for its PMLU, or a Site Management Plan has been developed
	Landform development and reshaping / re-profiling (RM3)	a) All major earthworks completed with evidence (e.g., photographs and surveys) b) Evidence (e.g., photographs, construction design and surveys) that the backfilled material is re-instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition c) Evidence (e.g., photographs and surveys) of landshaping that incorporates drainage where relevant to reinstate pre-mining drainage paths
	Surface preparation (RM4)	a) Shallow ripping or scarifying of the land during rehabilitation to encourage water capture and retain topsoil where placed b) Placement of up to 10 mm of topsoil on disturbed areas where topsoil used to exist
	Revegetation (grazing) (RM5)	a) Completed seeding of target species at <1 - 4kg/ha depending on species b) Identification and establishment of reference monitoring sites
	Achievement of surface requirements (grazing) (RM6)	a) Revegetation is comparable to reference sites for ground cover biomass b) Revegetation is comparable to reference sites for weed and pest species presence
	Achievement of post-mining land use to stable condition (grazing) (RM7)	a) A contaminated land survey carried out by an appropriately qualified person indicates that no contamination unsuitable for the post-mining land use is occurring. b) Post mining survey by appropriately qualified person indicates no active areas of rill or gully erosion and drainage follows appropriate drainage paths c) Certification of rehabilitated areas that weed and pest species abundance is no greater than at reference sites.
Closure material sources	Topsoil and subsoil stockpiled from initial pre-stripping. Vegetation originally cleared and stored with topsoil and seeds of local species.	

Item	Description
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure)	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.
Closure control strategies to lower residual risk	Ripping or scarifying of the land during rehabilitation will encourage seeds and water capture.

4.5 PRCP Schedule

The PRCP Schedules have been prepared for submission to DES using the DES spreadsheet template ESR/2019/5103.xls. This section provides a summary of the PRCP Schedules including RA, RMs and the general timeframes for achieving these milestones.

There are no proposed NUMAs for the project, therefore no Improvement Area or Management Milestones have been proposed.

4.5.1 Final site design

Figure 28 and Figure 29 show the PMLU as the conceptual final site design across the Project Area. This figure shows the total area disturbed by mining (maximum disturbance footprint approved under the EA), the PMLU (grazing on native pastures) and the flood plain extent (1:100 AEP) and the undisturbed areas.

There are no NUMAs proposed.

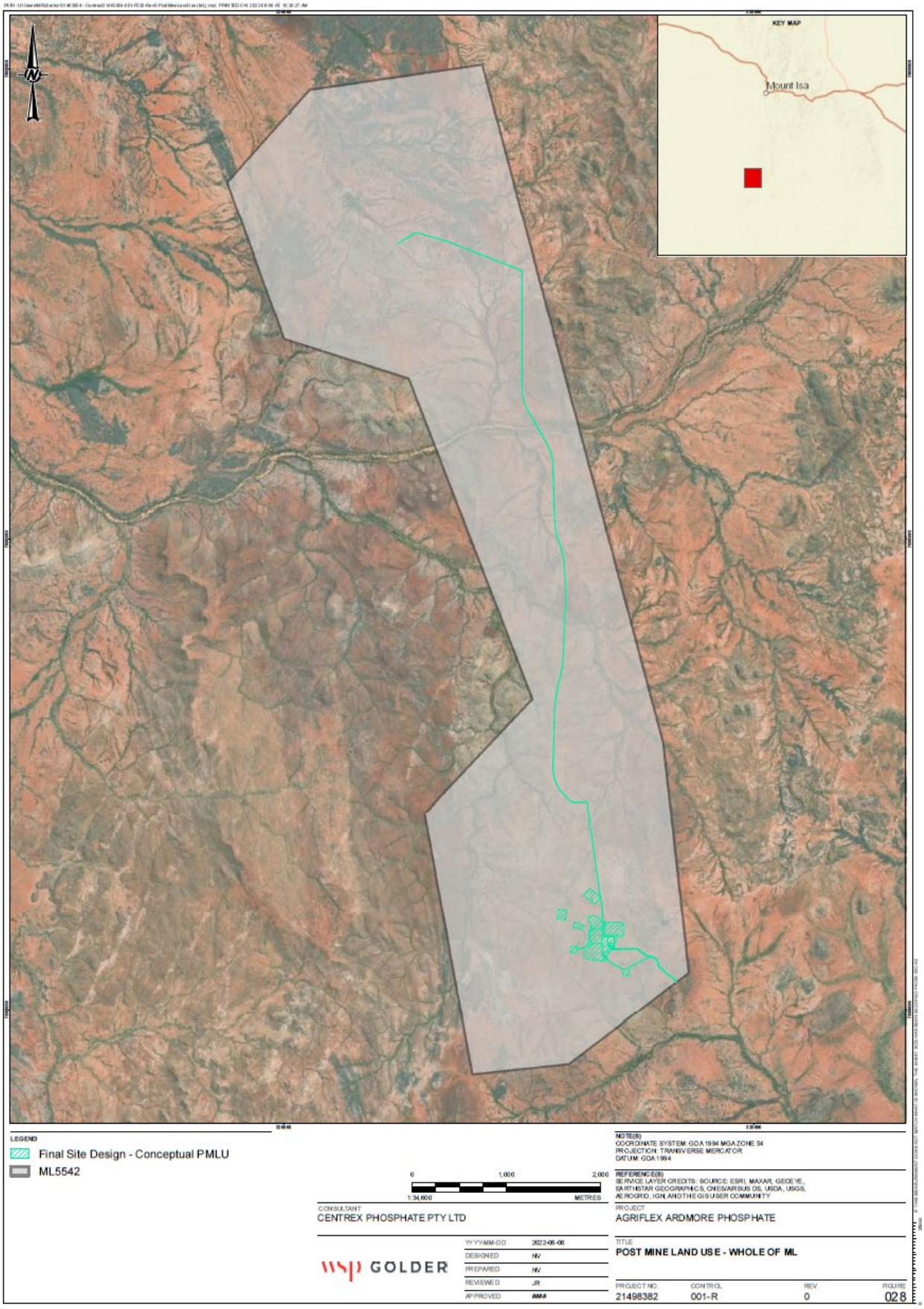


Figure 28: Final site design and conceptual PMLU (whole of ML)

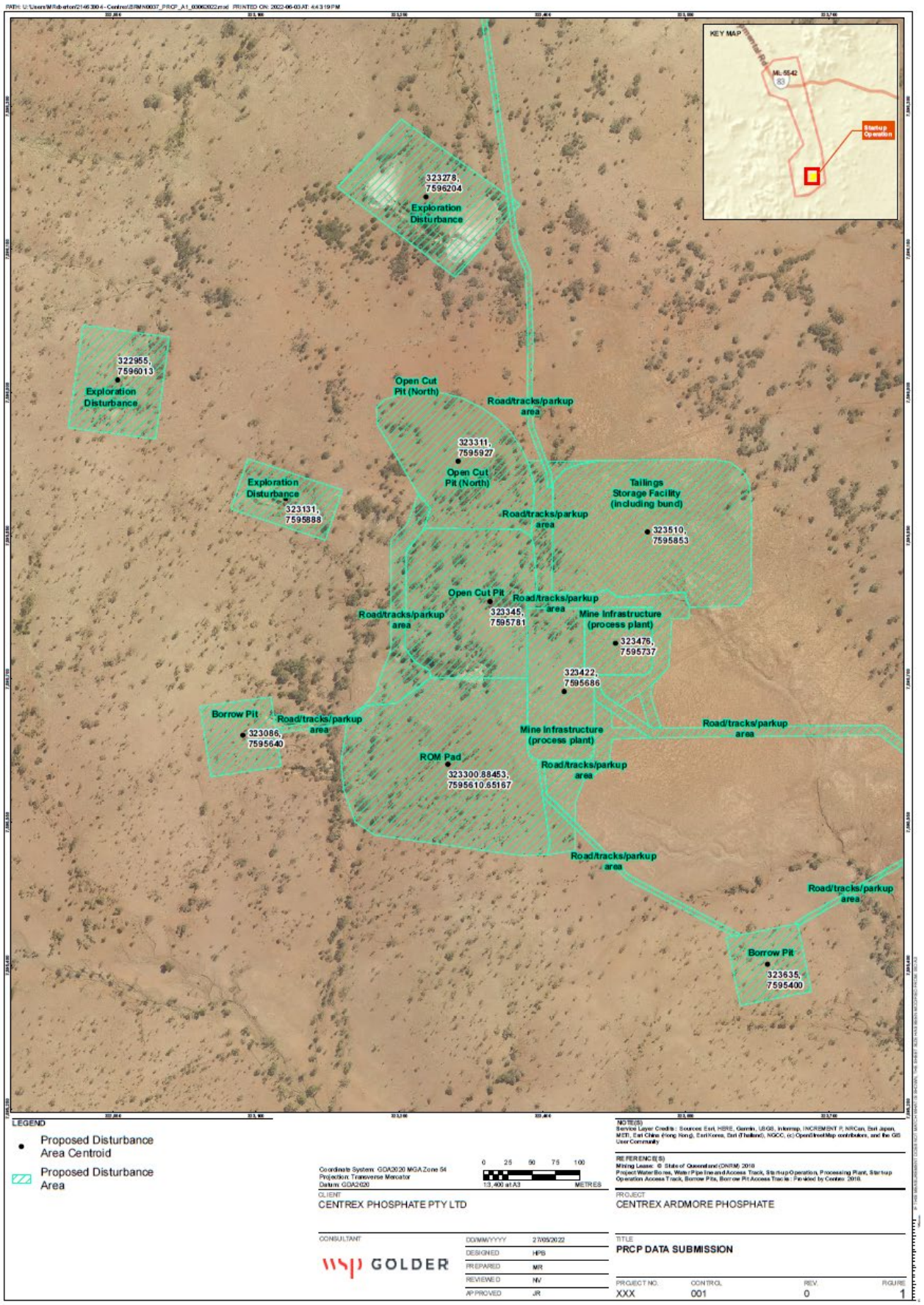


Figure 29: Final site design and conceptual PMLU (close up)

4.5.2 Rehabilitation milestones criteria

For each of the RAs specified in the previous section, a set of RMs apply to achieve a stable condition for the relevant PMLU. Each RM has detailed milestone criteria, which contain parameters that are measurable for achieving the milestone.

The criteria are to be assessed to determine whether an RM is achieved by the date stated in the PRCP schedule.

5.0 NON-USE MANAGEMENT AREA

There are no Non-Use Management Areas (NUMAs) proposed for the project. All areas disturbed by mining will return to a PMLU, as described in Section 4.0.

6.0 REHABILITATION MANAGEMENT METHODOLOGY

The land systems of the regional area have been mapped by the CSIRO (1954). The land system mapping considers the topography and land forms, soils, vegetation, and climate and categorise the land suitability. The Project area is mapped as ‘Pasture land – native pastures’, which is in line with what the land is currently used for. The current land use is grazing and native vegetation which is mostly and rocky in places.

An understanding of the existing environment prior to mining is important to obtain baseline characteristics of the site. This baseline can then be used for a comparison to the post mining environment and assist in developing suitable rehabilitation milestone criteria. Further detail of the existing environment is included in Section 2.1.

The groundwater, surface water, soil, geology and geochemistry properties play an important role in the mine planning and closure processes. The baseline characteristics of the area, such as the physical and chemical properties of the soil can be used to consider potential impacts of the differing soil properties on rehabilitation (e.g., saline soil, limited top soil).

The geology and geochemistry properties need to be understood to plan the mining sequence and determine if there is potential for any acid generating material over the life of the mine and post closure.

The existing soil to be disturbed by mining is mainly chromosols and kandosols, with the Project Area dominated by chromosol soils. This soil is characterised by saline and high electrical salinity and elevated concentrations of chloride. The topsoil layer is either not existent or very narrow with limited humus organic matter present. Two of the three test sites have high concentrations of sulphates in the subsoils, with gypsum the likely source at these locations. These characteristics are important to understand to assess potential problems with planned rehabilitation and vegetation establishment.

The geochemistry properties of the rock to be disturbed have been assessed and there are no predicted problems such as acid mine drainage from the storage of overburden over the life of the mine or closure. Geochemical testwork of tailings samples was undertaken by RGS (2018) the full report with the sample results is provided in Appendix B (as Appendix B within that document).

Baseline flora and fauna surveys recorded both feral and pest animals and flora species. There are important areas of vegetation and habitat that will not be disturbed by mining such as the Purple-necked Rock-wallaby rocky outcrop habitat located to the northwest of the Project Area.

The existing environment provides baseline information for development of the PRCP and proposed PMLU. The existing interrelationships between the land, flora, fauna and water resources will be incorporated into the closure plan as far as possible. The existing environment does not highlight any major restrictions for the proposed PMLU.

Progressive rehabilitation of areas impacted by mining activities will occur as soon as practical to a stable landform with a self-sustaining vegetation cover. As detailed in Section 2.2 the short-term mining method proposes to extract ore from a 10 m deep pit. The overburden will be stored to the west of the pit with subsoil and topsoil stored separately. As the mining campaign duration is short, progressive rehabilitation and mine closure will not occur until the after a decision is made whether Agriflex will proceed with the Full-scale Operation.

Assuming the Full-scale Operation does not proceed and the Project is not within a Care and Maintenance phase the disturbed areas will be rehabilitated as follows:

- **Pits**. Stockpiled overburden will be used to backfill the pits. The backfilled pits will be covered with sub-soil and topsoil will be spread. It will be direct seeded to encourage revegetation with pasture species or native species of local provenance. The pit will be backfilled back to natural elevation with waste and stockpiled soils and there will be no localised depression.
- **Borrow pits**. The pits, bunds, ramps will be contoured to maintain a stable landform, and soil stored in stockpiles will be respread at the completion of mining.
- **Tailings Storage Facility.** The TSF will be backfilled with material from the TSF bund. The lining will be left in-situ and the surface will be rehabilitated with stockpiled sub-soil and topsoil.
- **Overburden storage facility**. Overburden will be separated and stored. If the Full-scale Operation does not proceed the overburden will be placed back into the pits and be used to backfill the pits. The surfaces will be returned to the original topographic level and it will be spread with topsoil and direct seeded to encourage revegetation with native species.
- **ROM**. The ROM material will be used to backfill the pits.
- **Mine infrastructure areas.** The demonstration plant and infrastructure will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated, and the areas will then be revegetated with native grass species.
- **Roads**. The access tracks will remain in place post mining with agreement from the landowner.

Figure 30 shows the conceptual cross-section of the proposed final landform for the Project.

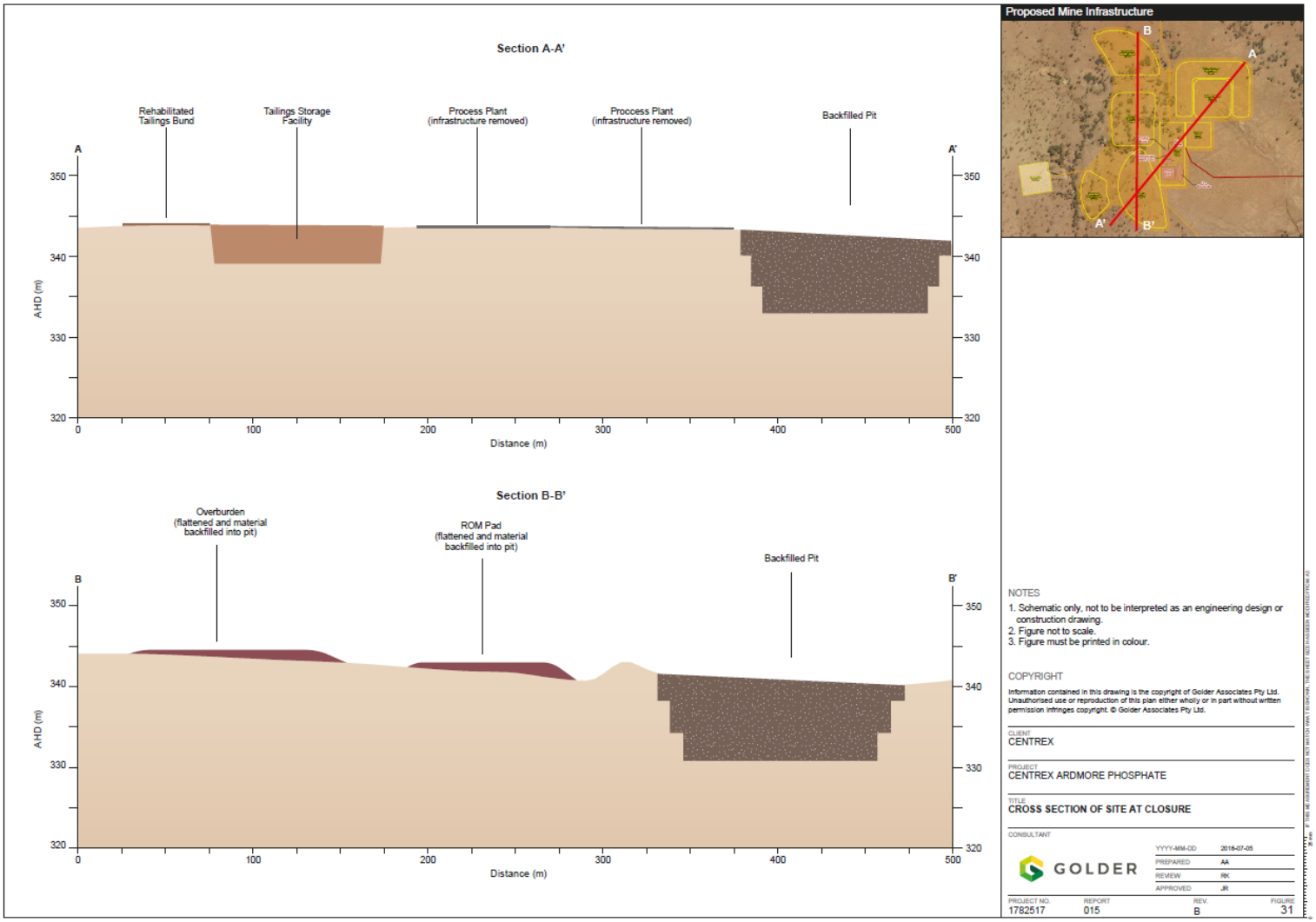


Figure 30: Cross section of the site at closure

6.1 Hydrogeology

Exploration drilling by Agriflex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 mbgl, which is much deeper than the proposed depth of the pits (10 m). The pits will not exceed 10 m depth and any groundwater within the aquifer that may be present in the southern part of the ML would be at depths greater than 50 m. Therefore, there is no potential for a reduction in groundwater quantity available for users or GDEs from excavating the pits during operations or after rehabilitation

Two pumping wells are proposed for the purposes of the Project, with pumping rates of 7.5 L/s per well for the short-term duration (approximately 12 weeks) of the operation.

Predicted groundwater level drawdowns were calculated after 90 days of pumping at 15 L/s using the Theis radial flow equation for non-leaky confined aquifers and hydraulic properties determined from onsite testing. The drawdown were calculated for two cases considering the most and least conservative values of transmissivity and storativity. In all cases, the 2 m drawdown cone is within 50 m of the pumping wells, due to the high formation transmissivity and short pumping duration. For the most conservative case, a 1 m drawdown contour extends approximately 820 m from the pumping wells at the end of the 90-day pumping period. Figure 23 shows the estimated drawdown in the BCF.

Table 17 presents the drawdown for a selection of radius surrounding the pumping well after 90 days of pumping at 15 l/s (i.e., life span of Project). The first estimated drawdowns (column 2) considers the most conservative values of Transmissivity and Storativity while the second estimated drawdowns (column 3) considers the most conservative values. The extent of the drawdown is presented in Figure 23.

Table 17: Calculated Drawdowns after 90 Days of Pumping (15 L/s)

Radius (m)	Drawdown (m) for S= 2.82×10^{-5} and T=950.5 m^2/day	Drawdown (m) for S= 9.79×10^{-3} and T=1761.0 m^2/day
50	1.61	1.02
100	1.46	0.48
200	1.31	0.40
300	1.22	0.35
500	1.11	0.29
1000	0.96	0.21

During operations the drawdowns in groundwater levels in the aquifer in the area of Split Creek will not impact any potentially present aquatic GDEs in Split Creek as it is sustained by rainfall and not groundwater. Drawdowns in the groundwater levels in the aquifer in the area of the potential terrestrial GDEs will not impact the terrestrial GDEs as they are not sustained by groundwater.

After the operation ceases and there is no longer water extraction from the bores, there is not expected to be any long-term impacts to the groundwater within the aquifer. The water level changes in the aquifer are expected to recover from the water extraction.

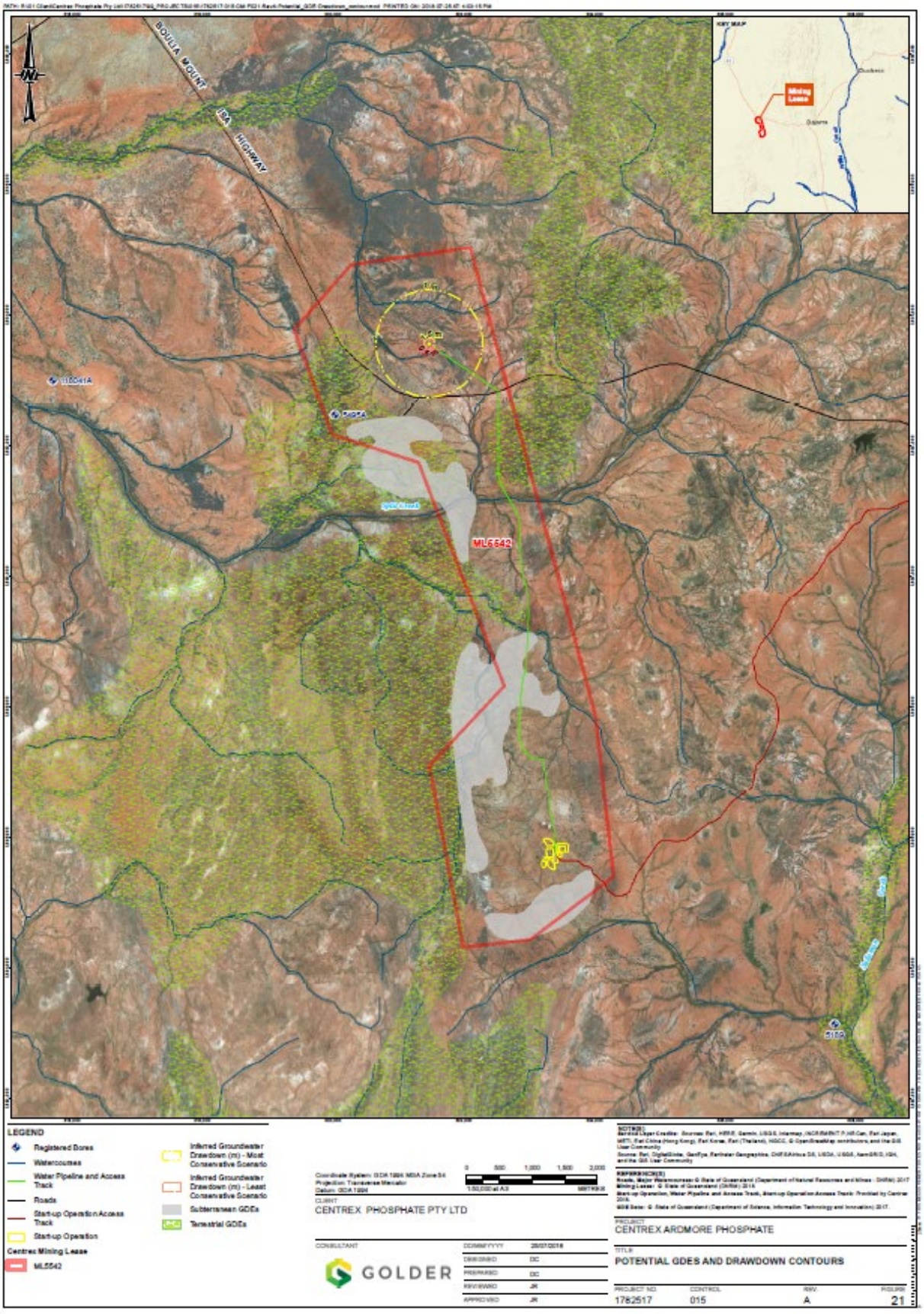


Figure 31: Potential GDEs and drawdown contours

6.2 Flooding

The site is located within a flat area with no significant water courses. Watercourses are ephemeral and only flow after heavy rainfall which also causes local flooding (Figure 10). The mine design and infrastructure layout has been designed to avoid surface water drainage lines and minimise potential for adverse impacts to mine infrastructure and to downstream watercourses. The site is located in the upstream portion of the “B” catchment (Figure 10), reducing the site’s potential exposure to flooding.

A site flooding assessment was undertaken, assessing flood depth, velocity, and severity for 1% AEP, 0.1% AEP as well as PMP scenarios. These are shown in Figure 32 to Figure 40. The mine extent was assumed to be hardstand with a Manning’s n value of 0.015. The remaining model extent was assumed to be natural vegetation with a Manning’s n value of 0.045.



Figure 32: 1% AEP event maximum flood depth

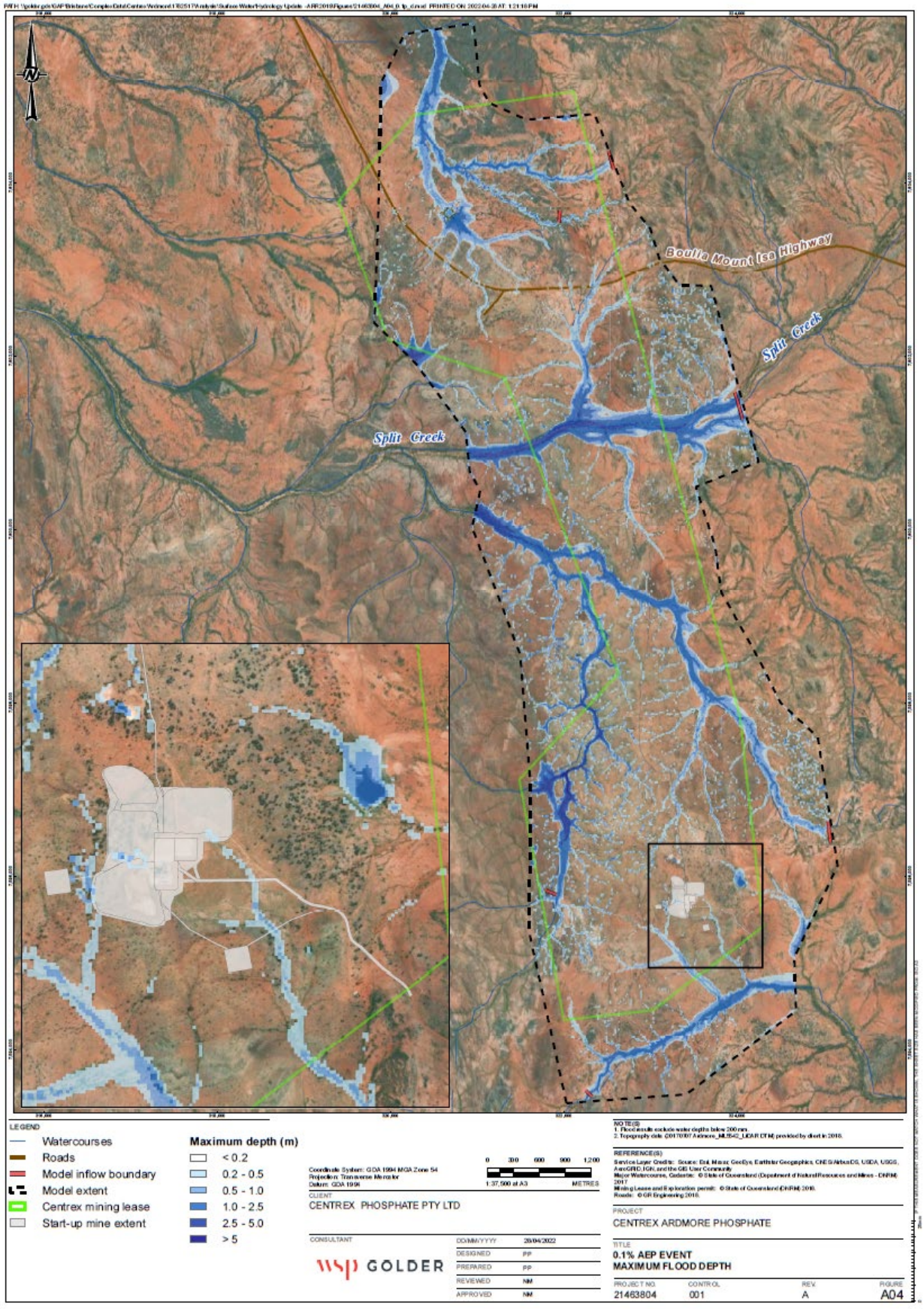


Figure 33: 0.1% AEP event maximum flood depth

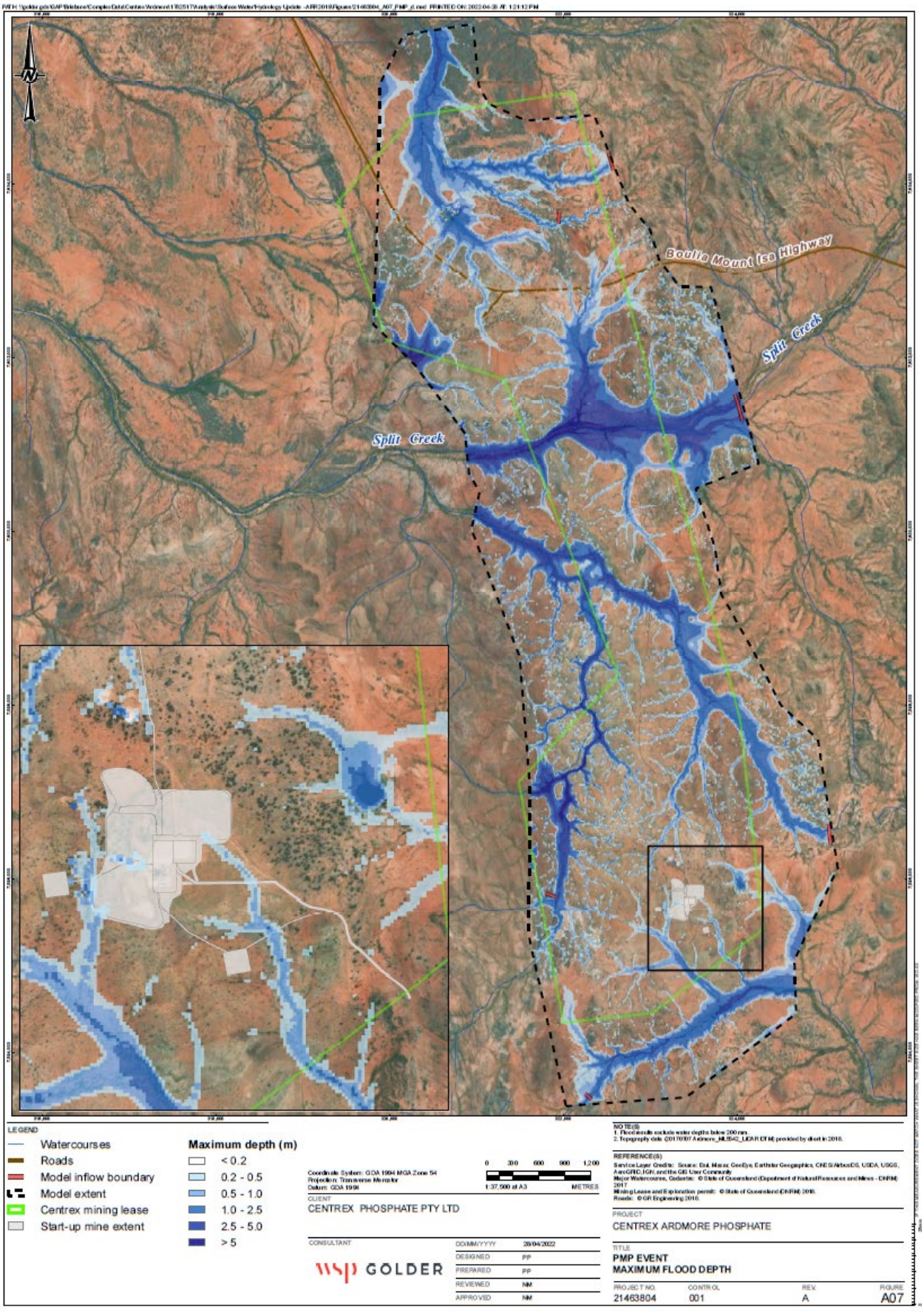


Figure 34: PMP event maximum flood depth



Figure 35: 1% AEP event maximum flood velocity



Figure 36: 0.1% AEP event maximum flood velocity

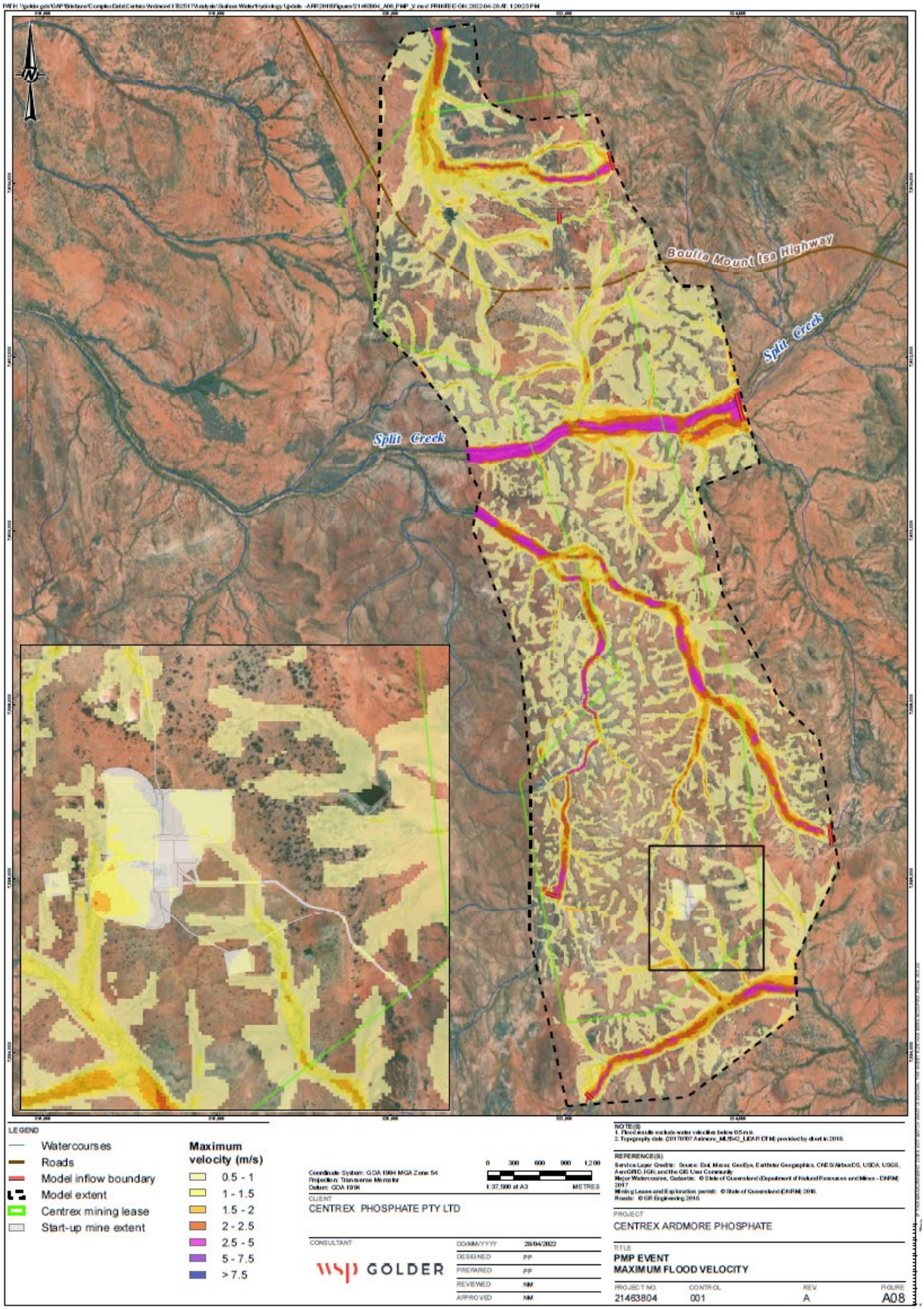


Figure 37: PMP event maximum flood velocity

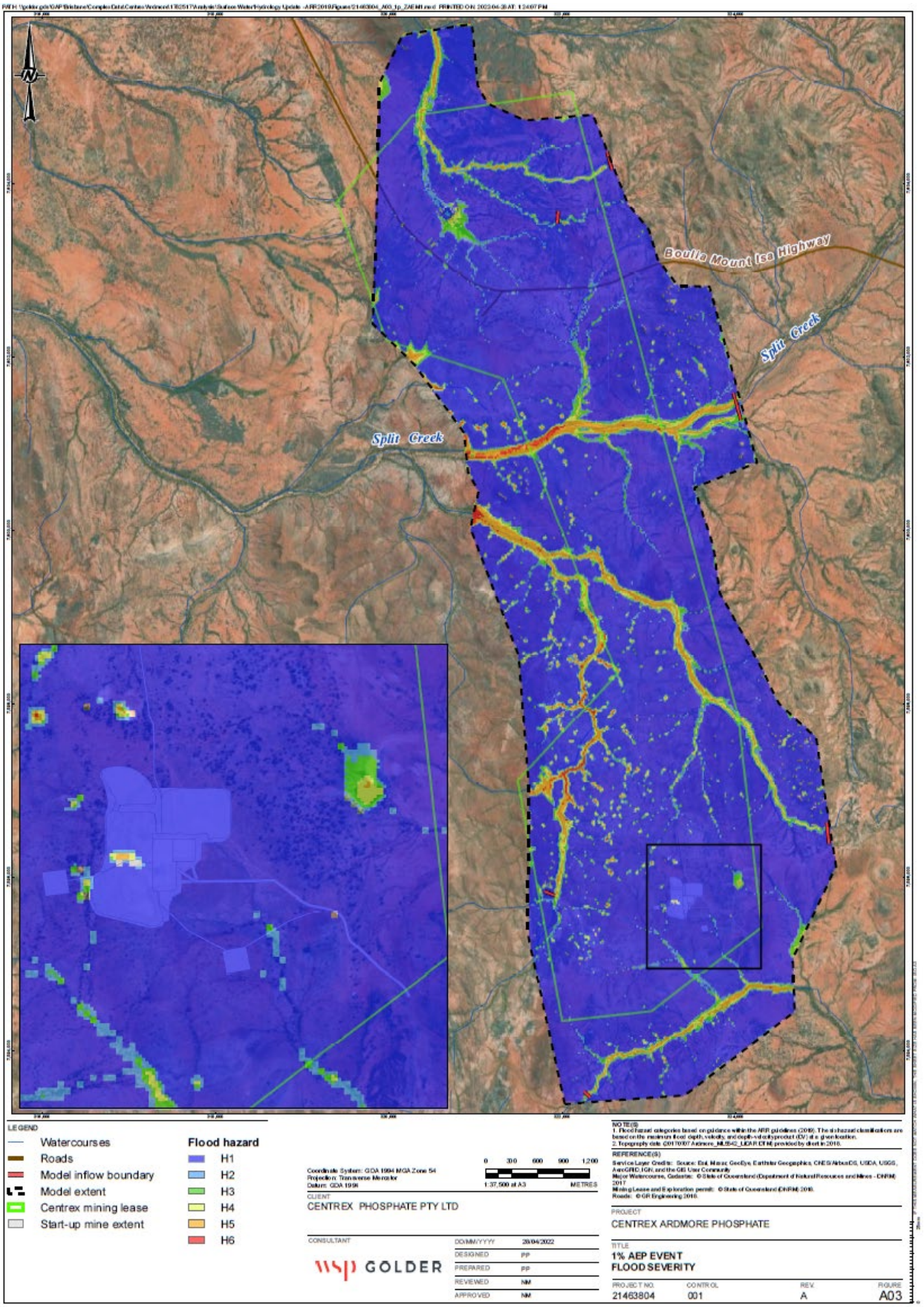


Figure 38: 1% AEP event flood severity

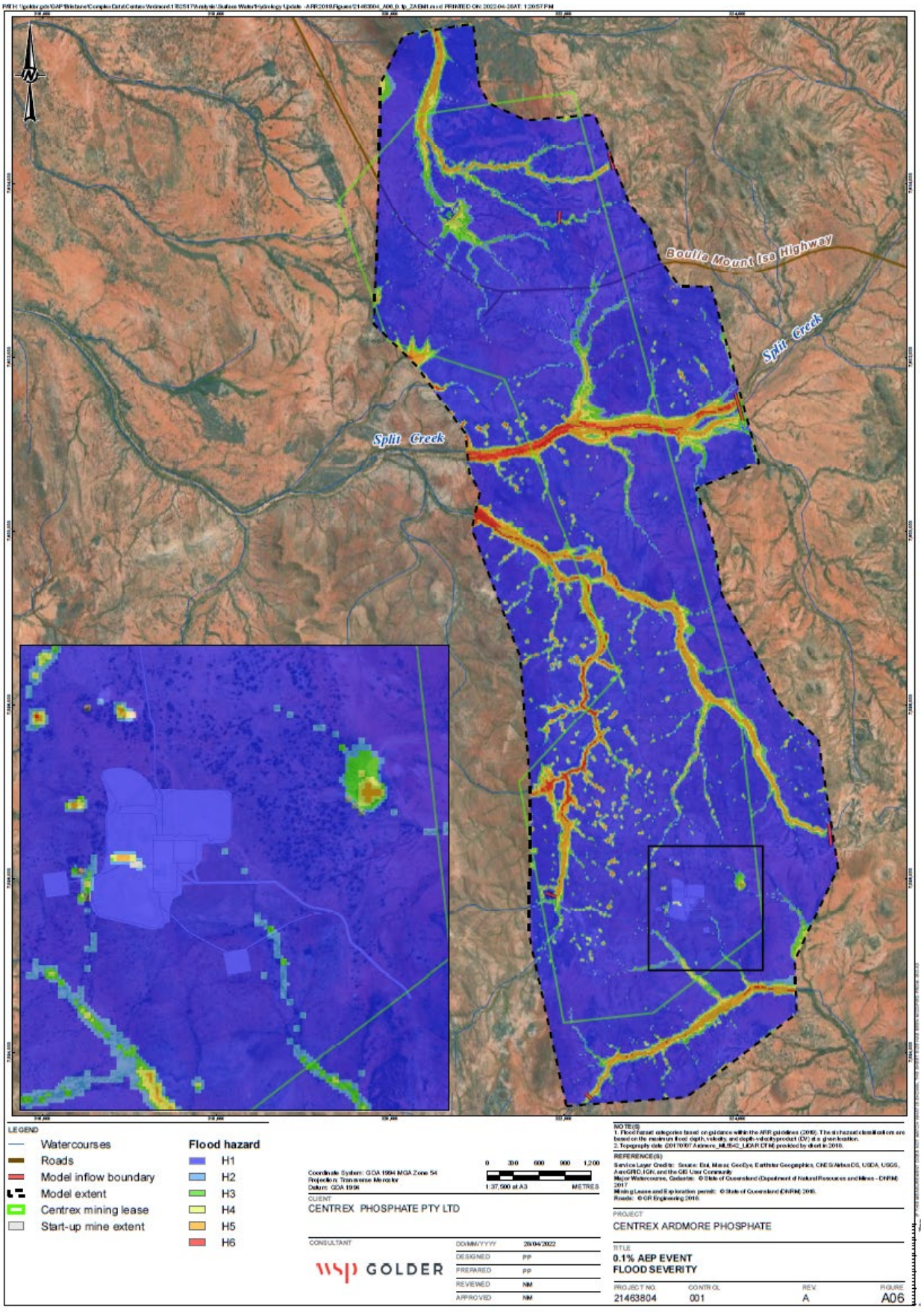


Figure 39: 0.1% AEP event flood severity

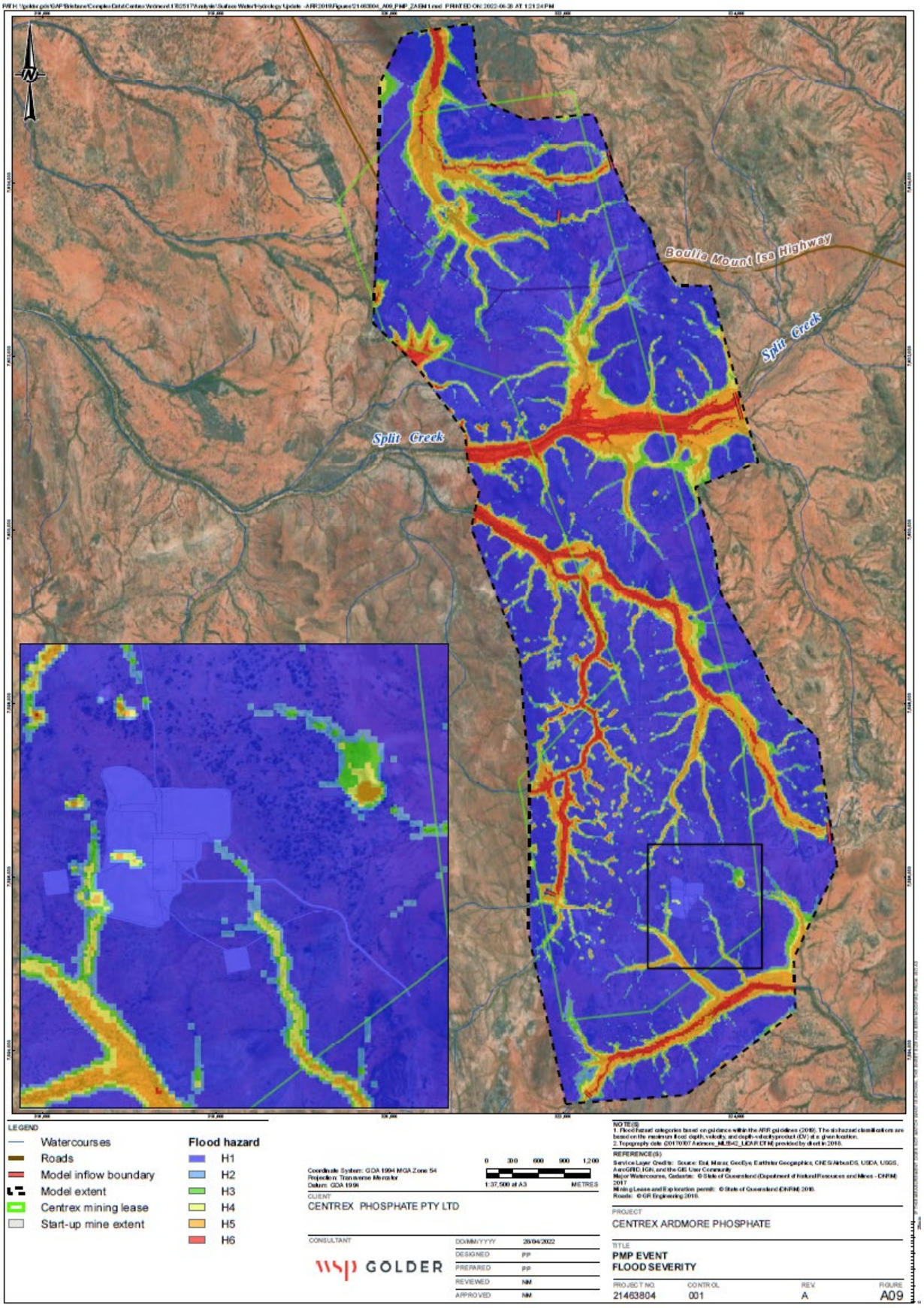


Figure 40: PMP event flood severity

Given the flooding described above, the risks of flooding at the site are extremely low. A key consideration for closure is the potential for flooding at the TSF. The TSF area is largely unaffected by flooding (in terms of flooding severity) for 1%, 0.1% scenarios (Figure 38, Figure 39, and Figure 40). Though the PMP event flood velocity shows some water movement over the TSF (Figure 37), the PMP depth is very low (Figure 34).

After rehabilitation and closure activities are undertaken, there is minimal inundation across the start-up mine extent except for one small section directly above the southern pit.

There are no proposed water management structures post mining.

6.3 Soils and capping material assessment

Topsoil is thin to non-existent at the site (<10 cm) comprising mostly of silty sand with limited organic matter present, however where it is recoverable, it will be stockpiled separately for use in rehabilitation activities.

The soil analytical results indicate that the surface stripping or disturbance should be limited to a maximum of 20 cm depth due to the sodic and saline nature of the subsoils in the area of the Start-up Operations. Dozers will remove the topsoil and subsoil and place them in separate stockpiles. Vegetation and topsoil will also be removed from the area of the overburden storage facility prior to the first waste rock material being dumped.

The overburden will be stored to the west of the pits. The cleared vegetation in the disturbance footprint will be mulched (if possible) and stockpiled with topsoil to provide additional organic material for later use in rehabilitation of the site. Topsoils and subsoil stockpiles will be managed and separated in accordance with best practises to ensure stability and suitability for future re-use. This approach should ensure that the topsoil stockpiles maintained and allow for the rehabilitation of the disturbance area (noting that in some areas the topsoil is naturally non-existent).

Over the life of the mine, priority will be given to topsoil and subsoil recovery to be available for use during rehabilitation.

During rehabilitation, soil placement on top of the TSF cap will be in reverse of the soil stripping (i.e. subsoils replaced first followed by topsoil replacement), topsoil will be redistributed across the disturbance area at the same thickness as initially removed (approximately 10 cm thick). It is envisaged that ameliorants will be required during rehabilitation given that the PMLU will consist of reverting to pre-mining land use of low intensity grazing on native pastures (described in Section 2.1.6) and the soil quality described in this section.

The soil chemical results indicated that the topsoil and subsoils represented by TP08 are classified as sodic soils. Additionally, the chloride and sulfate content of the subsoils at TP08 are considered very high, the salinity of this soil is considered to likely reduce the potential for vegetation growth (Figure 17). The material from this low laying alluvial area should be excluded from the use of capping material unless appropriately managed with use of gypsum and other ameliorants to reduce the erosion potential and allow for revegetation. Soil represented by TP07 and TP09 are classified as non-sodic with low to moderate chloride content, making the soil represented by these sampling locations more suitable for use in the TSF bund and as capping material.

Despite variability in the soils observed in the soil investigation locations, the soils across the site have poor physical and chemical properties and a moderate propensity for dispersion, the soils are typical of the region’s arid environment. Proper stripping of topsoil and stockpiling of topsoil and subsoils for re-using the soil for capping and rehabilitation of the site are considered suitable to achieve the pre-site disturbance condition. Soils with higher clay content soils are better suited for use in the TSF bund walls and as an impermeable barrier for capping of the TSF following operations. The capping of the TSF with low permeable soil will reduce the potential mobilisation of salt through the soil profile impacting vegetation regrowth.

Stripping and stockpiling (or use in TSF bund walls) of soils will degrade the soil physical properties to some extent. Given the low soil quality (physical and chemical), particularly of the subsoils, in the area of the proposed TSF expected to be used as the TSF bund walls, the replacement of this soil following Start-up operations, is not expected to pose many additional limitations for revegetation of the area. The TSF post Start-up operations is expected to contain additional salt (chloride), sulfates and likely some metalliferous material, limiting surface water ponding and water infiltration and thus mobilisation of these wastes through the use of surface water flow diversion, surface contouring to limit standing water and the impermeable clay capping layer will reduce the potential risk of the TSF waste material to rehabilitation.

Some amelioration (gypsum) is considered suitable to achieve a stable landform in the short term while vegetation re-establishes.

6.4 Mine waste characterisation

6.4.1 Waste types

The waste types likely to be generated by the proposed activities, excluding waste rock and tailings, would mostly be defined as ‘general waste’ and include construction materials waste, green waste, putrescible and domestic waste. These wastes are removed from the site to the Dajarra waste disposal site that is lawfully able to accept the waste under the EP Act. There is some capacity to dispose of waste on site as the current EA permits limited a limit of no more than 50 tonnes of general waste to be disposed of within ML5542 per annum.

Limited ‘regulated waste’ generated on site such as oils and tyres will be removed and transported from site by a person who holds a current authority to transport such wastes to the waste handling facility at Mount Isa. This facility is lawfully able to accept the regulated waste under the EP Act.

The description of tailings waste is covered in Section 6.8.

6.4.2 Mine waste

The geochemistry assessment of the mine waste material has been undertaken as by RGS (2018). The full report is provided within Appendix B (as Appendix B within that document).

The overburden and footwall samples (the material below the ore deposit) are a neutral pH (between 6 and 9). The net acid producing potential and acid neutralisation potential ratio indicated that the overburden samples were NAF or acid consuming (AC).

The overburden and footwall samples contained elevated concentrations of salts (greater than 8,000 µS/cm). It is likely that the elevated salinity is present in the form of sodium chloride and sulfate bearing minerals. The concentrations of total phosphorous suggest phosphate may also contribute to the elevated EC levels.

The geochemical abundance index (GAI) is used to identify samples with elevated mineralisation concentrations. The GAI is used to guide to highlight metals or metalloids that require further investigation.

The overburden and footwall samples GAI and elevated sulphide concentrations indicated that the footwall material in the Northern zone (outside of the Project Area) may have potential for metalliferous drainage. However, in the Southern zone there was low potential for metalliferous draining from the samples.

6.4.2.1 Net Acid Producing Potential

The overburden and footwall samples (the material below the ore deposit) were a neutral pH (between 6 and 9). The net acid producing potential and acid neutralisation potential ratio indicated that the overburden samples were NAF or acid consuming (AC).

6.4.2.2 Saline drainage potential

The overburden and footwall samples contained elevated concentrations of salts (greater than 8,000 µS/cm). It is likely that the elevated salinity is present in the form of sodium chloride and sulfate bearing minerals. The concentrations of total phosphorous suggest phosphate may also contribute to the elevated EC levels.

6.4.2.3 Metalliferous drainage potential

The geochemical abundance index (GAI) is used to identify samples with elevated mineralisation concentrations. The GAI is used to guide to highlight metals or metalloids that require further investigation. A 16 hour leach test was used to verify that there is a low potential for metalliferous draining from the samples.

The overburden and footwall samples GAI and elevated sulphide concentrations indicated that the footwall material in the Northern zone (outside of the Project Area) may have potential for metalliferous drainage. However, in the Southern zone there was low potential for metalliferous draining from the samples.

6.4.3 Use of mine waste in rehabilitation

Assuming the Full-scale Operation does not proceed and the Project is not within a Care and Maintenance phase the pits, overburden and ROM areas will be rehabilitated as follows:

- **Pits**. Stockpiled overburden will be used to backfill the pits. The backfilled pits will be covered with sub-soil followed by topsoil. The topsoil will be direct seeded to encourage revegetation with pasture species or native species of local provenance.
- **Overburden storage facility**. Overburden will be separated and stored. If the Full-scale Operation does not proceed overburden will be used to backfill the pits to the original topographic level. Topsoil will be placed on top of the overburden and it will be direct seeded to encourage revegetation with native species.
- **ROM**. The ROM material will be used to backfill the pits.

  The use of mine wastes as backfill can create potential for impacts on rehabilitation from the wastes stored. Limiting interaction of water with the waste materials reduces the potential for the migration of salts and contaminates. The reduction of surface water ponding by completing the rehabilitation to pre-disturbance elevations and encouraging surface water runoff, the potential for impacting soil and water quality are decreased. The movement of salts and metalliferous material through the soil column will be reduced by the low permeability capping material, backing filling of the sub soil on top of waste, followed by the placement of topsoil, creating a barrier to root zone of the vegetation regrowth.

6.5 Landform and cover design

Rehabilitation objectives provide a clear description of proposed rehabilitation outcomes within the individual RAs in the mine site. For the landforms relating to the Start-up Operation, the relevant objectives are the following:

- Provide for chemically stable and non-polluting final landforms post mining.
- Provide for geotechnically stable final landforms post mining.

Progressive rehabilitation of areas impacted by mining activities will occur as soon as practical to a stable landform with a self-sustaining vegetation cover.

As described in Section 6.8.2, geochemical analysis indicates that the tailings are likely to be NAF with a low potential for saline drainage.

Assuming the Full-scale Operation does not proceed and the Project is not within a Care and Maintenance phase the disturbed areas will be rehabilitated as follows:

- **Pits**. Stockpiled overburden and waste material will be used to backfill the pits. The backfilled pits will be covered with sub-soil and topsoil will be spread. It will potentially be direct seeded to encourage revegetation with native species of local provenance. The pits will be backfilled back to natural elevation and there will be no localised depression.
- **Tailings Storage Facility.** The TSF will be built as a 5 m deep pit with no 'dam walls'. The TSF will be capped and backfilled with material from the TSF bund (supplemented with low permeability soils (high clay content)). The lining will be left in-situ and the surface will be rehabilitated with stockpiled sub soil and topsoil. The 1 m freeboard, maintained during operations, will be backfilled with material from the TSF bund and/or low permeability soils with a high clay content (as required) back to pre-mining topography. Backfilling will create a cap of at least 1 m thickness over the TSF. A slightly concave structure on the backfilled TSF will assist in retaining rainfall to aid in vegetation growth. The initial backfill is likely to be convex due to the reduction in void volume by tailings.

Figure 30 shows cross-sections of the proposed final landform for the Project. The final topography will be returned to a similar topography as the pre-mining landscape. There will be no remaining overburden material storage facilities at closure. Therefore, there are no slopes or geotechnical hazards.

The soil suitability for both the pits and the TSF capping is described in Section 6.3. Soils with higher clay content soils (TP08) are better suited for use in the TSF bund walls and as an impermeable barrier for capping of the TSF following operations. The capping of the TSF with low permeable soil will reduce the potential mobilisation of salt through the soil profile impacting vegetation growth. The use of waste material for backfill, based on the properties outlined in Section 6.4.2, is not expected to incur any issues regarding rehabilitation objectives and the achievement of a safe and stable environment.

The exploration costeans will be backfilled with the material which has been displaced for exploration purposes in a similar manner as the pits.

Due to the small scale and the short timeframe of the Start-up Operation, landform design options will not be trialled.

6.6 Water management

The site is located within a flat area with no significant water courses. Watercourses are ephemeral and only flow after heavy rainfall which also causes local flooding. The mine design and infrastructure layout has been designed to avoid surface water drainage lines and minimise potential for adverse impacts to mine infrastructure and to downstream watercourses. Site water management during operations includes minimising changes to natural surface water flow, diverting clean water from disturbed areas and preventing runoff and erosion from disturbed areas or discharges downstream.

6.6.1 Description of contaminants

The TSF has been designed to allow for the appropriate storage capacities and water management requirements to ensure dam safety as well as environmental safety. The tailings and water stored in the TSF are likely to be of quality exceeding the water quality guidelines. Appropriate storage allowances built into the design will reduce the risk of spill from the dam during operations. The Southern Zone, which includes the Project area, contains footwall material which is completely oxidised and the potential for PAF material in this area is negligible.

The environmental risks associated with management of water from surface material during mining, temporary stockpiling and ultimate placement of overburden during rehabilitation is relatively low. A summary of potential water contaminants is provided below:

- **Ore and tailings streams –** Sampling has found ore and tailings streams are non-acid forming (NAF) and geochemically benign, with low risk of generating acidic or saline drainage.
- **Overburden –** Sampling suggests overburden materials taken from the south of the ML are NAF. Some samples showed elevated EC measurements.
- **Basement/Footwall units –** Sampling has identified basement/footwall units in the Southern Zone as being completely oxidised and the potential for PAF material in this area is negligible.
- **Vehicles, mine plant and equipment, storage areas, and washdown areas** – Leaks and spills of chemicals and hydrocarbons are possible from these areas.

The contaminants have potential impacts to receiving environments including a reduction of soil productivity (and rehabilitation success) due to excess salts. As described throughout Section 6.0, the pits will be backfilled and the TSF will be appropriately capped in-line with rehabilitation objectives. The potential impact of contaminant transport related to water management will be mitigated by the TSF cap. Based on the material assessment (Section 6.3), it is expected that limited salt migration through the soil column will occur, to an extent not likely to impacted vegetation re-growth or rehabilitation.

During operations there are sources of contaminants on the Project site which could be mobilised by surface runoff and result in pollution to the environment. However, spill protocols are in place to reduce this potential for water quality impacts. The Project will store approximately 40,000 litres of diesel during site operations. The diesel will be stored in specialised fuel tanks with built-in bunding and spill protection measures compliant with Australian Standard 1940: 2017. The storage and handling of flammable and combustible liquids. Chemicals used on site will include a flocculant for the ore processing, and oils for machinery and vehicle maintenance such as engine and hydraulic oils.

This will not affect water quality at closure, as the site will be rehabilitated, backfilled, and appropriately capped, as described in Section 6.5.

6.6.2 Source, pathway, and fate of contaminants

A detailed surface water impact assessment (Golder, 2018d) concluded that, during operations, the Project will increase surface water yield and sediment generation, but have negligible impact on peak flows within the ML. The Project has the potential to increase the presence of contaminants (associated with spills, leaks etc.) and therefore contaminant run-off, which could affect aquatic habitats.

Changes to water quality and reduction in surface water flows can result in changes in habitat quantity and quality, particularly for aquatic and semi-aquatic species (for example, frogs). Changes in surface water flows can cause changes to soil, vegetation, riparian ecosystems, and wetlands, thereby affecting habitat quantity and quality. However, any such changes in habitat quantity and quality are expected to be negligible given the very seasonal nature of the water flows in the ML, and the short duration of the Project. Furthermore, the footprint of the Project makes up less than 0.1% of the Regional Study Area (RSA); therefore, the impacts are minimal and manageable with appropriate erosion and sediment control measures.

In terms of saline drainage, the main source of contamination would be the TSF. Through the effective capping and rehabilitation of the TSF, the pathway of the contaminants is limited therefore there is no potential for impacts to the receptors.

Surface water diversions or management of surface water are not required to be maintained after closure.

6.7 Revegetation process

If the Full-scale Operation does not proceed the overburden will be placed back into the pits and stockpiled ore from the indurated storage facility will also be used to backfill the pits. The surfaces will be returned to the original topographic level and it will be spread with topsoil and direct seeded to encourage revegetation with pasture species or native species of local provenance. There will be no irrigation of revegetation.

The proposed PMLU will be the same as the pre-mining land use; grazing on native pastures (Section 4.0).

Revegetation will be undertaken by direct seeding of native grass species within the areas of disturbance. The key benefits of revegetation include:

- Stabilisation of the land to minimise erosion and release of sediment into water
- Improvement of visual amenity
- Replacement of habitat lost from vegetation clearance
- Reduce the likelihood for establishment and proliferation of weeds
- Develop site to a grazing post mining land use.

Revegetation will be undertaken as part of the rehabilitation process described in Table 13 to Table 16 in Section 6.5.

Species used for revegetation will include a mix of native and introduced pasture grasses. The species used will depend upon availability at time of sourcing. The indicative species list is provided in Table 18. Opportunistic seed collection and sowing of native shrub and tree species will also be undertaken. Buffel grass (*Cenchrus ciliaris*) has been omitted from the list due to its high potential to out-compete native and other pasture grasses.

Revegetation will be undertaken by direct seeding of native species within the areas of disturbance. The key benefits of revegetation include:

- Stabilisation of the land to minimise erosion and release of sediment into water.
- Improvement of visual amenity.
- Replacement of habitat lost from vegetation clearance.
- Reduce the likelihood for establishment and proliferation of weeds.
- Develop site to a grazing post mining land use.

Table 18: Indicative revegetation species list and sowing rate

Form	Common Name	Scientific Name	Sowing Rate
Tree	Inland Bloodwood	*Corymbia terminalis*	<1kg/ha
Shrub	Whitewood	*Atalaya hemiglauca*	<1kg/ha
Shrub	Bauhinia	*Lysiphyllum gilvum*	<1kg/ha
Grass	Bunched Kerosene grass	*Aristida contorta*	<1kg/ha
Grass	Hoop Mitchell grass	*Astrebla elymoides*	<1kg/ha
Grass	Curly Mitchell grass	*Astrebla lappacea*	<1kg/ha
Grass	Barley Mitchell grass	*Astrebla pectinate*	<1kg/ha

Form	Common Name	Scientific Name	Sowing Rate
Grass	Bull Mitchell grass	*Astrebla squarrosa*	<1kg/ha
Grass	Golden Beard Grass (Ribbon) grass	*Chrysopogon fallax*	<1kg/ha
Grass	Queensland bluegrass	*Dichanthium sericeum subsp. Sericeum*	2-4 kg/ha
Grass	Bottlewasher grasse	*Enneapogon spp.*	<1kg/ha
Grass	Silky Browntop	*Eulalia aurea*	<1kg/ha
Grass	Soft Spinifex	*Triodia pungens*	<1kg/ha

6.7.1 Reference values

Baseline assessments considered that vegetation communities within the ML to be represented across the greater regional area. Significant disturbance from cattle grazing and the invasion of pest plant species was observed across the ML.

The environmental values present within the direct vicinity of the proposed start-up operation location were predominately very sparse with limited to no habitat values, on RE 14.9.12x4a/4.9.10b. Vegetation comprised a sparse ecotonal mix of *Acacia cambagei* and *Corymbia terminalis* very open woodland on skeletal soils, with large portion of the proposed start-up location containing only a sparse groundcover of *Enneapogon polyphyllus.*

The ML reference values identified above will serve as a reference site that will be used for the rehabilitation objective. Aligning revegetation objectives with ML baseline environmental values will support the PMLU (as described in Section 4.0).

6.7.2 Completion criteria

The completion criteria are the basis on which successful rehabilitation and mine completion is determined. It provides for a broad agreement on final land use outcomes and a basis for measuring the achievement of that outcome. The criteria are designed to be flexible enough to adapt to changing circumstances without compromising the end outcome.

The completion criteria are included in in Table 13 to Table 16 in Section 4.4.

6.8 Tailings Storage Facility

The TSF will be surrounded by a bund on the north, east and west raised 4 m above ground level and with a total area of approximately 1.4 ha. A spillway will be installed to manage extreme high rainfall events. The provision of the bund on three sides of the dam will prevent sheet water inflow and the 1 m freeboard will cater for any direct rainfall onto the dam. Analysis of rain events by Golder shows that a 1:100 AEP 72-hour event will not generate sufficient volume from direct fall to exceed the 1 m freeboard.

The TSF will be built as a 5 m deep pit with no ‘dam walls’ constraining the tailings, as it will be filled into a purpose built pit with sufficient freeboard to prevent overtopping. The TSF for the Project does not meet the criteria for a ‘referable dam’ or a ‘hazardous waste dam’ as it is not greater than 8 m in height and it will not include a barrier to impound water. The dam is likely to be considered a non-referable, non-hazardous waste dam.

The EP Reg defines a ‘regulated structure’ as being a structure that is assessed under the DES (2016) *Manual for assessing consequence categories and hydraulic performance of structures ESR/2016/1933 Version 5.01* (2016a). The manual explains that regulated structures include ‘*land-based containment*

structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity'. The manual also links to the DEHP guideline *Structures which are dams or levees constructed as part of environmentally relevant activities (2017) ESR/2016/1934, Version 8.00* (DEHP, 2017).

These two documents outline the process for determining whether a structure is considered a 'regulated structure'. A 'consequence assessment' determines the category of the structure and a structure is only a regulated structure where the consequence category for the structure is 'significant' or 'high. The manual states that all structures which are dams associated with the operation of an ERA must have their consequence category assessed based on the potential environmental harm that would result from the failure event scenarios described in the manual (DES, 2016).

The consequence category assessment methodology is an assessment of environmental harm and it considers harm to humans, general environmental harm and general economic loss or property damage. The 'low' consequence category is relevant for the Start-up Operation TSF.

6.8.1 TSF rehabilitation and closure methodology

The location of the TSF, which is adjacent to the plant site, comprises colluvium (fine to medium grained, brown sand with medium to coarse grained, sub-angular gravel with low plasticity clay and trace rock fragments) to depths ranging from 0.2 m to 1.8 m overlying medium to very high strength weathered siltstone.

6.8.2 Tailings characterisation

The tailings will consist of benign materials comprising predominately kaolinite, quartz, apatite, smectite and goethite. Geochemical analysis indicates that the tailings is likely to be NAF with a low potential for saline drainage. However, as the brine from the plant will be co-deposited into the tailings pond, the salt load within the TSF is expected to be elevated, however the TSF will not contain hazardous waste.

Screened undersize tailings slurry, with an anticipated slurry density of approximately 11-15% solids will be pumped to the tails thickener. A compact, high-rate styled tail thickener will be used to dewater and thicken the low-grade material from the primary and secondary cyclones and ultra-fines screen undersize streams, using an added flocculant (approximately 45 g/t) via a dedicated flocculant dosing pump to improve settling characteristics. Water recovered in the thickener will be recycled to the plant water tank.

Tailings will be deposited using sub-aerial deposition techniques from multi spigot locations on the perimeter deposition embankments. Tailings spigotting or deposition is to be executed in thin layers of not more than 300 mm to ensure a uniform tailings beach with a fall of 1% towards the decant. The spigotting sequence is to be formulated such that the supernatant water pond is always maintained around a decant structure.

Tails thickener underflow pumps will then pump the thickened tails 30-37% solids via one tailings discharge pipe to deposit in the tailings facility, which is a storage pond lined with an impervious geofabric/polymer liner approximately 0.8 ha and measuring 90 m wide x 90 m long x 5 m deep. The tailings will consist of benign materials comprising predominately kaolinite, quartz, apatite, smectite and goethite.

The conceptual design for the TSF (Appendix C) utilised the guiding principles in the following documents:

- Department of Environment and Heritage Protection (DEHP) (2017) document titled, '*Guideline, Environmental Protection Act 1994, Structures which are dams or levees constructed as part of environmentally relevant activities'*, dated 5 July 2017.
- Department of Environment and Science (DES) (2016) document titled, '*Manual for Assessing consequence categories and hydraulic performance of structures'*, dated March 2016.

- Australian National Committee on Large Dams (ANCOLD) document titled, *'Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure'*, as dated May 2012

Geochemical characterisation

To date there has been no tailings produced at the Start-up Operation and therefore the geochemical characterisation has been undertaken on tailings samples.

Geochemical analysis indicates that the tailings is likely to be NAF with a low potential for saline drainage. However, as the brine from the RO plant will be co-deposited into the tailings pond, the salt load within the TSF is expected to be elevated. The TSF will not contain hazardous waste. Geochemical testwork of tailings samples was undertaken by RGS (2018) the full report with the sample results is provided in Appendix B (as Appendix B within that document).

Geotechnical characterisation

To date there has been no tailings produced at the Start-up Operation and therefore the geotechnical characterisation has been undertaken on tailings samples.

The results of the PSD and Atterberg Limits testing indicate that the tailings can be classified as a high plasticity clay, with silt Unified Soil Classification (USC) group symbol CH. The Emerson Class Number Test indicates that the materials are non-dispersive.

The particle size distribution with hydrometer testing of the minus 75-micron fraction of the tailings and Atterberg Limits tests indicate that the tailings are very fine, being classified as a high plasticity silty clay with 100% passing 38 microns and more than 40% passing 2 microns.

The air drying and settling tests, drained and undrained, indicate that the tailings will settle out of suspension very slowly. The objective of the drained and undrained settling test is to monitor the tailings settlement and the development of clear supernatant water. By monitoring the height of the solids and the achieved dry density over time, an indication of the speed at which this water is released can be assessed. The points to note from the results of the undrained settling test, undertaken on tailings slurry with a slurry density of 30% solids, are:

- At discharge, the tailings slurry has an equivalent dry density of nominally 0.375 t/m^3 for both settling tests.
- After a period of 7 days, the dry density increases to nominally 0.635 t/m3 for the undrained test, whereas the drained test reaches a dry density of 0.836 t/m3 after approximately 14 days. The shape of the curves in both tests suggests some water release can be expected within the first 1.4 days following tailings deposition.
- The airdrying test indicates water is available to decant for up to 2 days after deposition.
- Under field conditions it is likely that supernatant water recovery would be very low, given the hot dry conditions at the project site.
- The oedometer testing (consolidation testing) indicates a slow consolidation rate which will result in an increase in dry density. However, the increase in dry density is not going to make a substantial difference to the consolidation and settlement of the tailings, given the relatively low total height of the tailings stack.

For the purposes of the Start-up Operation, a low, conservative settled density, 0.46 t/m^3, has been adopted to reflect the intermittent operation of the Start-up Operation. Actual settled density used in the Feasibility Study for planning purposes for the Full-scale Operation is in the range of 0.75 t/m^3 to 0.85 t/m^3. This target in-

situ dry density is provided in Figure 41, with the water release and recovery to achieve an in-situ dry density of 0.75 t/m^3 is 50 tph.

The summary of geotechnical test results for the tailings is provided in the TSF conceptual design report (Appendix C) and also within the tailings testwork Appendix D.

The geotechnical tailings testwork undertaken by TriLab Pty Ltd in Brisbane comprised of the following tests:

- Particle Size Distribution (PSD) with hydrometer (AS 1289 3.6.3, 3.5.1 and 2.1.1)
- Atterberg Limits (AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1)
- Emerson Class Number (AS 1289 3.8.1)
- Air Drying Test (non-AS test method)
- Settling Test – Drained (non-AS test method) x 1
- Settling Test – Undrained (non-AS test method) x 1
- Oedometer Test – (AS1289.6.6.1, 3.5.1)

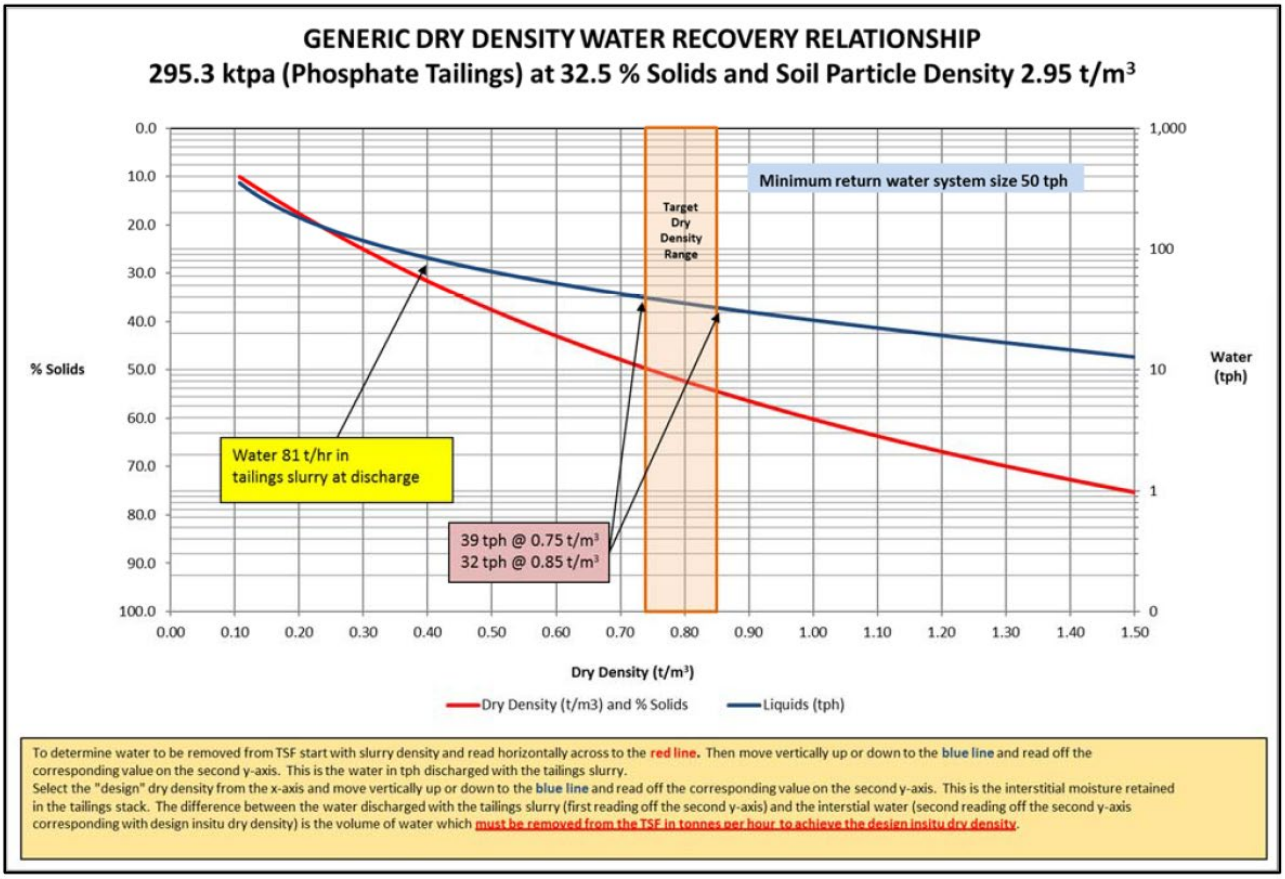


Figure 41: Generic moisture density curve at zero air voids for 800 ktpa

6.8.3 Geotechnical stability

The TSF has been designed to hold the tailings inside an excavated pit. There are no tailings dam walls or tailings raises therefore the geotechnical stability has not been assessed for the in-ground TSF for the Start-up Operation.

6.8.4 Tailings water management and erosion protection

The TSF for the Project comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m, surrounded by a 1.38 m high bund to prevent entry of runoff.

Soil erosivity is expected to increase significantly compared to the existing site conditions where areas of limited vegetation ground cover exist. The Revised Universal Soil Loss Equation (RUSLE) analysis indicated that the overburden stockpiles have a potential loss of soil of 15.1 t/ha/yr without the consideration of implementation of erosion and sediment control measures.

The facility will have the capacity to store a considerable volume of water during a storm event. The minimum operational freeboard for the TSF under normal operating conditions is 1.0 m at the perimeter discharge embankments.

On eventual decommissioning, the facility will temporarily remain as a feature of the landscape until closure. The top surface and batters will be stabilised and rehabilitated according to the closure plan for the project.

6.9 Voids

There will be no void remaining at closure.

6.10 Underground mining

The Project does not involve underground mining.

6.11 Built infrastructure

All infrastructure is to be decommissioned, removed from the site, and the associated disturbance rehabilitated at closure, unless written approval by landowner/new landowner is obtained. There is currently no agreement in place with the landowner and full removal and rehabilitation will be undertaken.

The demonstration processing plant and infrastructure will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated, and the areas will then be revegetated with native grass species.

A 5 m wide corridor approximately 8.5 km in length will accommodate an 80 mm diameter water pipeline from two bores in the north of the ML to the processing facilities and an accompanying single vehicle access track for pipeline maintenance (4.3 ha). The pipeline will be temporarily laid on the surface along a route from the north to the south of the ML as shown in Figure 5, buried at a depth of 0.5 m under three creek crossings and disturbing approximately 4 ha of vegetation in total. An access track will be formed along-side the water pipeline for maintenance purposes.

An access haul road will be 11 km in length from the processing plant to the highway (1 km from the processing plant to the ML boundary). It will be located on a pre-existing track with some minor widening and therefore it is not included in the area of disturbance.

7.0 RISK ASSESSMENT

The PRCP Guidelines require that a risk assessment is undertaken to identify the risks of a stable condition of land not being achieved and other risks that may be present at closure and to propose how the risks will be managed or minimised.

As per section 126C(1)(f) of the EP Act, the focus of the risk assessment related to the risk of not achieving the proposed post-mine land use (grazing on native pastures). It did not aim to identify internal project risks or financial risks to the company from closure activities.

7.1 Methodology

The aspects of risk assessment, as described by the AS ISO 31000:2018: Risk Management – Guidelines (Standards Australia, 2018), were included in the risk assessment:

- Risk identification – sources of risk, areas of impacts, events and causes, potential for consequences
- Risk analysis – causes of risk, positive and negative consequences, and likelihood of consequences occurring
- Risk evaluation – analysis to determine what risks need to be managed and prioritised
- Risk treatment – select and implement options for addressing identified risks.

The risks associated with the ability to return the RAs to a stable PMLU were analysed using qualitative criteria to assess likelihood and consequences. Table 19 to Table 21 provide the descriptors for the likelihood and consequence rankings and also the overall risk matrix provided.

Table 19: Qualitative criteria for likelihood

Likelihood probability	Description (single events)	Frequency
Almost certain	Common occurrence	Once per decade
Likely	Probably will occur or has happened in the past	Once every 10 – 50 years
Possible	Could happen at some time	Once every 50 – 100 years
Unlikely	Occurs infrequently	Once every 100 – 500 years
Rare	Not likely to occur	Once every 500+ years

Table 20: Qualitative criteria for consequence

Insignificant	Minor	Moderate	Major	Catastrophic
Environmental issues/impact resolved within normal business operations Community complaint resolved via existing site procedures	Environmental incident contained on site Incident tolerated without external complaints Repeated community complaints requiring	Minor impact to sensitive environments or moderate impact to non-sensitive environments Isolated community and customer complaints	Moderate impact to sensitive environments or medium-term impact to non-sensitive environments Requires long term recovery and leaving some residual damage	Long term impact to sensitive environments, requiring long-term recovery, leaving major residual damage

Insignificant	Minor	Moderate	Major	Catastrophic
	site management or business unit response Minor, repairable damage to cultural heritage items or sites	Community and social unrest stops operations for up to one week Significant but repairable damage to heritage items of significance	Community and social unrest stops operations for between one week and one month Irreparable damage to site or item of cultural significance	Emergency response involving external emergency services Community and social unrest stops operations for greater than one month Significant irreparable damage to a site or items of cultural significance

Table 21: Qualitative risk assessment matrix

	Most serious consequence				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Table 22 provides the risks identified together with the risk treatment (controls) in place to lower the risk.

7.2 Risk assessment findings

This section provides the findings of the risk assessment which identified the potential risks to achieving a PMLU if rehabilitation and closure activities are undertaken as they are currently proposed.

The risk assessment findings indicate that there is a low potential risk of not achieving the PMLU of low intensity grazing on native pastures.

Table 22: Risk assessment findings

Risk No.	Risk	Impacts	Causes	Controls	Inherent Risk		
					Likelihood	Consequence	Severity
1	Availability of rehabilitation materials	Inability to achieve rehabilitation and revegetation to support future land use/s	Insufficient growth medium quality and/or quantity recovered from topsoil stockpile for use on TSF and backfilled pit and other disturbed areas	Topsoil (where available) has been stripped and stockpiled from disturbed areas TSF cover material will be sourced from the bund on the perimeter of the TSF.	Unlikely (natural environment supports grazing on native pastures in areas of very thin to non-existing topsoil)	Minor	Low
2	Geochemical characteristics of TSF released into the environment	Safety issue for public / livestock	Uncontrolled release of waste material to downstream environment (including from seepage)	TSF backfilled and covered with the TSF bund Geochemical analysis indicates that the tailings is likely to be NAF with a low potential for saline drainage. However, as the brine from the RO plant will be co-deposited into the tailings pond, the salt load within the TSF is expected to be elevated.	Unlikely	Minor	Low
3	TSF Landform stability - erosional	TSF cover landform erosion	Storm event occurs while cover construction is in progress. TSF cover not in place including vegetation cover	TSF vegetated to stabilise Short timeframe to push bund material over TSF and adequate cover material located close to TSF	Unlikely	Minor	Low

Risk No.	Risk	Impacts	Causes	Controls	Inherent Risk		
					Likelihood	Consequence	Severity
4	Erosion of growth media (material suitable for revegetation) prior to vegetation establishment within general site rehabilitation areas	Erosion and sedimentation of landform and downstream environment, landform rilling/gullying etc.	Storm event occurs while cover construction is in progress. Lack of vegetation growth	Stabilise with vegetation/grasses	Unlikely	Minor	Low
5	Residual infrastructure or equipment	Injury to a member of the public	Access tracks and groundwater bores to remain at closure	Agreement with landholder to transition items at closure Make safe to agreed condition at closure	Rare	Insignificant	Low
6	Weeds and pests	Weed and pest increase during/following rehabilitation Unable to achieve PMLU	Inadequate weed and pest program during operations	Weed and pest management during rehabilitation/revegetation to prevent issues with weeds and pests post closure if required. Buffel Grass and Mimosa Bush were present on the ML prior to operations.	Unlikely	Minor	Low
7	Vegetation growth (Pit)	Rehabilitation failure or a long time before vegetation growth occurs. Unable to achieve PMLU	The natural environment is not conducive to prolific vegetation growth. The likelihood of the failure depends upon the future grazing regime and timeframe between adequate rainfall.	A slightly concave structure on the backfilled pit will assist in retaining rainfall to aid in some vegetation growth. Soil conservation and erosion and sediment control best practises will be utilised to reduce the risk of soil erosion and reduce the risk of salt and sulfate impacted soils being mobilised into the receiving environment.	Unlikely (The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.)	Minor	Low

Risk No.	Risk	Impacts	Causes	Controls	Inherent Risk		
					Likelihood	Consequence	Severity
8	Vegetation growth (TSF)	Rehabilitation failure or a long time before vegetation growth occurs. Unable to achieve PMLU	The natural environment is not conducive to prolific vegetation growth.	A slightly concave structure on the backfilled TSF will assist in retaining rainfall to aid in vegetation growth. The initial backfill is likely to be convex due to the reduction in void volume by tailings but the remaining overburden could be used in the pit to ensure a concave landform.	Unlikely	Minor	Low
9	Vegetation growth (Overburden and ROM)	Rehabilitation failure or a long time before vegetation growth occurs. Unable to achieve PMLU	The natural environment is not conducive to prolific vegetation growth.	Ripping or scarifying of the land during rehabilitation will encourage water capture. Soil conservation and erosion and sediment control best practises will be utilised to reduce the risk of soil erosion and reduce the risk of salt and sulfate impacted soils being mobilised into the receiving environment.	Unlikely	Minor	Low

Risk No.	Risk	Impacts	Causes	Controls	Inherent Risk		
					Likelihood	Consequence	Severity
10	Vegetation growth (Infrastructure areas)	Rehabilitation failure or a long time before vegetation growth occurs. Unable to achieve PMLU.	The natural environment is not conducive to prolific vegetation growth.	Ripping or scarifying of the land during rehabilitation will encourage seeds and water capture. Soil conservation and erosion and sediment control best practises will be utilised to reduce the risk of soil erosion and reduce the risk of salt and sulfate impacted soils being mobilised into the receiving environment.	Unlikely	Minor	Low
11	Stable post-mine land use	Failure of proposed control measures. Failure to meet rehabilitation milestones. Unable to achieve PMLU.	The natural environment is not conducive to prolific vegetation growth. Storm event occurs while cover construction is in progress. Incorrect capping on TSF leads to increased salt migration. Lack of vegetation growth.	Soil conservation and erosion and sediment control best practises will be utilised to reduce the risk of soil erosion and reduce the risk of salt and sulfate impacted soils being mobilised into the receiving environment.	Unlikely	Major	Medium
12	Rehabilitation schedule	Inability to meet milestones (safe, stable, non-polluting) on time.	The natural environment is not conducive to prolific vegetation growth. Storm event occurs while cover construction is in progress. Lack of vegetation growth.	Progressive rehabilitation will be undertaken as possible and as appropriate across the mine site. The PRCP schedule allows for 2 years for revegetation.	Unlikely	Minor	Low

Risk No.	Risk	Impacts	Causes	Controls	Inherent Risk		
					Likelihood	Consequence	Severity
13	Tailings consolidation	Failure of proposed control measures. Failure to meet rehabilitation milestones. Unable to achieve PMLU.	Tailings not achieving the required density to allow capping	Scheduled rehabilitation delay period to allow drying and consolidation of tailings	Unlikely	Major	Medium

8.0 MONITORING AND MAINTENANCE

Post closure monitoring aims to demonstrate that the milestone criteria have been met and that the key post closure residual risks have been effectively managed. Monitoring will also enable any unforeseen issues to be identified and further management implemented.

8.1 Monitoring schedule

Monitoring at the site will focus on the public safety, stability of backfilled landforms and the establishment of a stable landform with limited vegetation groundcover (as is present prior to mining). Achieving criteria for the safety, non-polluting and stable landform aspects is expected within one (1) year post closure. However, to allow for unexpected/uncontrolled aspects such as weather, a total of five (5) years has been assumed for the achievement of surface requirements, and achievement of post-mining land use to stable condition for grazing.

Monitoring of the site will comprise of:

- Photographic evidence of land shaping and backfilled material being re-instated.
- Photographic evidence of shallow ripping and scarifying the land during rehabilitation.
- Records indicating evidence of thin topsoil re-spreading.
- Visual inspection to monitor weeds, stabilisation techniques and plant establishment and growth.
- Photographic evidence of revegetation shows the site is comparable to reference sites for ground cover biomass.
- Photographic evidence of rehabilitated areas shows the site is comparable to reference sites for weed and pest species presence.

8.2 Contingency strategies

The rehabilitation monitoring program will help identify and quantify problems, risks and opportunities for corrective actions and adaptive management.

Contingency strategies if rehabilitation monitoring indicates milestone criteria are not being met include:

- Remediation of any areas of instability within backfilled pits and TSF areas.
- Re-seeding of revegetation if there is failure evident.

8.3 Post-closure monitoring

Post-closure monitoring aims to demonstrate that the final rehabilitation milestone criteria have been met and that the key post closure residual risks have been effectively managed. Monitoring will also enable any unforeseen issues to be identified and further management implemented.

Post-closure monitoring of the site will focus on demonstrating the achievement of post-mining land use to stable condition (grazing). The monitoring will consist of:

- A contaminated land survey carried out by an appropriately qualified person indicates that there is no remaining contamination that makes the land unsuitable for the post-mining land use to occur.
- Vegetation survey to determine whether rehabilitation areas are aligning with target reference sites in ground cover, species diversity and presence of weed species

- Post mining survey by appropriately qualified person indicates no active areas of rill or gully erosion (or evidence of sediment deposition), and surface drainage follows appropriate drainage paths

Maintenance will be undertaken on the following area if/as necessary:

- Areas of observed erosion will be remediated and wherever possible the cause of erosion eliminated or reduced so that erosion is minimised to a rate similar to reference sites once the vegetation has established
- Reseeding if bare patches are observed within the revegetated areas.

8.3.1 Rehabilitation monitoring

Rehabilitation monitoring activities will be undertaken annually aiming to analyse the progress of rehabilitated areas against undisturbed reference sites and demonstrate a stable condition and the achievement of the PMLUs has been achieved (as described in Section 8.3.2). Monitoring will be undertaken as close to the end of the wet season as possible, to allow for the identification of annual species.

As described in the PRCP schedule, the achievement of surface requirements constitutes the following:

- Revegetation is comparable to reference sites for ground cover biomass
- Revegetation is comparable to reference sites for weed and pest species presence.

The aims of the rehabilitation monitoring activities are to confirm successful achievement of surface requirements through:

- Collection of detailed information at each of the reference sites, including species composition, density, richness, and percentage ground cover to compare site performance against previous results.
- Assess the performance of rehabilitation activities against the rehabilitation criteria outlined in the PRCP Schedule milestone criteria.

8.3.2 Reference and monitoring sites

Reference sites are established in undisturbed areas within the ML. These reference locations have been considered as a suitable representation of the pre-mining environment for each RA and will provide a comparison to disturbed areas for erosion, vegetation and drainage. Further surveys will be undertaken to develop metrics for these reference sites that will be used as the comparison of rehabilitated area progress towards achieving criteria. The proposed reference sites are listed in Table 23.

Table 23: Proposed reference sites

Site ID	Reference site association with disturbance type	Locations	
		Easting	Northing
Site 1	Mine pits	323857.48	7596069.86
Site 2	TSF and bund	323902.54	7595716.90
Site 3	ROM and overburden	323749.32	7595792.17
Site 4	Mine infrastructure, exploration areas, and tracks and laydown area	323384.82	7595727.36

8.4 Reporting

Records of monitoring and contingency strategies will be internal and provided to the landowner as required.

Annually (after the end of a return period) there will be evaluation of the effectiveness of the PRCP Schedule and the milestone criteria, provided within the Annual Return report to DES.

Once the PRCP is approved, the second reporting option “A resource activity with an approved PRCP Schedule” will apply for the Start-up Operation. Consequently, section 2 (table 2) of the reporting form.

This reporting will include:

- Total site reporting as at last day of return period.
- Completion works / rehabilitation activities carried out under the schedule.
  - Whether any milestones completed under the PRCP Schedule during the year have been met.
  - Monitoring results against milestone criteria.
- Proposed works for next return period.
  - Milestones to be completed under the PRCP Schedule during the year.
  - Monitoring results against milestone criteria.
- If any contingency strategies have been implemented for failed rehabilitation.
- Spatial information relating to the location of any disturbance and rehabilitation.

9.0 REFERENCE LIST

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10.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - “Important Information Relating to this Report”, which is presented in Appendix E. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

Signature Page

Golder Associates Pty Ltd

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APPENDIX A

PRCP checklist

Table A1: PRCP Checklist (as per Section 6 of the DES application form)

PRCP Requirement	Requirement met? (Yes / NA)	PRCP Section No.	Justification
Project description			
Describe the following: ■ Each resource tenure, including the area of each tenure, to which the application relates	Yes	2.2.1	
■ The relevant activities to which the application relates	Yes	2.2.2	
■ The likely duration of the relevant activities	Yes	2.2.5	
Include a detailed description, including maps, of how and where the relevant activities are to be carried out.	Yes	2.2.4	
Consultation			
Include details of the consultation undertaken by the applicant in developing the proposed PRCP.	Yes	3.2	
Include details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.	Yes	3.3	
Post-mining land use			
State the extent to which each proposed post-mining land use identified in the proposed PRCP Schedule for the plan is consistent with the outcome of consultation with the community in developing the PRCP.	Yes	4.0	

PRCP Requirement	Requirement met? (Yes / NA)	PRCP Section No.	Justification
State the extent to which each proposed post-mining land use identified in the proposed PRCP Schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	Yes	4.1	
Non-use management area			
State the extent to which each proposed non-use management area identified in the PRCP Schedule for the plan is consistent with the outcome of consultation with the community in developing the PRCP.	NA		No NUMAs proposed as part of this PRCP
State the extent to which each non-use management area identified in the PRCP schedule for the plan is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	NA		No NUMAs proposed as part of this PRCP
For each proposed non-use management area, state the reasons the applicant considers the area cannot be rehabilitated to a stable condition because of a matter mentioned in section 126D (2).	NA		No NUMAs proposed as part of this PRCP
For each matter mentioned in the requirement above, include copies of reports or other evidence relied on by the proponent for each proposed non-use management area.	NA		No NUMAs proposed as part of this PRCP
Rehabilitation and management methodology			
For each post-mining land use, state the applicant's proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the RM under the proposed PRCP Schedule.	Yes	6.0	

PRCP Requirement	Requirement met? (Yes / NA)	PRCP Section No.	Justification
For each non-use management area, state the applicant's proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP Schedule for the area.	NA	NA	No NUMAs proposed as part of this PRCP
Risk assessment			
Identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.	Yes	7.0	
PRCP Guideline			
Include any other information prescribed by the administering authority in the Guideline – Progressive Rehabilitation and Closure Plans (ESR/2019/4964)	NA		Relevant information included throughout report
Include the spatial information required in the Guideline – Progressive Rehabilitation and Closure Plans (ESR/2019/4964).	Yes		Provided separately
Other information			
Include the other information the administering authority reasonably considers necessary to decide whether to approve the PRCP Schedule.	NA		Relevant information included throughout report
PRCP Schedule			
Include a PRCP schedule prepared using the PRCP schedule template (ESR/2019/5103)	Yes		Provided separately

PRCP Requirement	Requirement met? (Yes / NA)	PRCP Section No.	Justification
Include maps showing all of the land mentioned in the PRCP schedule, as it relates to being progressively rehabilitated.	Yes	4.4	

APPENDIX B

EA amendment application supporting information report

REPORT

Environmental Authority Amendment Application - Supporting Report

Ardmore Phosphate Rock Project - Start-up Operation

Submitted to:

Centrex Metals Limited
Level 6, 44 Waymouth Street
Adelaide, SA 5000

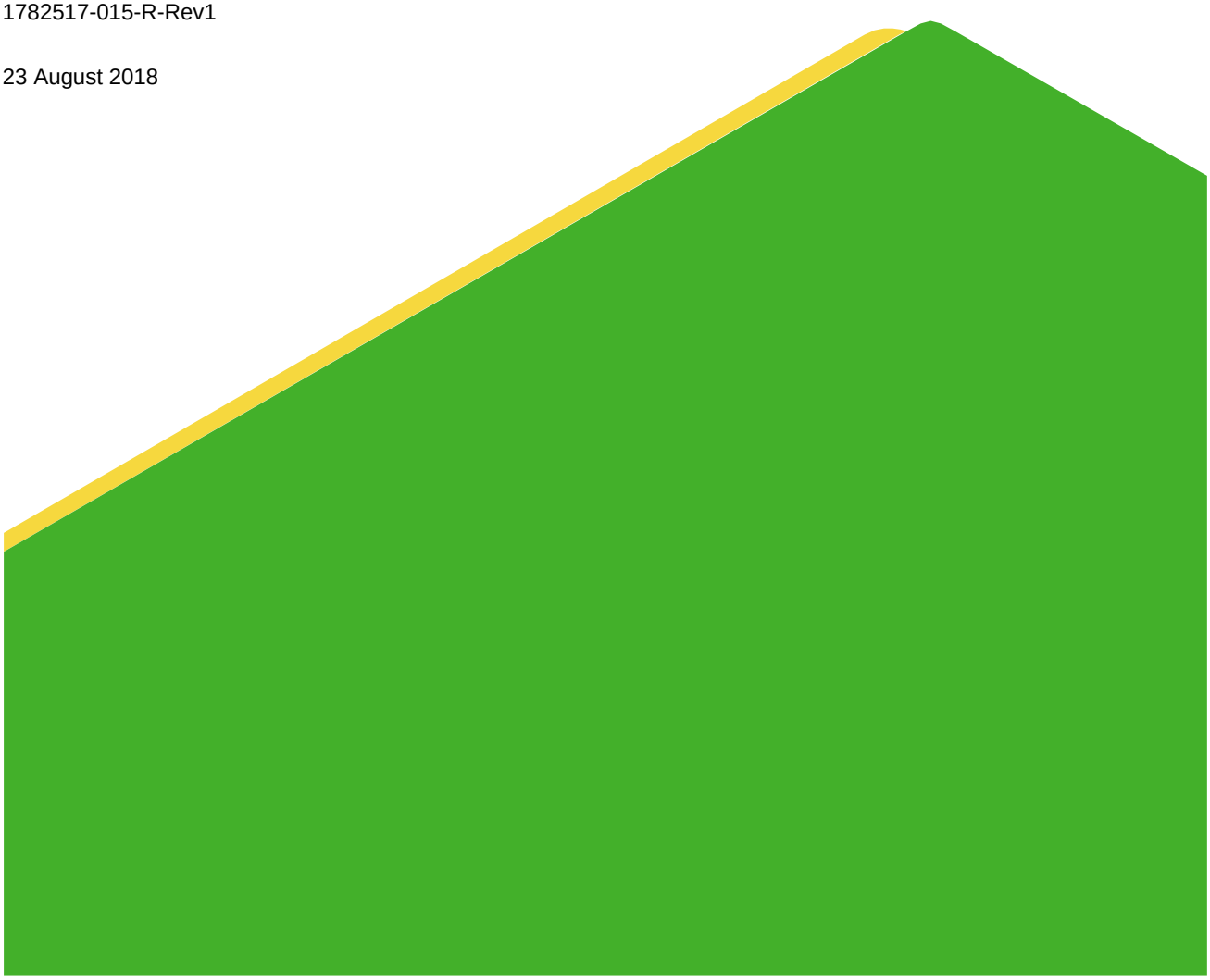
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Centrex Metals Limited	Gerard Bosch – Approvals and Stakeholder Manager	Rev 1 – Finalised version	23/08/2018	Word and pdf

Executive Summary

Golder Associates Pty Ltd (Golder) has prepared this supporting report on behalf of Centrex Metals Limited. Centrex propose to develop a high-grade phosphate deposit located at Ardmore, approximately 128 km south of the city of Mt Isa and 23 km west of the town of Dajarra in North West Queensland.

This application is for the Start-up Operation only (referred to as 'the Project'), which is a small-scale pit and demonstration plant to be constructed within the Southern Zone of Mining Lease 5542 (ML5542). The operation will target to extract approximately 70,000 t of ore using shallow open-cut strip mining over a 2 – 3 month period.

Centrex is the holder of an existing Environmental Authority (EA) BRMN0037, which authorises mineral exploration and small-scale mining activities within ML5542. To proceed with the Start-up Operation, Centrex must make an application to the administering authority seeking a major amendment to the current EA under the *Environmental Protection Act 1994* (Qld) (EP Act). This report and the appendices accompany the amendment application submitted by Centrex under Section 224 of the EP Act.

This report provides details of the Project to the regulatory authorities, the general public and other stakeholders. It details information on the existing environment of the proposed Start-up Operation site, assesses the environmental and social impacts and describes how the impacts can be managed and mitigated.

This EA amendment application supporting report meets the requirements of the EP Act (section 224, Chapter 5, section 226 and section 227AA) by assessing the potential environmental and social impacts associated with the development of the project and identifies the residual impact once management and mitigation measures have been implemented. Technical studies contained within the appendices and material referenced in the body of the report have been used to support this impact assessment. This report also addresses the objectives and performance outcomes in Schedule 5, Part 3 in order to demonstrate the expected impact associated with the EA amendment application and the proposed future production on ML5542.

The proposed Start-up Operation project is small scale and the impact assessment findings demonstrate that the potential impacts to the ambient environment, land, soil, visual amenity, ecology, surface water, groundwater, cultural heritage, traffic and socioeconomic environment are negligible to minor.

Proposed mitigation and management measures aim to reduce the potential for impacts, although in most cases the potential impact is negligible prior to mitigation being applied. The mitigation measures are therefore a commitment of Centrex to demonstrate good practice environmental management as part of the existing health, safety and environmental management framework.

Table of Contents

1.0 INTRODUCTION 15

1.1 The Proponent 15

2.0 LEGISLATIVE CONTEXT 17

2.1 Environmental Protection Act 1994 (EP Act) 17

2.1.1 Assessment Level Decision 21

2.1.2 Environmental Impact Statement 22

2.2 Environmental Protection Legislation and Policies 23

2.2.1 Technical Guidelines 24

2.3 Mineral Resources Act 1989 24

2.4 Water Act 2000 24

2.5 Environmentally Relevant Activities 25

2.6 Other Legislative Requirements 25

2.6.1 Environment Protection and Biodiversity Conservation Act 1999 25

2.6.2 Aboriginal Cultural Heritage Act 2003 25

2.6.3 Nature Conservation Act 1992 26

2.6.4 Environmental Offsets Act 2014 26

2.7 Local Government Context 26

3.0 PROJECT DESCRIPTION 28

3.1.1 Deposit Geology 32

3.1.2 Mineral Resource Estimates 32

3.1.3 Deposit Geochemistry 34

3.1.3.1 Net Acid Producing Potential 34

3.1.3.2 Saline Drainage Potential 34

3.1.3.3 Metalliferous Drainage Potential 36

3.1.4 Naturally Occurring Radiation 36

3.2 Project (Start-up Operation) Overview 37

3.3 Project Need and Rationale 37

3.4 Mining Process 38

3.5 Surface Water Management 45

3.6 Development Timing and Schedule 45
3.7 Demonstration Processing Plant 45
3.8 Tailings Characterisation and Management 46
3.8.1 Dam Assessment Criteria 46
3.9 Transport 49
3.9.1 Access Road and On-Site Transport 49
3.9.2 Ore Transport to Cloncurry 49
3.9.3 Port of Townsville 49
3.10 Power Supply 49
3.11 Fuel and Chemicals 49
3.12 Water Supply and Treatment 50
3.12.1 Processing Water Supply 50
3.12.2 Potable Water Supply 50
3.13 Borrow Pits 50
3.14 Workforce 51
3.15 Accommodation 51
3.16 Communications 51
3.17 Waste Management 51
3.18 Future Full-Scale Mining Operation 51
3.19 Mine Closure and Rehabilitation 53
3.19.1 Closure Planning 53
3.19.2 Goals of Closure 53
3.19.3 Rehabilitation Hierarchy 54
3.19.4 Regulatory Requirements 54
3.19.5 Objectives 55
3.19.6 Pre-Mining Land Use 55
3.19.7 Pre-Mining Environment 55
3.19.8 Proposed Post-Mining Land Use 56
3.19.9 Progressive Rehabilitation and Mine Closure 56
3.19.9.1 Material Management 58
3.19.9.2 Revegetation 58

3.19.10 Completion Criteria 60
3.19.11 Closure Domains 60
3.19.12 Post Closure Monitoring 66
3.19.13 Closure Costs and Financial Assurance 66
4.0 STAKEHOLDER ENGAGEMENT / CONSULTATION 67
4.1 Consultation Objectives 67
4.2 Stakeholder Identification 67
4.3 Stakeholder Engagement 69
4.3.1 Project Stakeholder Database 69
4.3.2 Contact with Directly Affected Landholders 69
4.3.3 Community Information Session 69
4.3.4 Meeting with Regulatory Agencies 70
4.3.5 Information Sheets and Media 70
4.4 Outcomes of Community Engagement 70
4.5 Future Activities 71
5.0 ENVIRONMENTAL IMPACT ASSESSMENT METHOD 72
5.1 Impact Assessment Methodology 73
5.2 Environmental Values 73
5.2.1 Describing the Sensitivity of Values 74
5.3 Intensity of Potential Impacts 76
5.3.1 Geographic Extent of Potential Impact 76
5.3.2 Duration of Effect 76
5.3.3 Reversibility 76
5.4 Overall Impact Severity 77
5.5 Avoidance, Mitigation and Management Measures 78
5.6 Environmental Objectives and Performance Outcomes 78
5.7 Environmental Management Plan 79
6.0 GENERAL DESCRIPTION OF ENVIRONMENT 80
6.1 Sensitive Receptors 80
6.2 Temperature and Rainfall 80
6.3 Wind 84

6.4 Floods 85
7.0 AIR 87
7.1 Baseline Environment 87
7.1.1 Baseline Deposited Dust 87
7.1.2 Particulate Matter (PM_{10} and $PM_{2.5}$) 89
7.1.3 Environmental Values 90
7.2 Impact Assessment Method 91
7.3 Emission Sources 91
7.4 Potential Impacts 92
7.4.1 Decrease in Air Quality at Sensitive Receptors 93
7.4.2 Decrease in Air Quality Due to Ore Transport to Duchess Railway Siding 93
7.4.3 Decrease in Air Quality Due to Combustion 93
7.5 Avoidance, Mitigation and Management Measures 93
7.6 Residual Impact 94
7.7 Environmental Protection Objectives 96
7.8 Greenhouse Gas 96
8.0 NOISE 98
8.1 Baseline Environment 98
8.1.1 Environmental Values 98
8.2 Impact Assessment Method 99
8.3 Emissions Sources 100
8.4 Potential Impacts 100
8.4.1 Exceedance of Noise Criteria at Sensitive Receptors 100
8.5 Avoidance, Mitigation and Management Measures 102
8.6 Residual Impact 102
8.7 Environmental Protection Objectives 103
9.0 LAND 104
9.1 Baseline Environment 104
9.1.1 Geology 104
9.1.2 Soils 104
9.1.2.1 Soil Lithology 105

9.1.2.2 Laboratory Results 109
9.1.3 Pre-Existing Land Contamination 110
9.1.4 Land Use 110
9.1.5 Environmental Values 110
9.2 Potential Impacts 110
9.2.1 Soil Erosion 111
9.2.2 Soil Compaction 111
9.2.3 Localised Soil Contamination 111
9.2.4 Issues with Soils Available for Rehabilitation 112
9.3 Avoidance, Mitigation and Management Measures 112
9.4 Residual Impact 113
9.5 Environmental Protection Objectives 114
10.0 VISUAL AMENTITY 115
10.1 Baseline Environment 115
10.1.1 Environmental Values 122
10.2 Potential Impacts 122
10.2.1 Reduction in Visual Amenity 122
10.3 Avoidance, Mitigation and Management Measures 123
10.4 Residual Impact 123
10.5 Environmental Protection Objectives 123
11.0 ECOLOGY 124
11.1 Baseline Environment 124
11.1.1 Methodology 125
11.1.2 Terrestrial Ecology 125
11.1.3 Aquatic Ecology 132
11.1.4 Threatened Species and Communities 132
11.1.5 Environmental Values 133
11.2 Potential Impacts 133
11.2.1 Project Footprint 133
11.2.2 Traffic 134
11.2.3 Vegetation Clearing and Site Preparation 134

11.2.4 Dust and Air Emissions 135
11.2.5 Sensory Disturbance 135
11.2.6 Surface Water Quality 136
11.2.7 Invasive and Pest Species 136
11.2.8 Environmental Offsets 137
11.2.9 Major Hazards 137
11.3 Avoidance, Mitigation and Management Measures 137
11.4 Residual Impact 139
11.5 Environmental Protection Objectives 139
12.0 SURFACE WATER 141
12.1 Baseline Environment 141
12.1.1 Surface Water and Hydrology 141
12.1.2 Surface Water Quality 144
12.1.3 Environmental Values 146
12.2 Potential Impacts 146
12.2.1 Water Quality 147
12.2.2 Sediment and Soil Loss 148
12.2.3 Surface Water Yields 148
12.2.4 Peak Flows 148
12.3 Avoidance, Mitigation and Management Measures 148
12.4 Residual Impact 149
12.5 Environmental Protection Objectives 150
13.0 GROUNDWATER 151
13.1 Baseline Environment 151
13.1.1 Registered Groundwater Bores 152
13.1.2 Groundwater Dependent Ecosystems 153
13.1.3 Groundwater Quantity 155
13.1.4 Groundwater Quality 155
13.1.5 Environmental Values 156
13.2 Potential Impacts 156
13.2.1 Reduced Quantity of Water due to Excavation of the Pit 156

13.2.2 Reduced Quantity of Water due to Groundwater Extraction....156
13.3 Avoidance, Mitigation and Management Measures....157
13.4 Residual Impact....157
13.5 Environmental Protection Objectives....158
14.0 CULTURAL HERITAGE....159
14.1 Baseline Environment....159
14.1.1 Desktop Assessment....159
14.1.1.1 Indigenous Cultural Heritage....159
14.1.1.2 Non-Indigenous Cultural Heritage....160
14.1.2 Field Assessment....160
14.1.3 Environmental Values....160
14.2 Potential Impacts....162
14.2.1 Disturbance of Identified Archaeological Sites or Objects....162
14.2.2 Disturbance or Destruction of Unidentified Archaeological Sites of Significance....162
14.3 Avoidance, Mitigation and Management Measures....162
14.4 Residual Impact....163
14.5 Environmental Protection Objectives....163
15.0 WASTE....164
15.1 Waste Management Strategy....164
15.2 Waste Types....165
15.3 Environmental Protection Objectives....165
16.0 TRAFFIC....166
16.1 Baseline Environment....166
16.2 Potential Impacts....167
16.2.1 Traffic Hazards or Traffic Accidents....170
16.2.2 Air and Noise Impacts from Traffic....170
16.3 Avoidance, Mitigation and Management Measures....170
16.4 Residual Impact....170
16.5 Environmental Protection Objectives....171
17.0 SOCIO-ECONOMIC ENVIRONMENT....172
17.1 Baseline Environment....172

17.1.1 History, Community Values and Infrastructure 172
17.1.2 Population and Demography 173
17.1.3 Economy and Industry 176
17.2 Potential Impacts 176
17.3 Management Measures 177
17.4 Residual Impact 177
17.5 Socio-Economic Environment Objectives 178
18.0 MANAGEMENT SYSTEMS 179
18.1 Environmental Polices 179
18.1.1 Occupational Health and Safety Policy 179
18.1.2 Social Responsibility Policy 180
19.0 CONCLUSION 181
20.0 REFERENCES 182
21.0 IMPORTANT INFORMATION 187

TABLES

Table 1: Proponents Details 15
Table 2: Application Requirements 19
Table 3: Assessment Level Decision 21
Table 4: State EIS Triggers 23
Table 5: Environmentally Relevant Activities 25
Table 6: Geological Stratigraphy 30
Table 7: JORC Compliant Mineral Resource Estimate (16% P_2O_5 Cut-Off) 33
Table 8: JORC Compliant Mineral Resource Estimate (19% P_2O_5 Cut-Off) 33
Table 9: Key Project Characteristics 38
Table 10: Approximate Area of Disturbance by Project Component 41
Table 11: Project Mine Stages and Volumes 41
Table 12: Consequence category 47
Table 13: Key Details for Full-scale Operations 51
Table 14: Annual Mining Schedule Summary by Mineral Resource Classification 52
Table 15: Closure Domain - Pit 60
Table 16: Closure Domain - Tailings Storage Facility 61
Table 17: Closure Domain - Overburden Storage Facility, Indurated Storage Facility and ROM 63

Table 18: Closure Domain - Mine Infrastructure Areas 64
Table 19: Key Stakeholders and Issues Discussed 68
Table 20: Example Definitions for Sensitivity of Environmental Values and Ranking 74
Table 21: Intensity Ranking 76
Table 22: Overall Impact Severity Matrix 77
Table 23: Descriptors of Overall Impact Severity 78
Table 24: Peak Flow Results - Baseline Catchments 85
Table 25: Dust Deposit Gauge Results 89
Table 26: The GAP AQMS – Summary of Results for PM_{10} in 2016 90
Table 27: Project Air Quality Criteria 90
Table 28: Project Related Air Emission Dust Sources 91
Table 29: Operating Parameters 92
Table 30: Emission Inventory 94
Table 31: Maximum Predicted PM10 GLC Concentration at Receptor (AUSPLUME) 96
Table 32: Summary of Air Quality Residual Impacts 96
Table 33: Project Noise Criteria 99
Table 34: Estimated Sound Power Levels at Nearest Sensitive Receptor (15 km) 101
Table 35: Summary of Noise Residual Impacts 102
Table 36: Soil Lithology 107
Table 37: Summary of Land Residual Impacts 113
Table 38: Summary of Visual Amenity Residual Impacts 123
Table 39: Area of Disturbance Associated with Project Footprint 134
Table 40: Summary of Ecology Residual Impacts 139
Table 41: Site Catchments 142
Table 42: Summary Water Quality Parameters Compared to Guideline Values (Burke River at Boulia) 144
Table 43: Summary Water Quality Parameters Compared to Guideline Values (Georgina River at Roxborough Downs) 145
Table 44: Summary of Surface Water Residual Impacts 150
Table 45: Summary of Registered Bores within 10 km from the Project Area 152
Table 46: Calculated Drawdowns after 90 Days of Pumping (15 L/s) 157
Table 47: Summary of Groundwater Residual Impacts 158
Table 48: Summary of Cultural Heritage Residual Impacts 163
Table 49: TARS Base Traffic Volume 167
Table 50: Project Traffic Volume 169
Table 51: Summary of Traffic Residual Impacts 170

Table 52: Summary of Socio-Economic Residual Impacts 178

FIGURES

Figure 1: Project Location 16
Figure 2: Process for Environmental Authority Major Amendment Application 18
Figure 3: Mining Lease Area Conceptual Layout 29
Figure 4: Surface Geology 31
Figure 5: Start-up Operation Conceptual Layout 43
Figure 6: Cross Section of Site During Mining 44
Figure 7: Demonstration Processing Plant Schematic 48
Figure 8: Cross Section of the Site at Closure 59
Figure 9: Topography 81
Figure 10: Sensitive Receptors and Viewpoints 82
Figure 11: Temperature Statistics - BOM Monument Airport Station (2012 – 2015) 83
Figure 12: Rainfall Statistics - BOM Monument Airport Station (2012 – 2015) 83
Figure 13: Wind Rose Plots - BOM Monument Airport Station (2012 – 2015) 85
Figure 14: Surface Water Flooding Extent (1:100 year) 86
Figure 15: Deposited Dust Monitoring Locations 88
Figure 16: Soil Test Pit Locations and Mapped Surface Soils 106
Figure 17: Fauna Survey Sites 126
Figure 18: Regional Ecosystems (Verified) 127
Figure 19: Areas of Ecological Concern 128
Figure 20: Site Catchments 143
Figure 21: Potential GDEs and Drawdown Contours 154
Figure 22: Native Title Determination Boundary 161
Figure 23: Waste Management Hierarchy 164
Figure 24: Key Roads for Transport of Concentrate 168

PLATES

Plate 1: Rock exposed in wall of southern costean, with Blazan Shale overlying Beetle Creek Formation 35
Plate 2: Pre-mining land use – ROM pad area 57
Plate 3: Pre-mining land use – Processing Plant area 57
Plate 4: Location of Test Pit TP08 108
Plate 5: Location of Test Pit TP08 108

Plate 6: Viewpoint 1 at Urandangie South Road facing SE (direction of Project) 116
Plate 7: Viewpoint 1 at Urandangie South Road facing SW 116
Plate 8: Viewpoint 1 at Urandangie South Road facing North West 117
Plate 9: Viewpoint 1 at Urandangie South Road facing North East 117
Plate 10: Viewpoint 2 at Boulia-Mount Isa Highway facing East (to Dajarra) 118
Plate 11: Viewpoint 2 at Boulia-Mount Isa Highway facing South 118
Plate 12: Viewpoint 2 at Boulia-Mount Isa Highway facing North-West 119
Plate 13: Viewpoint 3 at Split Creek facing North-East (Upstream) 120
Plate 14: Viewpoint 3 at Split Creek facing South-West (Downstream) 120
Plate 15: Viewpoint 3 at Split Creek facing North-West (to Mount Isa) 121
Plate 16: Viewpoint 3 at Split Creek facing South-East (to Dajarra) 121
Plate 17: RE1.3.7b River Red Gum (E. camaldulensis) Fringing Open Woodland (NRC, 2017) 130
Plate 18: Narrow RE1.3.7b Riparian Community with Buffel Grass Invasion (NRC, 2017) 130
Plate 19: Current Site Condition – TSF Location facing North-West 131
Plate 20: Current Site Condition – Test Pit Location facing South-West 131
Plate 21: Dajarra Hotel 174
Plate 22: Dajarra Roadhouse 174
Plate 23: Dajarra State School 175
Plate 24: Jimberella Community Hall 175

APPENDICES

APPENDIX A
Soils Technical Report

APPENDIX B
Geochemical Technical Report

APPENDIX C
Air and Noise Technical Report

APPENDIX D
Ecology Technical Reports

APPENDIX E
Surface Water Technical Report

APPENDIX F
Groundwater Technical Report

APPENDIX G
Traffic Technical Report

APPENDIX H
Socio-Economic Baseline Report

APPENDIX I

Environmental Management Plan - Start-up Operation

APPENDIX J
Important Information Relating to this Report

ABBREVIATIONS

Abbreviation	Description
ACHA	*Aboriginal Cultural Heritage Act 2003* (Qld)
AHD	Australian Height Datum
AS	Australian Standard
ATSIHP	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
BoM	Bureau of Meteorology
Centrex	Centrex Phosphate Pty Ltd, a wholly owned subsidiary of Centrex Metals Pty Ltd
CHMP	Cultural Heritage Management Plan
CLLP	Community and Landowner Liaison Program
Cth	Commonwealth
DATSIP	Department of Aboriginal and Torres Strait Island Partnerships
DEHP	Department of Environment and Heritage Protection (former)
DES	Department of Environment and Science
DoEE	Department of Environment and Energy (Cth)
DNRME	Department of Natural Resources, Mines and Energy
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning
EA	Environmental Authority
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1994* (Qld)
EPM	Exploration Permit for Minerals
EP Reg	*Environmental Protection Regulation 2008* (Qld)
EPBC	*Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
ERA	Environmentally Relevant Activity
ESA	Environmentally Sensitive Area
GAI	Geochemical Abundance Index
GHG	Greenhouse Gas
Ha	Hectare

Abbreviation	Description
kL	Kilolitre
ML	Mining Lease
MNES	Matters of National Environmental Significance (Cth)
MSES	Matters of State Environmental Significance (Qld)
N/A	Not Applicable
NC Act	*Nature Conservation Act 1992* (Qld)
QHA	*Queensland Heritage Act 1992* (Qld)
Qld	Queensland
RE	Regional Ecosystem
RO	Reverse Osmosis
ROM	Run of Mine
SC	DES Standard Conditions for Activities
T	Tonnes
TPH	Tonnes Per Hour
TSF	Tailings Storage Facility
VSAT	Very Small Aperture Terminal
VM Act	*Vegetation Management Act 1999* (Qld)

1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) has prepared this supporting report on behalf of Centrex Metals Limited. Centrex Phosphate Pty Ltd (Centrex) is a wholly owned subsidiary of Centrex Metals Limited (ABN 97 096 298 752). Centrex Metals Limited is an ASX listed company, with mineral exploration licences for iron, gold and phosphate in Queensland, New South Wales, and Western Australia.

Centrex propose to develop a high-grade phosphate deposit located at Ardmore, approximately 128 km south of the city of Mt Isa and 23 km west of the town of Dajarra in North West Queensland (Figure 1). This is referred to as the Ardmore Phosphate Rock Project. This application is for the Start-up Operation only (referred to as 'the Project'), which is a small-scale pit and demonstration plant to be constructed within the Southern Zone of Mining Lease 5542 (ML5542). The operation will target to extract approximately 70,000 t of ore using shallow open-cut strip mining over a 2 – 3 month period.

To proceed with mining activities on ML5542 Centrex must apply for an amendment to the existing Environmental Authority (EA) BRMN0037 under the *Environmental Protection Act 1994* (Qld) (EP Act). This report and the appendices accompany the amendment application submitted by Centrex under Section 224 of the EP Act.

1.1 The Proponent

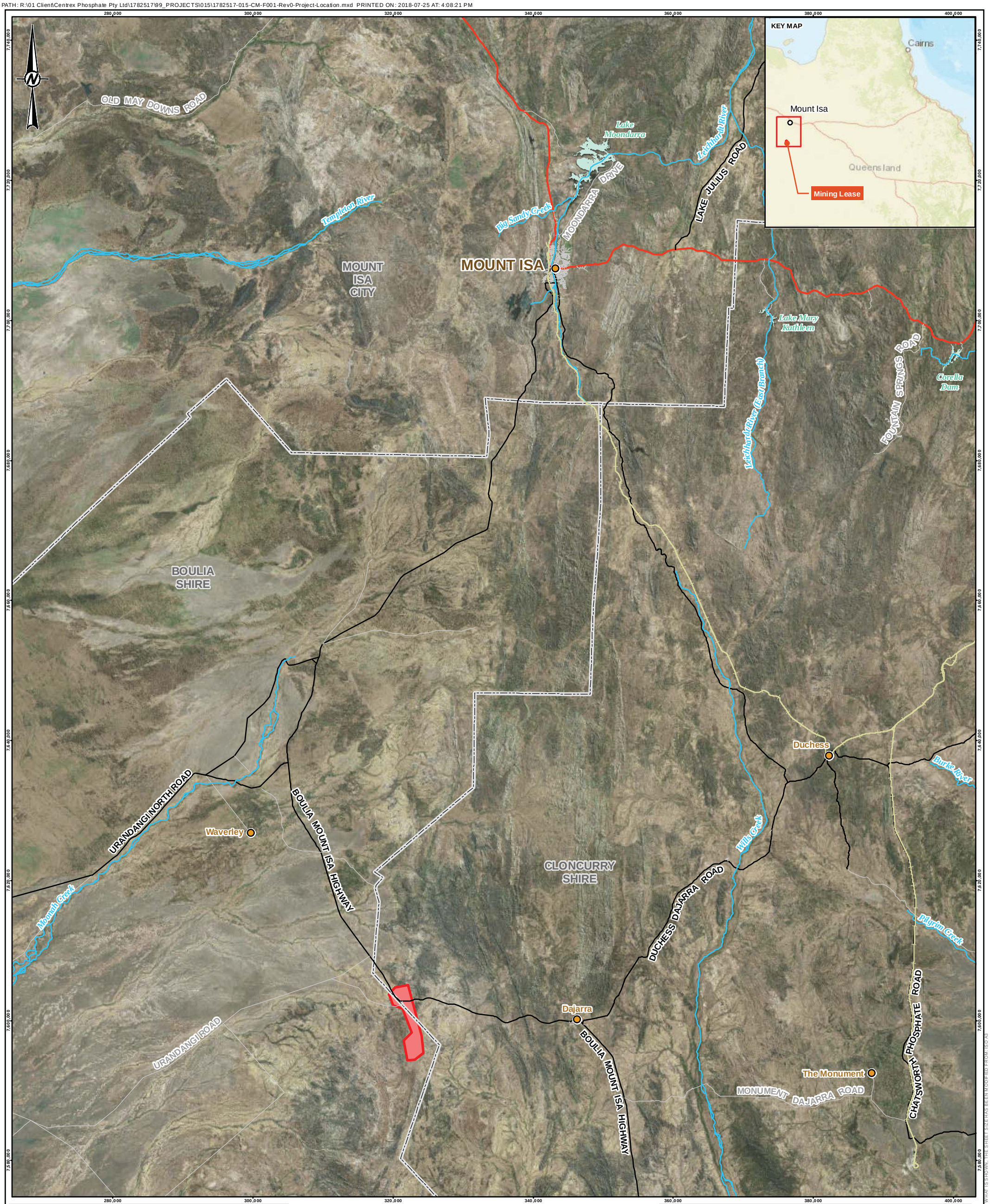
Centrex is the holder of EA BRMN0037, which authorises mineral exploration and small-scale mining activities within ML5542. The EA was issued by the administering authority, the former Department of Environment and Heritage Protection (DEHP), under standard conditions for mineral exploration (*Eligibility criteria and standard conditions for exploration and mineral development projects – Version 2 (ESR/2-16/1985, version 2.00))* and standard conditions for mining lease activities (*Eligibility criteria and standard conditions for mining lease activities – Version 2 (ESR/2016/2241, version 2.00))*. The EA was subsequently amended with varied conditions that reduced the distance that activities could be conducted in proximity to category B environmentally sensitive areas to 100 metres.

Under the EP Act the EA authorises the carrying out of mineral exploration and small-scale mining which is considered an Environmentally Relevant Activity (ERA). To carry out an ERA Centrex are required to be a registered suitable operator under the Act. Centrex is a suitable operator registered with DEHP, now the Department of Environment and Science (DES). The Proponents details are provided in Table 1.

Table 1: Proponents Details

	Description
The Proponent	Centrex Phosphate Pty Ltd
ABN / ACN	32 132 019 357 / 132 019 357
Suitable operator number	RSO001134
Registered address and contact details	Level 6, 44 Waymouth Street Adelaide, South Australia 5000 Phone: +61 8 8213 3100 Website: http://www.centrexmetals.com.au/

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LEGEND

- Locality
- Watercourses

Road Type

- Highway
- Major Road
- Local Road
- Railway
- Local Government Area
- Reservoirs

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 5 10 15 20 Km

1:500,000 at A3

CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

NOTE(S)

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Locality, Mining Lease: © State of Queensland (DNRM) 2018
Roads, Watercourses, Local Government Area: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Reservoirs: © State of Queensland (DNRM) 2016

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
PROJECT LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	1

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2.0 LEGISLATIVE CONTEXT

The key approvals and statutory processes that will apply to the proposed amendment application are described below.

2.1 Environmental Protection Act 1994 (EP Act)

The *Environmental Protection Act 1994* (EP Act) provides the key legislative framework for environmental management and protection in Queensland. The objective of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (*ecologically sustainable development)*. To meet its objective, the EP Act sets out a program for the identification and protection of environmental values and creates a range of regulatory tools for controlling activities of individuals for companies.

The holder of an EA may, at any time pursuant to section 224 of the EP Act, make an application to the administering authority seeking an amendment to an EA. Chapter 5 of the EP Act specifies the process and information requirements for an application to amend an EA. It also defines the administering authority's considerations in the assessment of the application to amend an EA and the EA conditions, which may be imposed on an EA by the administering authority.

Section 226 and section 227AA of the EP Act specifies the requirements for making a valid application to amend an EA. Section 227AA, which refers to section 126A(2), applies for an amendment application if, the application relates to a site-specific authority for a resource project for which the relevant tenure is a mining lease. The project will not require pit dewatering and therefore will not interfere with associated water. There are no changes proposed to the existing underground water rights for the project under the current EA. The requirements are outlined in Table 2 with specific references to where these requirements are addressed in this application.

Figure 2 shows the EA amendment application process under the EP Act for the Project.

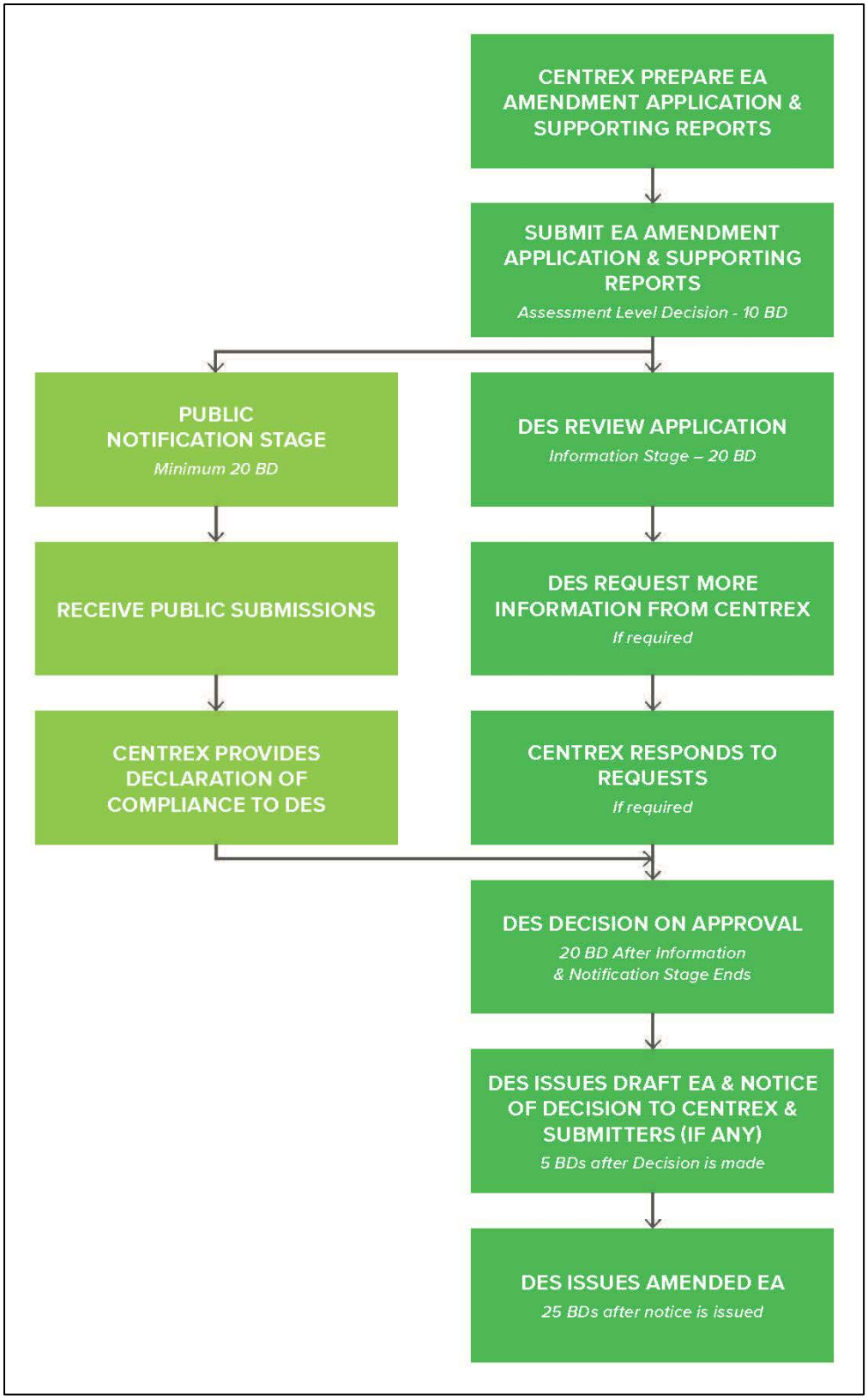


Figure 2: Process for Environmental Authority Major Amendment Application

Table 2: Application Requirements

EP Act Section	Requirement	Reference
226	**Requirements for amendment applications generally**	
226(1)	An amendment application must –	
226(1)(a)	Be made to the administering authority; and	The application has been lodged with the DES who is the administering authority of the EP Act
226(1)(b)	be made in the approved form; and	Refer to Attachment A of application
226(1)(c)	be accompanied by the fee prescribed under a regulation; and	To be provided separately
226(1)(d)	describe the proposed amendment; and	Refer to Section 3.0 of this Supporting Report
226(1)(e)	describe the land that will be affected by the proposed amendment; and	Refer to Section 6 and Section 9.0 of this Supporting Report
226(1)(f)	describe any development permits in effect under the Planning Act for the carrying out of the relevant activity for the authority; and	Refer to Attachment A of application – No Development Approval required under the Planning Act
226(1)(g)	state whether each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity; and	Refer to Attachment A of application
226(1)(h)	if the application states that each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity—include a declaration that the statement is correct; and	Refer to Attachment A of application
226(1)(i)	state whether the application seeks to change a condition identified in the authority as a standard condition; and	Refer to Attachment A of application
226(1)(j)	if the application relates to a new relevant resource tenure for the authority that is an exploration permit or GHG Greenhouse Gas permit—state whether the applicant seeks an amended environmental authority that is subject to the	N/A – The application relates to a mining lease.

EP Act Section	Requirement	Reference
	standard conditions for the relevant activity or authority, to the extent it relates to the permit; and	
226(1)(k)	include an assessment of the likely impact of the proposed amendment on the environmental values, including—	
226(1)(k)(i)	a description of the environmental values likely to be affected by the proposed amendment; and	Refer to the environmental values sections 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, 12.1, 13.1, 14.1, 15.1, 16.1, 17.1, 18.1, 19.1 of this Supporting Report
226(1)(k)(ii)	details of any emissions or releases likely to be generated by the proposed amendment; and	Refer to sections 7.3 and 8.3 of this Supporting Report
226(1)(k)(ii)	a description of the risk and likely magnitude of impacts on the environmental values; and	Refer to the residual impact sections of this Supporting Report
226(1)(k)(iv)	details of the management practices proposed to be implemented to prevent or minimise adverse impacts; and	Refer to mitigation and management sections of this Supporting Report
226(1)(k)(v)	details of how the land the subject of the application will be rehabilitated after each relevant activity ceases; and	Refer to Section 3.18 of this Supporting Report
226(1)(l)	include a description of the proposed measures for minimising and managing waste generated by any amendments to the relevant activity; and	Refer to Section 15 of this Supporting Report
226(1)(m)	include details of any site management plan or environmental protection order that relates to the land the subject of the application; and	N/A – Refer to Question 17 of Attachment A – There are no site management plans or environmental protection orders relating to the land the subject of the application
226(1)(n)	include any other document relating to the application prescribed under a regulation.	N/A – There are no documents prescribed under the *Environmental Protection Regulation 2008* for mining activities.

2.1.1 Assessment Level Decision

Section 223 of the EP Act defines a 'major amendment' for an EA as an amendment that is not a 'minor amendment'. The proposed amendment does not satisfy the minor amendment threshold and is therefore considered it will be a major amendment, as outlined in Table 4.

Table 3: Assessment Level Decision

Section 223 of the EP Act	Minor amendment (threshold) criteria for an environmental authority, means an amendment that the administering authority is satisfied—	Relevant information
(a)	is not a change to a condition identified in the authority as a standard condition, other than— (i) a change that is a condition conversion; or (ii) a change that is not a condition conversion but that replaces a standard condition of the authority with a standard condition for the environmentally relevant activity to which the authority relates; and	The amendment is a change to a condition identified as a standard condition. The EA BRMN0037 is a variation EA, and the proposed amendment will result in a site-specific EA, with no identified standard conditions. The current EA authorises mining and exploration activities on ML5542.
(b)	does not significantly increase the level of environmental harm caused by the relevant activity; and	The current EA authorises mining and exploration activities. The amendment proposes an expansion to the development activities for the Project and will result in an increase in potential environmental harm.
(c)	does not change any rehabilitation objectives stated in the authority in a way likely to result in significantly different impacts on environmental values than the impacts previously permitted under the authority; and	The proposed amendment does not change any rehabilitation objectives. The EA currently contains rehabilitation conditions.
(d)	does not significantly increase the scale or intensity of the relevant activity; and	The current EA authorises mining and exploration activities. The amendment proposes an expansion to the development activities for the Project and will result in an increase in scale and intensity of the relevant activity.

Section 223 of the EP Act	Minor amendment (threshold) criteria for an environmental authority, means an amendment that the administering authority is satisfied—	Relevant information
(e)	does not relate to a new relevant resource tenure for the authority that is— (i) a new mining lease; or (ii) a new petroleum lease; or (iii) a new geothermal lease under the Geothermal Energy Act; or (iv) a new GHG injection and storage lease under the GHG storage Act; and	N/A – The amendment application does not relate to a new relevant resource tenure. The current EA BRMN0037 contains ML5542. No new tenure is being applied for as part of this amendment application.
(f)	involves an addition to the surface area for the relevant activity of no more than 10% of the existing area; and	The current EA authorises up to 10 ha of disturbance. The amendment proposes an expansion to the development activities for the Project and will result in an addition to the surface area of more than 10%.
(g)	for an environmental authority for a petroleum activity— (i) if the amendment involves constructing a new pipeline—the new pipeline does not exceed 150km; and (ii) if the amendment involves extending an existing pipeline—the extension does not exceed 10% of the existing length of the pipeline; and	N/A – The application relates to a mining activity, not a petroleum activity.
(h)	if the amendment relates to a new relevant resource tenure for the authority that is an exploration permit or GHG permit—the amendment application under section 224 seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit.	N/A - The application does not relate to a new relevant resource tenure. The current EA BRMN0037 contains ML5542. No new tenure is being applied for as part of this amendment application.

2.1.2 Environmental Impact Statement

In accordance with section 143 of the EP Act, for an application for a resource activity, the administering authority may include in an information request a requirement that the applicant provide an environmental impact statement (EIS) for the application.

In deciding whether an EIS is required for an application, the administering authority must consider the standard criteria. Further, the DES has published a guideline – *Triggers for environmental impact statement under the Environmental Protection Act 1994 for mining and petroleum activities*.

An assessment against the EIS triggers are outlined in Table 4 below, which indicates that an EIS is not triggered for the Project.

Table 4: State EIS Triggers

EIS Triggers for Mining Activities for major amendment applications	Relevant information
For existing mines extracting between 2–10 million tonnes/year (t/y) Run of Mine (ROM) ore or coal, an increase in annual extraction of more than of 100% or 5 megatonnes/y (Mt/y) (whichever is the lesser)	The existing operation does not extract between 2-10 million tonnes/year of ROM ore or coal. The proposed amendment will not result in an increase in annual extraction of more than 100% or 5 Mt/y.
For existing mines extracting over 10 million t/y ROM ore or coal, an increase in annual extraction of more than 50% or 10 Mt/year (whichever is the lesser)	The existing operation does not extract over 10 million tonnes/year ROM ore or coal. The proposed amendment will not result in an increase in annual extraction of more than 100% or 5 Mt/y.
For existing mines extracting more than 20 million t/y ROM ore or coal extraction, an increase in annual extraction greater than 25%	The existing operation does not extract more than 20 million t/y ROM ore or coal. The proposed amendment will not result in an increase in annual extraction greater than 25%.
Proposed activities in a Category A or B environmentally sensitive area (ESA), unless previously authorised under Queensland legislation	The proposed activity will occur within Category B ESA at minor creek crossing for the proposed groundwater supply pipeline, however, the impacts are not significant.
A substantial change in mining operations, e.g. from underground to open cut, or (for underground mining), or a change from minor subsidence to potentially substantial subsidence	The amendment application does not propose a substantial change in mining operations.
The introduction of a novel or unproven resource extraction process, technology or activity.	The amendment application does not propose any novel or unproven resource extraction process.

2.2 Environmental Protection Legislation and Policies

The EP Act has a number of subordinate legislation which establishes the qualities and physical characteristics of the environment. The subordinate legislation relevant to this Project include:

- Environmental Protection Regulation 2008 (EP Reg)
- Environmental Protection (Air) Policy 2008 (EPP Air)

- Environmental Protection (Noise) Policy 2008 (EPP Noise)
- Environmental Protection (Water) Policy 2008 (EPP Water).

Section 51 of the EP Reg describes the matters to be considered by the administering authority in making an environmental management decision. For the purposes of this amendment application, section 51(1)(a), (b) and (c), require the administering authority to:

- Carryout an environment objective assessment against the environmental objective and performance outcomes mentioned in Schedule 5, Part 3, tables 1 and 2;
- Consider the environmental values declared under the EP Reg; and
- Consider each of the following under the environmental protection policies – the management hierarchy, environmental values, quality objectives and the management intent.

This EA amendment application supporting report addresses the objectives and performance outcomes in Schedule 5, Part 3 in order to demonstrate the expected impact associated with the EA amendment application and the proposed future production on ML5542.

2.2.1 Technical Guidelines

Reference was made to the following DEHP technical guidelines, where necessary:

- Application requirements for activities with impacts to air – ESR/2015/1840, version 4 (DEHP, 2017a).
- Application requirements for activities with noise impacts, ESR/2015/1838, version 3 (DEHP, 2017b).
- Application requirements for activities with impacts to land, ESR/2015/1839, version 4 (DEHP, 2017c).
- Application requirements for activities with waste impacts, ESR/2015/1836, version 4 (DEHP, 2017d).
- Application requirements for activities with impacts to water, ESR/2015/1837, version 4 (DEHP, 2017e).

2.3 Mineral Resources Act 1989

Centrex Phosphate Pty Ltd is the sole holder of the mining lease ML5542, granted under the *Mining Act 1969-1974,* which is now administered under the *Minerals Resources Act 1989.* The tenure was transferred from Southern Cross Fertilisers Pty Ltd to Centrex in 2017.

ML5542 is authorised on EA BRMN0037. This EA amendment application does not require a new tenure, or involve a change to the current tenure area of ML5542.

2.4 Water Act 2000

The *Water Act 2000* (Water Act) establishes a sustainable system for the planning, allocation and use of the majority of Queensland's non-tidal waters (including groundwater). Under section 808(1), a person must not take or supply water unless authorised under the Water Act. Section 808(2) states that a person must not interfere with water, other than overland flow water, unless authorised under the Water Act.

The mining operation will require extraction of groundwater for processing activities (Section 3.12). Section 13.1 and 13.2 provides the groundwater environmental values and potential impacts of the proposed activities, respectively.

Centrex will also require a water permit for temporary extraction of non-associated water for the Start-up Operation. If the Full-scale Operation proceeds, a water licence application will be submitted for longer-term surface water and groundwater supply.

2.5 Environmentally Relevant Activities

Environmentally relevant activities, as listed in Schedule 2 of the *Environmental Protection Regulation 2008* are being sought under this application. These are listed in Table 5 below.

In accordance with section 19A of the EP Act, activities listed in Schedule 2 of the EP Regulation are referred to as ancillary activities as they form part of the recourse activity as a single integrated operation on-tenure.

Table 5: Environmentally Relevant Activities

Environmentally Relevant Activity (Ancillary Activity)	Threshold	AES Score
21 (Resource)	A mining activity that is an ineligible ERA, other than a mining activity mentioned in items 9 to 20	136
31(2)(a) – Mineral Processing	Washing, leaching, classifying, mixing and concentrating mineral products (between 1,000t to 100,000t)	179
33 – Crushing, Milling, Grinding or Screening	Crushing, grinding, milling or screening more than 5,000t of material in a year	No score

Note: ***screening*** includes washing, crushing, grinding, milling, sizing or separating material.

2.6 Other Legislative Requirements

Other legislation relevant to the Project is provided below.

2.6.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) establishes a process for environmental assessment and approval of proposed actions that have, or are likely to have, a significant impact on Matters of National Environmental Significance (MNES) or the environment on Commonwealth land. Such an action is a considered a ‘controlled action’.

A self-assessment of the potential for significant impacts has been prepared by Golder and it was determined that the proposed amendment to the EA will not have a significant impact on MNES. Therefore, an EPBC Act referral has not been submitted for the Project.

2.6.2 Aboriginal Cultural Heritage Act 2003

The *Aboriginal Cultural Heritage Act 2003* (Qld) provides a system to protect, preserve and manage Aboriginal cultural heritage areas and objects. The object of the Act is to provide recognition, protection and conservation of Aboriginal cultural heritage.

The Act establishes a 'duty of care' that requires anyone conducting activities on land to take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage. The Duty of Care Guidelines (DATSIP, 2004) outline reasonable and practicable measures for ensuring activities are managed to avoid or minimise harm to cultural heritage values. An assessment under the Duty of Care Guidelines is provided in Section 14.0.

2.6.3 Nature Conservation Act 1992

The *Nature Conservation Act 1992* (Qld) (NC Act) provides for the conservation of Queensland's biodiversity. In support of the purpose and the provisions of the NC Act, the *Nature Conservation (Wildlife) Regulation 2006* (Qld) lists all flora and fauna species which are considered to be 'extinct in the wild', 'endangered', 'vulnerable', 'near threatened' and 'least concern' wildlife.

The assessment of potential impacts to flora and fauna is provided in Section 11.0.

2.6.4 Environmental Offsets Act 2014

In accordance with the *Environmental Offsets Act 2014,* an offset condition may be imposed for a significant residual impact on a prescribed environmental matter. A prescribed environmental matter under the *Environmental Offsets Regulation 2014* is a matter of National environmental significance (MNES), a matter of State environmental significance (MSES) or a matter of Local environmental significance (MLES).

The supporting information addresses the potential impact to these matters as a result of the Project (see Section 14.4.1).

2.7 Local Government Context

The ML encompasses two (2) land parcel tenures across two (2) council shires - Lot 16 on CW62 within the Cloncurry Shire local government area across the north-eastern corner, and Lot 4 on SP117500 within the Boulia Shire Council local government area for the remainder of the Project site. A plan showing the local government boundaries in relation to the mining lease area is shown in Figure 1.

The Cloncurry Shire Planning Scheme 2016 (Version 2) commenced on 15 February 2016, prepared as framework for management of development and sets Council's intention for future development in the Shire for the next 10 to 15 years. Boulia Shire Planning Scheme was originally adopted in October 2006, with Version 2 amendments effective as of 30 January 2015.

A number of values identified within both council planning schemes aim to achieve the following overall outcomes related to extractive industries, including:

- Extractive industries are established in locations that are adequately separated from sensitive land uses and do not have significant ecological, landscape or rural value;
- The industries are located so as not to detract, or diminish the scenic amenity of the surrounding area, landmarks or vistas;
- A separation area is established to maintain a buffer between the extractive industry and existing and future sensitive land uses;
- External impacts associated with extractive industry operations, e.g., haulage, do not impact on the scenic amenity and well-being of the community;

- Extractive industry sites are progressively rehabilitated including the achievement of a stable land form that is safe and suitable for other appropriate uses and prevent ongoing risk of adverse impacts of the environment;
- Are designed and operated so that the safety of persons and property is not compromised; and
- Land that contains extractive industry uses are protected, so that such resources can be extracted, when needed, in an environmentally acceptable manner.

Although the State government is the assessment manager for resource developments in Queensland, the State Planning Policy for mining and extractive resources (DILGP, 2016) advises local governments to consider known mineral, coal and petroleum and gas resources and proposed resource development proposals when developing local planning schemes to incorporate measures avoiding land use conflicts. Conversely, the planning schemes of both Cloncurry Shire Council and Boulia Shire Council have been reviewed and considered in conjunction with this application, and where achievable, measures have been included to assimilate local council values.

3.0 PROJECT DESCRIPTION

The Project is located approximately 128 km south of the city of Mt Isa and 23 km west of the town of Dajarra in North West Queensland (Figure 1). It is one of the few remaining undeveloped high-grade phosphate rock deposits with an estimated 16.2 million tonne phosphorite (P_2O_5) Inferred Mineral Resource at 27.8%, using a 16% P_2O_5 cut-off grade (Centrex Metals, 2018b).

Ardmore's deposits occur on ML5542 with an EA (BRMN0037) held by Centrex which currently allows for exploration and production activities. Centrex also holds Exploration Permits for Minerals; EPM 26551 and EPM 26568 and an EPM Application for EPM 26841 surrounding the ML5542.

The ML encompasses 2,209 hectares, with the target high-grade phosphorite deposit occurring as a single, essentially flat lying unit within two separate areas, the "Northern Zone" with a strike extent of approximately 4.0 km (N-S) and the "Southern Zone" with a strike extent of approximately 1.6 km (E-W). The target phosphorite unit is shallow dipping, with the average depths of the hanging wall and footwall contacts being 8.3 m and 12.0 m respectively based on drilling to date (Centrex Metals, 2017b).

Centrex propose to develop the ML in two phases, the Start-up Operation and the Full-scale Operation. The purpose of this EA amendment application is to gain approval for the Start-up Operation, referred to in this report as the Project.

The Start-up Operation consists of a demonstration processing plant and a small-scale open pit to be constructed within the Southern Zone of the ML. The Project will extract approximately 70,000 tonnes of ore using shallow open-cut strip mining over a 2 – 3 month period. ROM ore will be processed in the demonstration plant to produce between 30,000 – 40,000 tonnes of concentrate. The concentrate will be shipped to third party testing facilities for fertiliser conversion test work and to potential customers for independent testing through their facilities. At the completion of the Start-up Operation the viability and economic merits of the Project will be considered by Centrex to determine whether to expand the operation to a Full-scale Operation in the future. The aim of the mining operation is to supply phosphate rock concentrate to fertiliser plants in Australia (which are currently reliant on imported phosphate) and export throughout the region.

The conceptual layout of the Project within the mining lease area is provided in Figure 3. Further details of the Start-up Operation are provided in Section 3.2 to Section 3.19.

The regional geology of the area is described in Golder Associates (2017) and in Appendix A - Soils Technical Report. The 1:100,000 Ardmore geology map (Australia 1:100,000 geological series, Sheet Number 6754) indicates that there are a number of surface geological units present within the mining lease and a brief description of the geological units, from the youngest to the oldest, is presented in Table 6. Surface geology of the Mining Lease area is provided in Figure 4.

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BOULIA MOUNT ISA HIGHWAY

ML5542

KEY MAP



LEGEND

- Groundwater boreholes
- Water Pipeline and Access Track
- Watercourses
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	23/08/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
MINING LEASE AREA CONCEPTUAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	3

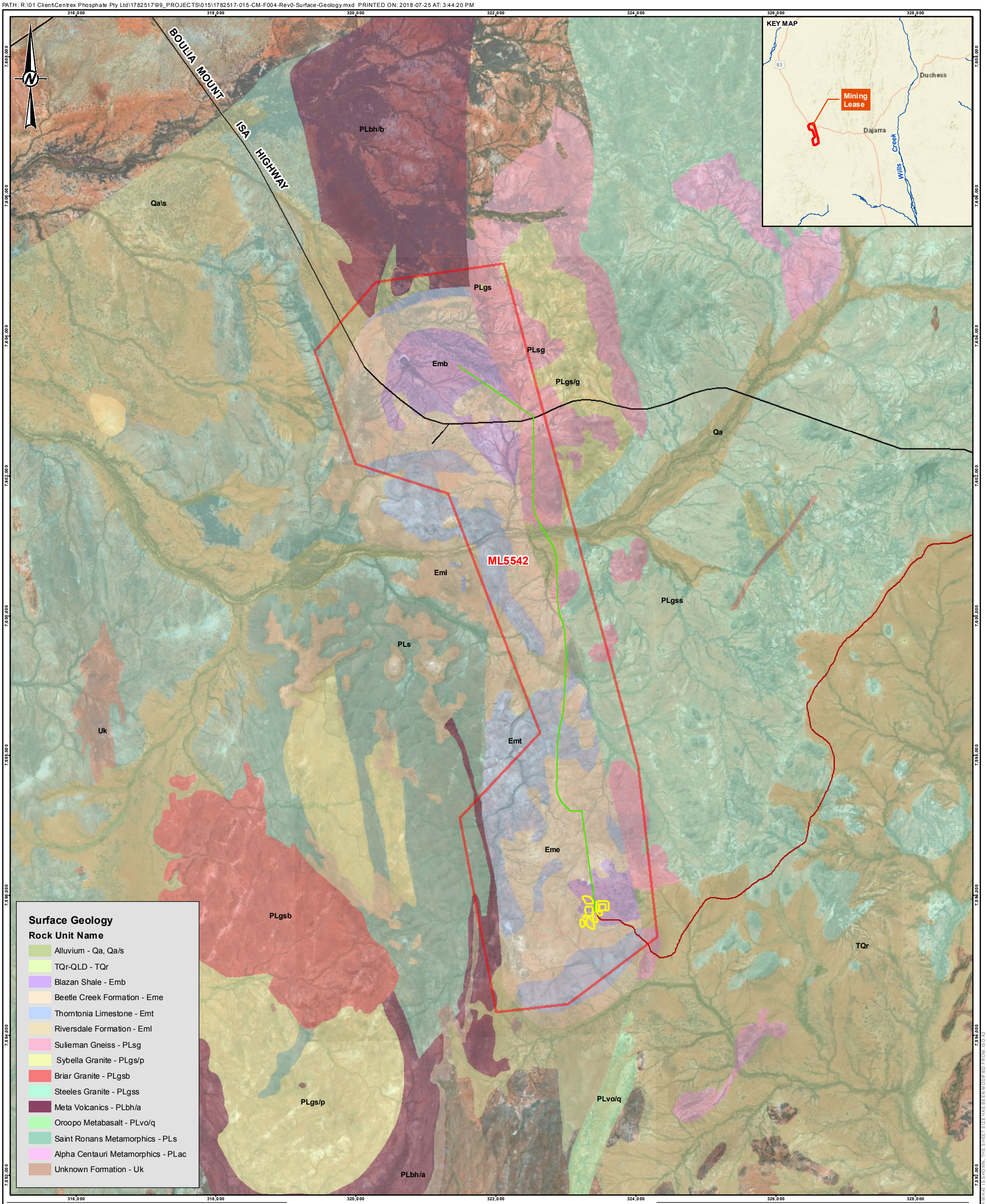
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The geological setting of the regional area is a well-defined stratigraphic sequence that includes a stable Precambrian basement. The two major Precambrian units within the region are the Easter Creek Volcanic and the Sybella Granite. These form a basement of crystalline rocks around outlier and by inference, underlie the younger sediments (Appendix A).

Table 6: Geological Stratigraphy

Age	Unit	Description
Quaternary	Alluvium	Clay, silt, sand, gravel; flood-plain alluvium.
Middle Cambrian	Blazan Shale	The uppermost formation preserved within the Ardmore Outlier. Siliceous shale, chert, siltstone, fine arenite, conglomerate, dolomitic and bituminous limestone, phosphorite.
Cambrian	Beetle Creek Formation (Sub units: Basal Phosphorite Member, Chert Member, Simpson Creek Phosphorite Member)	The significant phosphate containing unit within the Outlier. Chert, siliceous shale with trilobite fossils, basal conglomerate.
Thorntonia Limestone	Middle Cambrian	Lithologically it is a thinly to thickly bedded limestone or dolomitic limestone, with grey vuggy chert occurring as beds and nodules throughout the formation. This material underlies the phosphate ore.
Early Cambrian	Riversdale Formation	The basal sedimentary unit within the Ardmore Outlier and rests unconformably on the Precambrian basement. Underlies the Thorntonia Limestone. Conglomerate, arenite, arkose, shale, mudstone, dolomite.
Palaeo Proterozoic	Sulieman Gneiss	Felsic gneiss, augen gneiss, hornblende schist, amphibolite, quartzite.

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LEGEND

- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.
Surface Geology: © State of Queensland (Department of Employment, Economic Development and Innovation), 2011.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
SURFACE GEOLOGY

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	4

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3.1.1 Deposit Geology

The Ardmore deposit within the ML is located within the geological formation known as the Ardmore Outlier within the Georgina Basin. It is a small down-faulted block of Middle Cambrian sediments bounding the Proterozoic Sybella Granite on the eastern side and the Eastern Creek Volcanics on the western side (Notholt et. al., 1989). Within this outlier the sequence consists of the Riversdale Formation and the Thorntonia Limestone, overlain by up to 50 m of Beetle Creek Formation, which is in turn overlain by shales and cherts of the Blazan Shale. The phosphorites within the Beetle Creek Formation are predominantly pelletal phosphorites with an average thickness of 7 m and a maximum thickness of 12 m. (Notholt et. al., 1989).

Phosphatic marine sediment (phosphorite) occurs in the Middle Cambrian (505-515Ma) rocks of the Georgina basin with the sediments around the eastern edge of the Georgina Basin hosting significant phosphate resources with the most significant resource occurring within the Duchess Embayment approximately 75 km east of Ardmore at the Phosphate Hill mine. A number of other Phosphate Deposits are located around the Georgina Basin but no other deposits have been mined commercially (Centrex, 2018).

The Beetle Creek Formation hosts the phosphate mineralisation within the Simpson Creek Phosphorite Member and Basal Phosphorite Member sub-units. The upper Simpson Creek Phosphorite Member has high grade mineralisation and is the target of the Project. The Riversdale Formation represents the basal unit of the outlier which sits unconformably on Proterozoic basement volcanics below.

The Ardmore outlier is a roughly 10 km by 2 km fault block with its long axis striking North North West. The Northern Zone of the deposit consists of a synclinal nose with sediments dipping towards its centre. The entire zone plunges east into a bounding fault. Bedding dips around 3° to 5° on average. The Blazan Shale occurs in the centre of the syncline with Beetle Creek Formation surrounding it followed by the Thorntonia Limestone and Riversdale Formation. Only the latter two units outcrop to any great extent with the first two overlain by soils.

The Southern Zone is of a similar nature and comprises an east plunging syncline again abutting a bounding fault. Beetle Creek Formation and Blazan Shale occur on an outcropping plateau with erosion channels cutting through to underlying Thorntonia Limestone on the perimeters of the plateau. Bedding dips are similar to the Northern Zone (Centrex, 2018a).

The Blazan Shale and the Beetle Creek Formation (Plate 1) are exposed in the southern costean which was excavated in the 1970s within the Southern Zone (to the north of the proposed Project).

3.1.2 Mineral Resource Estimates

The main economic mineralisation occurs within the Simpson Creek Phosphorite Member (SCPM) with an average thickness of 4.5 m in the Southern Zone and 2-4 m in the Northern Zone. Within the Northern Zone the SCPM progressively thins from 4 m in the south to ~2 m in the north. The SCPM also pinches out (<1 m) and drops in grade (<20% P_2O_5) around the western boundary of the Northern Zone.

The SCPM and the Basal Phosphorite Member are mainly of the pelletal variety with minor beds of collophane mudstone. A 5-15 cm zone of collophane mudstone forms a distinct marker unit midway through the SCPM. The pellets are well rounded to irregular in shape and include phosphatised fossil fragments. Scanning electron microscope, XRD and chemical analysis indicates that the pellets consist dominantly of carbonate-fluorapatite (francolite) $Ca_5(PO_4,CO_3)3F$ with a small but not insignificant amount

of Crandallite $CaAl_3(PO_4)2(OH)_5.(H_2O)$ which forms as a secondary weathering product localised along faults and dissolution zones along the top SCPM contact with the overlying Blazen Shale. (Centrex, 2018a).

In the Southern Zone diamond drilling and costeans indicate that approximately 20% of the SCPM occurs as Indurated Phosphorite. The Northern Zone, although slightly more dense and less weathered than the Southern Zone does not contain any significant Indurated material. The majority of the deposit in the Southern and Northern Zones occur as the less consolidated and weekly cemented Friable ore type, due to secondary weathering removing the primary calcite cement. The level of induration is more common above the collophane marker bed and is likely a result of preferential near surface cementation by iron and phosphate and to a lesser extent silicification (Centrex, 2018a).

Within the weathered/oxide zone the iron occurs in the form of goethite and hematite as secondary coatings as well as finely disseminated within the phosphatic beds and pellets. Beneath the base of oxidation (14-16 m) in the Northern Deposit the iron occurs as finely disseminated pyrite.

Silica occurs as detrital quartz, clay silicates and as cryptocrystalline silica cement within the matrix of the phosphatic beds. Minor (cm) wide chert beds occur primarily at the base of the SCPM which are likely a result of silica alteration of primary calcareous muds (Centrex, 2018a).

Centrex announced the updated mineral resource estimates in an ASX announcement in June 2018 (Centrex Metals, 2018b). The estimate was based on a 342 hole reverse circulation (RC) drilling program plus 646 historic drill holes and 17 water bores (total 1,005 drill holes).

The Joint Ore Reserves Committee (JORC) compliant total mineral resource estimate for the Project is 16.2 million tonnes at 27.8% P_2O_5 using a 16% P_2O_5 cut-off. The mineral resource is inclusive of 14.2 million tonnes at 29.3% P_2O_5 using the 19% P_2O_5 cut-off applied in previous estimates. This includes 14.4 million tonnes of Indicated and Measured Mineral Resources (Table 7 and Table 8).

Table 7: JORC Compliant Mineral Resource Estimate (16% P_2O_5 Cut-Off)

16% P_2O_5 Grade Cut-Off		
Mineral Resource Category	**Million Tonnes**	**P_2O_5%**
Measured	3.3	29.8
Indicated	11.1	27.4
Inferred	1.7	26.8
Total Mineral Resources	16.2*	27.8

*Totals may not add due to rounding.

Table 8: JORC Compliant Mineral Resource Estimate (19% P_2O_5 Cut-Off)

19% P_2O_5 Grade Cut-Off		
Mineral Resource Category	**Million Tonnes**	**P_2O_5%**
Measured	3.3	29.8

19% P_2O_5 Grade Cut-Off		
Mineral Resource Category	**Million Tonnes**	**P_2O_5%**
Indicated	9.3	29.3
Inferred	1.6	27.8
Total Mineral Resources	**14.2***	**29.3**

Source: Centrex Metals (2018b) Ardmore Phosphate rock Project, Updated Mineral Resource Estimate Complete

*Totals may not add due to rounding.

3.1.3 Deposit Geochemistry

RGS Environmental Pty Ltd (RGS) prepared a geochemical assessment of the overburden, tailings and ore within the ML area. The results of the study are within Appendix B – RGS Geochemistry Technical Report. The purpose of the investigation was to evaluate the potential of the mined and processed material to produce:

- Acid, neutral or alkaline drainage.
- Saline drainage.
- Metalliferous drainage.

The assessment included static geochemical characterisation of 43 samples across the ML area, with seven samples located near the proposed Project in the southern portion of the ML. The geochemical results have also been incorporated into the Project material management and placement and proposed rehabilitation and closure plan. The details of the methods of the static testing are provided in Appendix B.

3.1.3.1 Net Acid Producing Potential

Ore and tailings samples are mildly alkaline pH with the presence of some sulphide minerals. Further analysis using the chromium reducible sulfur method verified that the actual sulphide concentration is <0.02%. The results also indicated that the ore and tailings samples were non-acid forming (NAF) and therefore negligible potential to produce acid drainage.

The overburden and footwall samples (the material below the ore deposit) were a neutral pH (between 6 and 9). The net acid producing potential and acid neutralisation potential ratio indicated that the overburden samples were NAF or acid consuming (AC).

3.1.3.2 Saline Drainage Potential

Ore and tailings samples were considered to have low potential for saline drainage. However, during the course of mining and processing, the ore will be processed with saline groundwater or surface water which will increase the salt load within the Tailings Storage Facility (TSF).

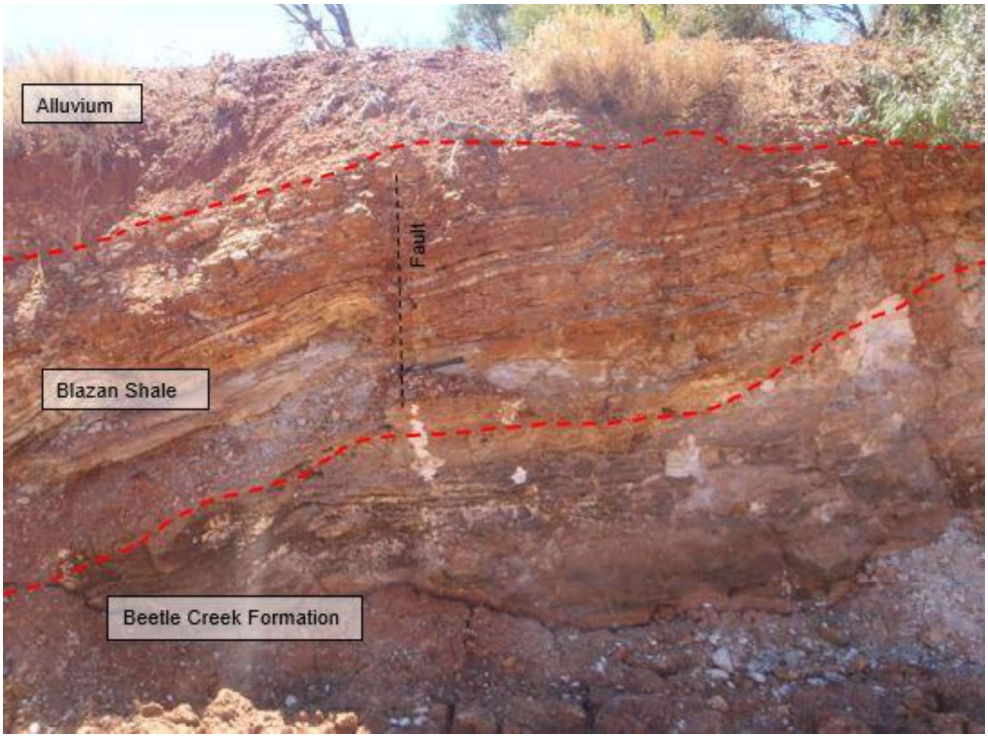


Plate 1: Rock exposed in wall of southern costean, with Blazan Shale overlying Beetle Creek Formation

The overburden and footwall samples contained elevated concentrations of salts (greater than 8,000 µS/cm). It is likely that the elevated salinity is present in the form of sodium chloride and sulfate bearing minerals. The concentrations of total phosphorous suggest phosphate may also contribute to the elevated EC levels.

3.1.3.3 Metalliferous Drainage Potential

The geochemical abundance index (GAI) is used to identify samples with elevated mineralisation concentrations. The GAI is used to guide to highlight metals or metalloids that require further investigation. Ore and tailings samples indicated that the results were within the median background soil concentrations. There were elevated levels of silver, beryllium and tellurium however it was still within the range of background concentrations. A 16 hour leach test was used to verify that there is a low potential for metalliferous draining from the samples.

The overburden and footwall samples GAI and elevated sulphide concentrations indicated that the footwall material in the Northern Zone (outside of the Project area) may have potential for metalliferous drainage.

3.1.4 Naturally Occurring Radiation

Phosphate rocks of sedimentary origin contain Uranium (238), Thorium (232) and its decay products in addition to phosphate minerals. Uranium was present in the ore and tailings samples at 99 and 93 ppm and Thorium at 18 and 14 ppm, which is common for phosphatic sediments in sedimentary rocks. (Appendix B).

The definition of radioactive ore differs between the various State legislation and regulations. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2017) developed a document (the National Directory for Radiation Protection, Radiation Protection Series Publication No. 6) to provide guidance for a uniform definition of radioactive material and exemption limits for regulatory purposes. However, this uniform definition has not yet been completed. In the absence of this, the definition of radioactive ore has been taken from South Australian and New South Wales legislation.

Under the South Australian *Radiation Protection and Control Act 1982* radioactive mineralisation and samples are considered to be ‘radioactive ore’ if the uranium or thorium concentrations exceed the concentrations in Regulation 6 and total activities in Regulation 7 of the *Radiation Protection and Control (Ionising Radiation) Regulations 2015.*

Regulation 6 defines a radioactive ore to be ore which has the prescribed concentration of a radioactive element or compound if the radioactive element or compound has a specific activity of more than 35 kilobecquerels per kilogram and it contains one or more radionuclide which when considered through the prescribed formula are more than or equal to 1.

Similarly, the NSW *Radiation Control Regulation 2013* states that material is classified as radioactive ore if the uranium and thorium ratios are equal to or greater than 1. For the purposes of the definition of radioactive ore in section 4(1) of the *Radiation Control Act 1990*, the prescribed concentrations of uranium and thorium are:

(a) in the case of an ore that contains uranium but not thorium, 0.02 per cent by weight of uranium, or

(b) in the case of an ore that contains thorium but not uranium, 0.05 per cent by weight of thorium, or

(c) in the case of an ore that contains both uranium and thorium, a percentage by weight of uranium and thorium such that the expression:

$$\frac{\mathrm{U}}{0.02} + \frac{\mathrm{Th}}{0.05}$$

Where U is the numerical value of percentage by weight for uranium and Th is the numerical value of percentage by weight for thorium.

To determine the classification of the ore and tailings, the Uranium and Thorium content ratios from the Project samples (Appendix B) were calculated using the above formula, expressed as:

$$\frac{0.009}{0.02} + \frac{0.0018}{0.05}$$

Where the percentage weight for Uranium (99 ppm) is calculated to be:

$$0.009 \div 0.02 = 0.45$$

The percentage weight for Thorium (18 ppm) is calculated to be:

$$0.0018 \div 0.05 = 0.036$$

Therefore:

$$0.45 + 0.036 = 0.48$$

For the Project the maximum ratio observed within the ore and tailings samples collected was 0.48. Therefore, the results indicate that the naturally occurring uranium and thorium is not in quantities that are above normal, and the ore and tailings will not be considered radioactive.

3.2 Project (Start-up Operation) Overview

The Start-up Operation consists of a demonstration processing plant and a small scale open pit to be constructed within the Southern Zone of the ML. The Project will extract approximately 70,000 tonnes of ore using shallow open-cut strip mining over a 2 – 3 month period. ROM ore will be processed in the demonstration plant to produce between 30,000 – 40,000 tonnes of concentrate. The concentrate will be shipped to third party testing facilities for fertiliser conversion test work and to potential customers for independent testing through their facilities.

At the completion of the Start-up Operation, the viability and economic merits of the Project will be considered by Centrex to determine whether to expand the operation to a Full-scale Operations in the future. The aim of the mining operation is to supply phosphate rock concentrate to fertiliser plants in Australia (which are currently reliant on imported phosphate) and export throughout the region.

3.3 Project Need and Rationale

Phosphate is one of three essential elements for plant and animal nutrition, the other two being potassium and nitrogen. At a general level it is a catalyst for energy transfer within plants and animals. There are no substitutes for phosphate in agriculture (phosphate rock is the only significant source of phosphate for agricultural purposes) (Centrex, 2016).

There are three types of primary phosphate rock deposits; sedimentary phosphorites, igneous apatites, and guano deposits (bird or bat faeces accumulations). Sedimentary phosphorites such as at Ardmore

are the dominant source for phosphate rock production globally at around 80% of the market. Since the advent of industrial fertilisers there has been a strong link between population growth and demand for phosphate rock, where as the world's population continues to grow, so too will demand for phosphate rock (Centrex, 2016).

The product from the Ardmore deposit will be accommodated within the expected market demand growth or by replacing imports to customers within Asia or Australasia from outside the region. High cadmium levels, a toxic metal which can become concentrated in crops, in phosphate rock exports are becoming a global health concern with the European Union moving to significantly reduce allowable import limits. Test work to date shows the Ardmore ore to be an ultra-low cadmium product (Centrex, 2016).

3.4 Mining Process

The target phosphorite unit is shallow dipping and outcropping in many areas with the average depths of the hanging wall and footwall contacts being between 8.3 m and 12.0 m. Excavations and dozer stripping trials of the overburden undertaken by Centrex to date indicate that mining will be possible by free-digging, with no blasting required.

Centrex propose to strip mine the deposit over six stages. Dozers will remove the topsoil and place it in stockpiles for later use in rehabilitation. The shale overburden will then be removed and placed within the overburden storage facility. A truck and shovel will then extract the ore placing it on the ROM ore stockpile.

The Project conceptual layout is provided in Figure 5 and consists of a single pit, overburden and indurated storage facility, ROM pad, processing plant and tailing storage facility including an earthen bund. The key Project characteristics are provided in Table 9.

Table 9: Key Project Characteristics

Project Item	Description
Project location	Ardmore in north-west Queensland, 23 km west of the town of Dajarra.
Tenure	Mining Lease ML5542
Disturbance footprint	Approximately 17 ha in total consisting of 13 ha direct disturbance with an additional 4 ha of disturbance in areas around and between the open pit and a 10 m buffer around Project infrastructure. A 5 m wide corridor approximately 8.5 km in length will accommodate the pipeline and an accompanying single vehicle maintenance access track, with 4.3 ha of ground disturbance required. The haul road access track will be 11 km from the highway to the processing plant site utilising an existing access track to the site. The portion of the access track on the ML will be 1 km.
Mining method	Shallow open-cut mining extracted by free digging (no explosives are required).
Mobile plant	1 x CAT 385C 85 t excavator

Project Item	Description
	1 x CAT D10 bulldozer 3-4 x 40 t CAT Ejector trucks 1 x Grader 1-2 x Front End Loaders 1 x 40,000L Water Truck 1 x Service Truck 4 x Light Vehicles
Open pit	Approximately 100 m wide, 140 m long and 10 m deep. The pit will be mined over six stages of stripping.
Life of operation	Plant erection and commissioning: 4-6 weeks Mining construction: 2-3 weeks Mining: 6-8 weeks Processing: 7-10 weeks
Overburden waste rock	70,000 t of overburden classified non-acid forming (NAF) material.
Tailings	Tailings will be 30-37% solids slurry, predominantly kaolinite, quartz, apatite, smectite and goethite. Pumped to a temporary and lined Tailings Storage Facility (90 m x 90 m x 5 m deep) containing approximately 33,200 m^3 over the life of the Project.
Indurated storage and Run of Mine (ROM)	The indurated storage facility will contain 25,000 m^3 of material and the ROM approximately 55,000 m^3.
Mining rate	Stripping ratio of 1.8:1 waste rock to ore.
Processing rate	Average rate of approximately 70 t per hour (tph), processing up to a total of 50,000 t of ore. Ore concentrate produced will be approximately 30,000 t (at a bulk density of 1.6).
Processing method	Single stage crush and deslime processing circuit designed to remove clays and other contaminants from the ROM ore to produce a high-grade phosphate rock concentrate. The ore is crushed to meet sizing specifications of 90% minus 2 mm and 10% minus 0.075 mm and then attritioned to abrade and remove clays from the phosphate rock. The fine clay is removed from the concentrate using hydrocyclones. This material is then thickened and pumped to the tailings pond. The concentrate produced will be dewatered and pad dried to produce a concentrate which will be loaded into containers for shipment to Townsville.
Operating hours	Processing activities: 20 hours per day; 7 days. Mining and construction activities: 12 hours per day, 7 days.

Project Item	Description
Power	Modular genset and distribution board, supplied at 415 V, 50 Hz. Located at the processing plant.
Raw water supply	Two bores located to the north of the Project within the ML area will supply water via an 8.5 km long 80 mm diameter polyethylene pipeline to the processing plant, which will be placed on the ground surface. Raw water will be stored in tanks at the processing plant for use at the RO plant which will make the water suitable for the processing plant.
Borrow pits	Two borrow pits for rock/gravel material will be sourced from borrow pits developed within the ML. The locations will avoid any sites that are within Cat B ESAs, MSES areas or areas of importance to the Purple-necked Rock-wallaby. The proposed pits will each be approximately 70 m x 70 m x 3 m depth. A borrow pit for sand for use prior to processing is proposed within Split Creek in an area that is devoid of vegetation. Approximately 500 m² of screened sand is required (from an area of approximately 30 m x 15 m).
Accommodation	Employees will be housed at Dajarra.
Employment (staff and on-site contractors)	Construction will require approximately 12-15 personnel and 12-20 personnel for mining and processing.
Main access roads	Access to the site will be via the Boulia Mount Isa Highway and on an unsealed access track, which will be upgraded for mining operations.

The Project will disturb a total area of approximately 17 ha. This accounts for 7.8 ha for Project infrastructure with an additional 4 ha of predicted disturbance incorporating the areas around and between the open pits and including a 10 m buffer around the infrastructure. The borrow pits for rock and sand will require approximately 1 ha.

A 5 m wide corridor approximately 8.5 km in length will accommodate an 80 mm diameter water pipeline from two bores in the north of the ML to the processing facilities and an accompanying single vehicle access track for pipeline maintenance (4.3 ha). The pipeline will be temporarily laid on the surface along a route from the north to the south of the ML as shown in Figure 5, buried at a depth of 0.5 m under three creek crossings and disturbing approximately 4 ha of vegetation in total. An access track will be formed along-side the water pipeline for maintenance purposes.

An access haul road will be 11 km in length from the processing plant to the highway (1 km from the processing plant to the ML boundary). It will be located on a pre-existing track with some minor widening and therefore it is not included in the area of disturbance.

The breakdown of Project components and the area of disturbance is provided in Table 10.

Table 10: Approximate Area of Disturbance by Project Component

Project component	Area of disturbance (ha)	Coordinates
Pit	1.43	323320.61mE 7595773.12mN
Overburden storage facility	1.14	323307.30mE; 7595938.46mN
Indurated storage facility	0.55	323225.33mE; 7595904.29mN
ROM pad	1.26	323338.12mE; 7595903.59mN
Process plant area	1.26	323414.48mE; 7595704.47mN
Tailing storage facility	0.79	323509.06mE; 7595830.57mN
Tailings storage facility bund	1.38	323509.06mE; 7595897.82mN
Area between Project components including a 10 m Project buffer	3.88	Surrounding components above
Pipeline and maintenance track	4.3	Liner infrastructure
Borrow pits (rock and sand)	1	Location not determined
Total	**17**	

Mining will be undertaken over seven stages with eight separate cuts. Table 11 provides the volumes of waste rock and ore for each stage. All waste rock is NAF. The cross-section of the Project at the full extent of mining is provided in Figure 6.

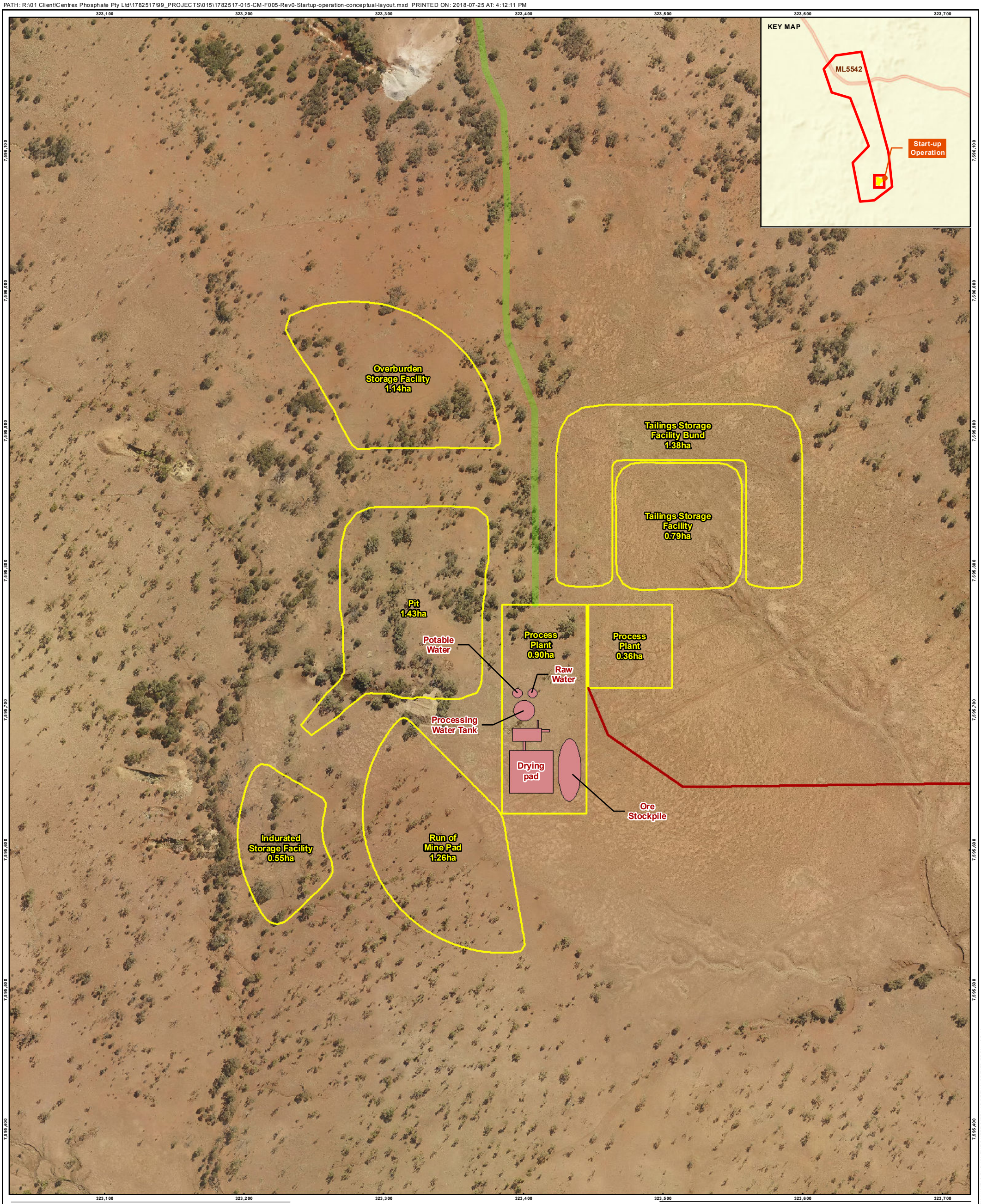
Table 11: Project Mine Stages and Volumes

Stage	Cut	Waste (kt)	ROM (kt)	Stripping ratio (waste to ore)
1	1	8.3	7.4	1.1 :1
2	2	9.8	7.2	1.4 :1
3	3	9.9	8.1	1.2 :1

Stage	Cut	Waste (kt)	ROM (kt)	Stripping ratio (waste to ore)
4	4	8.6	14	0.6 :1
5	5	15.1	2	7.6 :1
6	6	17.2	8.6	2 :1
7	7	0	12.4	0 :1
5	8	0.9	12.4	0.1 :1
Total		**69.7**	**72.1**	**1 :1**

Note: The Project is planning up to 100,000 tonnes of ore being mined, with a mine stage plan for approximately 72,000 tonnes.

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LEGEND

- Water Pipeline and Access Track
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542
- Processing Plant

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 20 40 60 80 100
1:2,500 at A3 METRES

REFERENCE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.
Processing Plant: Golder 2018.
Mining Lease: © State of Queensland (DNRM) 2018

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PROJECT
CENTREX ARDMORE PHOSPHATE

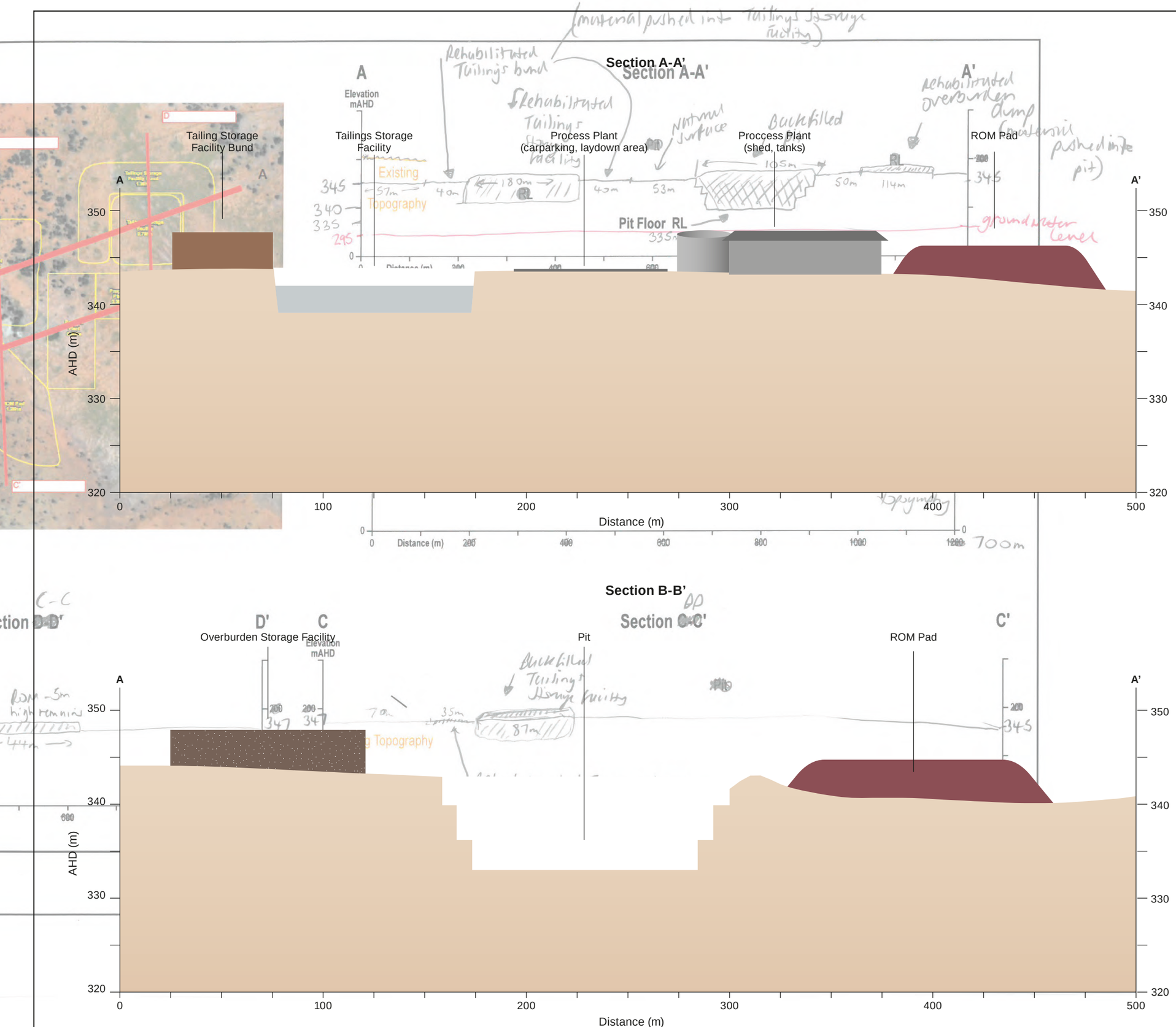
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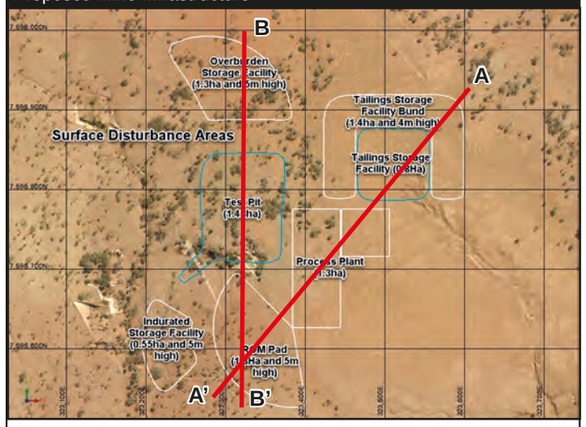
YYYY-MM-DD	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

TITLE
START-UP OPERATION CONCEPTUAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	5

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PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
CROSS SECTION OF SITE DURING MINING

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-15
PREPARED	AA
REVIEW	RK
APPROVED	JR

PROJECT NO.	REPORT	REV.	FIGURE
1782517	015	0	06

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3.5 Surface Water Management

The site is located within a flat area with no significant water courses. Watercourses are ephemeral and only flow after heavy rainfall which also causes local flooding. The mine design and infrastructure layout has been designed to avoid surface water drainage lines and minimise potential for adverse impacts to mine infrastructure and to downstream watercourses.

Site water management will include minimising changes to natural surface water flow, diverting clean water from disturbed areas and preventing runoff and erosion from disturbed areas or discharges downstream.

Flood protection measures include the TSF bund which will aim to prevent sheet flow upstream into the TSF, diversion channels around the mine infrastructure area and the pit, and to protect topsoil stockpiles.

3.6 Development Timing and Schedule

The Project will commence once all regulatory approvals are in place, which is anticipated to be in Q3 2018. Erection and commissioning of the plant infrastructure is expected to be completed in 4-6 weeks but will not occur until Q1 2019 due to the delivery time of the processing plant (24 weeks). The construction period for the pit will take approximately 2-3 weeks and the mining period 6-8 weeks. Processing of the extracted ore is expected to be undertaken over 7-10 weeks following commissioning of the plant. Mined ore will be stockpiled on the ROM pad until the process plant is complete.

Following completion of the mining, the pit will be left as a void and the process plant associated infrastructure will be de-commissioned. A significant portion of the infrastructure will be leased equipment therefore it will be removed from site and returned to the rental companies. The processing plant will be de-commissioned and made safe and will remain in situ for a period of approximately one year while a determination as to the viability of proceeding with Full-scale Operations is made. The conceptual mine closure plan is provided in Section 3.19.

If Full-scale Operations are to proceed on the ML, the pit void created by Start-up Operations will become part of the main southern pit and progressively backfilled with overburden as part of the Full-scale Operations mine plan. Processing equipment will be re-located to the Full-scale Operation processing plant location outside of the pit margins while the contents of the tailings dam will be relocated to the full scale TSF and the pond liner recovered.

3.7 Demonstration Processing Plant

The demonstration processing plant comprises two distinct circuits, the crushing and beneficiation circuits, which have been designed to process up to a total of 50,000 tonnes of ROM ore at a run rate of 70 tonnes per hour (tph). A simplified schematic of the Project demonstration processing plant is provided in Figure 7.

Within the crushing circuit, ROM ore will be fed to a dry crushing plant. Using a single stage impact crusher in closed circuit with a screen, product will be crushed to a suitable particle size for the downstream beneficiation plant and stockpiled before being fed into the plant feed bin using a front-end loader.

To upgrade the ROM ore, physical separation techniques will be used in the plant area of the beneficiation circuit. The beneficiation plant will receive crushed ore from the feed bin by a variable speed belt feeder and discharged onto a primary wet screen feed conveyor to supply the primary wet screen. To

achieve a cut point of less than 2 mm, primary wet screen apertures will be appropriately sized and process water will be added to the primary wet screen feed box to provide necessary screening capacity and improve screening efficiency. All oversize material will be discarded onto a separate stockpile.

Undersize slurry from the primary wet screen will be pumped to the primary cyclone, where the overflow stream (-53 µm fraction) will be directed to the tails thickener and the underflow (-2 mm to +53 µm coarse fraction) will gravitate to the attritioning cells. From here the attritioned slurry will be pumped to the secondary cyclone where any -53 µm material will be removed. Overflow from the secondary cyclone (i.e., -53 µm fraction) will also be directed to the tails thickener.

The secondary cyclone underflow (-2 mm to +53 µm coarse fraction) will gravitate to the ultra-fine screen (product screen) for dewatering and removal of all remaining -53 µm material in the secondary cyclone underflow stream. Fines removal will be aided by the addition of process water to the ultra-fine screen. Dry concentrate will be loaded using a front-end loader into 20’ containers for transport to Port of Townsville and export.

Process water for the plant will be sourced from a RO plant which will treat bore water to produce a process plant make-up water with a chloride level of less than 500 ppm (see Section 3.12.1).

3.8 Tailings Characterisation and Management

Screened undersize tailings slurry, with an anticipated slurry density of approximately 11-15% solids will be pumped to the tails thickener. A compact, high rate styled tail thickener will be used to dewater and thicken the low-grade material from the primary and secondary cyclones and ultra-fines screen undersize streams, using an added flocculant (approximately 45 g/t) via a dedicated flocculant dosing pump to improve settling characteristics. Water recovered in the thickener will be recycled to the plant water tank.

Tails thickener underflow pumps will then pump the thickened tails 30-37% solids via one tailings discharge pipe to deposit in the tailings pond, a temporary storage pond lined with an impervious geofabric/polymer liner approximately 0.8 ha and measuring 90 m wide x 90 m long x 5 m deep. The tailings will consist of benign materials comprising predominately kaolinite, quartz, apatite, smectite and goethite. Geochemical analysis indicates that the tailings is likely to be NAF with a low potential for saline drainage. However, as the brine from the RO plant will be co-deposited into the tailings pond, the salt load within the TSF is expected to be elevated. The TSF will not contain hazardous waste and no leak detection systems are proposed. The TSF is designed to operate with at least a 1 m freeboard and any available decant water will be reclaimed as feed to the RO plant.

The TSF will be surrounded by a bund on the north, east and west raised 4 m above ground level and with a total area of approximately 1.4 ha (Figure 5). A spillway will be installed to manage extreme high rainfall events. The provision of the bund on three sides of the dam will prevent sheet water inflow and the 1 m freeboard will cater for any direct rainfall onto the dam. Analysis of rain events by Golder shows that a 1:100 AEP 72-hour event will not generate sufficient volume from direct fall to exceed the 1 m freeboard.

3.8.1 Dam Assessment Criteria

There are three different categories for dams built on a Mining Lease; referable dams, hazardous waste dams and non-referable, non-hazardous waste dams. The definitions of these dams are provided within the Appendix 4: Criteria for Dams in the *Eligibility criteria and standard conditions for mining lease activities ESR/2016/224* (DEHP, 2016a).

The TSF will be built as a 5 m deep pit with no 'dam walls' constraining the tailings, as it will be filled into a purpose built pit with sufficient freeboard to prevent overtopping. The TSF for the Project does not meet the criteria for a 'referable dam' or a 'hazardous waste dam' as it is not greater than 8 m in height and it will not include a barrier to impound water. The dam is likely to be considered a non-referable, non-hazardous waste dam.

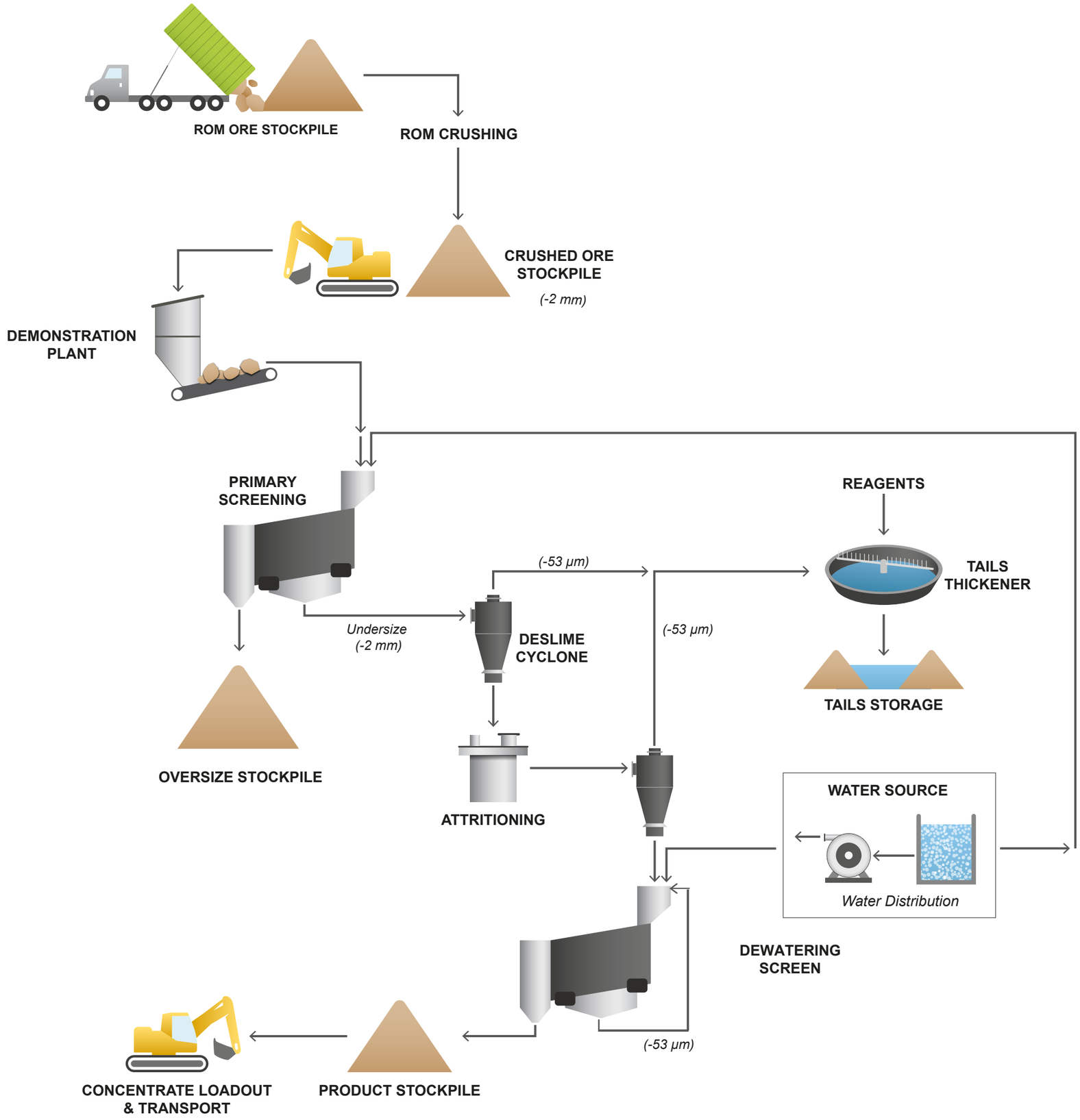
The EP Reg defines a 'regulated structure' as being a structure that is assessed under the DES (2016) *Manual for assessing consequence categories and hydraulic performance of structures ESR/2016/1933 Version 5.01* (2016a). The manual explains that regulated structures include '*land-based containment structures, levees, bunds and voids, but not a tank or container designed and constructed to an Australian Standard that deals with strength and structural integrity'*. The manual also links to the DEHP guideline *Structures which are dams or levees constructed as part of environmentally relevant activities (2017) ESR/2016/1934, Version 8.00* (DEHP, 2017h).

These two documents outline the process for determining whether a structure is considered a 'regulated structure'. A 'consequence assessment' determines the category of the structure and a structure is only a regulated structure where the consequence category for the structure is 'significant' or 'high. The manual states that all structures which are dams associated with the operation of an ERA must have their consequence category assessed based on the potential environmental harm that would result from the failure event scenarios described in the manual (DES, 2016a).

The consequence category assessment methodology is an assessment of environmental harm and it considers harm to humans, general environmental harm and general economic loss or property damage. Table 12 provides a high-level review of the 'low' consequence category descriptors as it is relevant for the Start-up Operation TSF.

Table 12: Consequence category

Environmental harm	'Low' consequence category
Harm to humans	Location such that people are not routinely present in the failure path and loss of life is not expected. Location such that contamination of waters (surface and/or groundwater) used for human consumption could result in the health of less than 10 people being affected.
General environmental harm	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas, but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects.
General economic loss or property damage	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs.



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PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
DEMONSTRATION PROCESSING PLANT SCHEMATIC

CONSULTANT
GOLDER

YYYY-MM-DD	2018-07-23
PREPARED	AA
REVIEW	KC
APPROVED	JR

PROJECT NO.	REPORT	REV.	FIGURE
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3.9 Transport

Centrex will truck product in 20’ containers from Ardmore 210 km to Cloncurry, where a dedicated train will transport product to the Port of Townsville. Aurizon will be responsible for the loading of containers at Cloncurry as well as the rail transport to Townsville, therefore this operation is not included in the Project approval.

3.9.1 Access Road and On-Site Transport

A single lane, unsealed access track currently exists from the south of the ML connecting to the Boulia Mount Isa Highway (Figure 3). This track, approximately 11 km in length, is intended to be widened to facilitate double and/or triple road trains carrying 20’ containers, which will be loaded with concentrate on the site. Oversized loads transporting construction equipment to and from the Project area will be managed on a case by case basis.

3.9.2 Ore Transport to Cloncurry

Ore concentrate will be transported via road trains along the Boulia Mount Isa highway through Dajarra township, and along the Duchess-Dajarra Road to Duchess located approximately 82 km from the junction of the access track and the highway (see Figure 1) and then on the Duchess-Cloncurry road to the Cloncurry rail terminal. Indicative vehicle movements are estimated at 36 loaded (72 trips) triple road trains per week over a 10-week period to transport 30,000 t of ore to Cloncurry. Transport will only be conducted during daylight hours, which will reduce safety risks and impacts to drivers, local communities and native wildlife.

A dedicated Ardmore train is confirmed for the duration of the Project, docking at the Cloncurry rail terminal once or twice a week, with the capacity for 124 containers per train. Full containers will be unloaded from road trains at the Cloncurry rail terminal using a reach stacker and stored. Upon arrival of the dedicated train, the reach stacker will unload empty containers (to be returned to the mine site for further product loading) and load the train with full containers for transport to the Port of Townsville.

3.9.3 Port of Townsville

The containers will be unloaded and stored in 20’ containers at the Port of Townsville into an existing bulk storage facility, with contracts to be confirmed prior to mining. The entire production run will be stored at this facility (estimated 30,000 t of ore concentrate) until completion of the Project.

The entire consignment will be loaded onto a single dedicated ship and exported from Townsville using existing port facilities via bulk or containerised haulage to Asian (India), Australian and New Zealand markets for testing and sale. An existing port shiploader will load the bulk stockpile onto a single dedicated ship for consignment.

3.10 Power Supply

A leased, containerised diesel genset and distribution board will provide power to the Project, supplying 415 V, 50 Hz. The distribution board will feed through to both individual small power users and the main process plant board. The borefield pump will be powered by a local leased diesel genset.

3.11 Fuel and Chemicals

The Project will store approximately 40,000 litres of diesel during site operations. The diesel will be stored in specialised fuel tanks with built-in bunding and spill protection measures compliant with Australian Standard 1940: 2017 The storage and handling of flammable and combustible liquids.

Chemicals used on site will include a flocculant for the ore processing, and oils for machinery and vehicle maintenance such as engine and hydraulic oils.

3.12 Water Supply and Treatment

The Project will require water for processing and potable water for the workforce. The details are provided below. The legislative process required for Centrex to extract groundwater for processing is described in Section 2.4. The potential impacts from using groundwater is covered in Section 13.0 (Groundwater).

3.12.1 Processing Water Supply

It is estimated that around 22 ML to 24 ML of water is required for Project mining and processing. Two water supply bores will be located to the north of the Project within the ML (Figure 3). The bores are within the Beetle Creek Formation which is an unconfined aquifer.

An 8.5 km long polyethylene pipeline (80 mm in diameter) will transport the water to the processing plant where it will be stored in a temporary water tank at the processing plant site before going through a Reverse Osmosis (RO) process to treat the water. The process plant make-up water will then contain a chloride level of less than 500 ppm.

3.12.2 Potable Water Supply

Drinking water for approximately 12 employees will be supplied by 20 L water bottles and water coolers brought onto site and located in offices and crib rooms. Water for toilets and external use will come from the site RO plant with a capacity of 35 m^3 per hour used to supply water to the process plant. The water will nominally be of potable quality but will not be treated to ensure it is suitable for human consumption.

It is expected that associated waste water production will be low, with toilet and kitchen waste water discharging to a modular sewerage treatment plant (bio reactor type).

3.13 Borrow Pits

Ground material required for the haul road access track upgrade, access track along the pipeline or other hardstand areas, will be sourced from borrow pits developed within the ML. The exact locations for these pits are currently not determined, however the details will be provided to DES in the Plan of Operations. When determining the location of each borrow pit, a site selection process will initially assess the potential sites with sufficient quantity of extractive material within close proximity to where the material is required. A review of these sites will then exclude any that are within MSES areas or areas of importance to the Purple-necked Rock-wallaby. Therefore, the borrow pit sites will avoid areas of high ecological value and minimise impacts.

The proposed pits will each be approximately 70 m x 70 m x 3 m depth, which includes an allocation for bunds, ramps and soil stockpiles. Subsoil and topsoil will be removed and stockpiled prior to mining. The soils will be respread at the completion of mining.

The Start-up Operation will require sand prior to processing of the ore to facilitate dewatering. Sand is proposed to be sourced from Split Creek before the commencement of mining. The Water Act requires that a permit is needed to destroy vegetation, excavate or place fill in a watercourse. As the excavation will occur under an ML with an EA, the riverine protection permit exemption requirements apply (DNRME, 2018) and a permit is not required.

Approximately 500 m^3 of screened sand is required (from an area of approximately 30 m x 15 m). The sand will be sourced from an location in Split Creek that is devoid of vegetation, therefore no clearance will be required.

3.14 Workforce

The Project will require approximately 12 people to be employed on a short-term basis for construction and operation phases. The work force will flex between 9 and 20 people for short durations dependent on the activities being undertaken.

3.15 Accommodation

Employees will be accommodated in Dajarra for the Project as on-site camp accommodation will not be constructed until Full-scale Operation.

3.16 Communications

A hired very small aperture terminal (VSAT) system suitable to manage in the order of 2/1 Mbps bandwidth from one voice over internet protocol (VOIP) phone and computer is proposed as sufficient communications equipment for the Project.

3.17 Waste Management

Management of general waste will adhere to the Queensland *Waste Reduction and Recycling Act 2011*. All general waste (e.g., cardboard, paper, plastics, timber, steel etc.) produced will be separated into general waste and recycling, and properly collected in appropriate waste disposal bins on site. These bins will be periodically transported to the Dajarra waste disposal facility.

Oils and diesel will be required for the mine machinery and general use. All used oils and associated industrial waste will be transported and disposed of at the registered waste handling facilities in Mount Isa.

The Project will not produce any regulated waste during construction or operation as defined under Schedule 2E of the *Environmental Protection Regulation 2008.* Section 15.0 provides more details on waste.

3.18 Future Full-Scale Mining Operation

As detailed in Section 3.0, the target phosphate deposit is located within two separate designated mining areas in the ML – the Northern and Southern Zones. Following an assessment of the viability of the Project in the southern portion of the ML, Centrex plans to make an investment decision, if this is favourable to expand the mining operations over the ML. Centrex's scoping study (2017) has estimated that approximately 800,000 tonnes per annum of premium 35% P_2O_5 phosphate rock concentrate product can be extracted over a 10-year period. Key assumptions outlined in the scoping study are outlined in. Table 13.

Table 13: Key Details for Full-scale Operations

Item	Approximate Range or Value
Potential Mine Life	10 years
First shipments	2019

Item	Approximate Range or Value
Full-scale (800 ktpa @ 3% moisture) production reached	2021
Life of mine (LOM) conceptual pit inventories	14.2 million tonnes
LOM in-pit phosphate grade	29% P_2O_5
LOM strip ratio	4:6:1
Selective mining recovery from conceptual pit inventories	90%
Estimated selectively mined process plant feed grade	31% P_2O_5
Annual process plant feed (dry)	1,063,013 tonnes
LOM concentrate production (dry)	7.3 million tonnes
Concentrate phosphate grade	35% P_2O_5

The Southern Zone pit will be extended (from the Project pit) to incorporate the extent of the phosphate mineralisation deposit located in this zone, and it is intended for this to be mined first. The mining operation schedule estimates mining in the Northern Zone to begin in year 5. The mining process outlined in Section 3.4 would be replicated in the Northern Zone, strip mining a total of 9 strips to a maximum depth of 50 m.

Ore mined from the Northern Zone would be trucked 7 km south on an internal haul road to the processing infrastructure (processing plant and ROM pad) located in the Southern Zone. Ore overproduction and stockpiling is scheduled for the first 6 years of the full-scale mining operation which will then be drawn down in the mine's final years.

The annual mining schedule summary from the start of Full-scale Operations by mineral resource classification is provided in Table 14.

Table 14: Annual Mining Schedule Summary by Mineral Resource Classification

Year	Classification			Ore Mined (Mt)
	Measured	Indicated	Inferred	
1		100%		1.1
2	12%	88%		1.4
3	33%	67%		1.5
4	23%	77%		1.5

Year	Classification			Ore Mined (Mt)
	Measured	Indicated	Inferred	
5	1%	98%	1%	1.2
6		100%		1.3
7		100%		0.7
8		93%	7%	0.7
9		98%	2%	0.9
10	26%	74%		0.9

3.19 Mine Closure and Rehabilitation

This section presents a conceptual mine closure and rehabilitation plan for the Project. It assumes that the Full-scale mining operation is not developed. If the Full-scale Operation Project proceeds, then the footprint area of the Project will be encompassed into the disturbance area and a separate mine closure and rehabilitation plan would be developed for this in the future.

3.19.1 Closure Planning

The mine closure process begins with planning during the design, assessment and permitting phases of the Project prior to its construction and continues throughout the life of the Project. Closure planning aims to reduce the residual liability and risk of a project. The aim of closure planning is to have a structured and systematic mine closure and completion process to:

- Achieve acceptable environmental outcomes.
- Reduce the financial burden of mine closure and rehabilitation.
- Avoid the site becoming hazardous and a source of pollution for legacy in the future.

This mine closure concept has been developed to demonstrate that the Project can be adequately closed and the plan is technically, economically and socially feasible.

3.19.2 Goals of Closure

The goal of mine closure for the Project is to prevent and minimise adverse long-term impacts from mining and to create a self-sustaining natural ecosystem or alternate land use based on an agreed set of objectives. Closure of the mine will ensure that the site is:

- Safe to humans and wildlife;
- Non-polluting;
- Stable; and
- Able to sustain a post mining land use.

These overarching goals have been considered when planning the decommissioning and closure of the mine. Both progressive rehabilitation during the mining operations and final rehabilitation will meet the closure and rehabilitation goals. There are no site-specific closure goals proposed for the Project.

3.19.3 Rehabilitation Hierarchy

The rehabilitation hierarchy (provided by the DEHP Guideline: Rehabilitation Requirements for Mining Resource Activities – EM1122 (DEHP, 2014b)) has assisted the development of the proposed post mining land uses for the site. The hierarchy sets out the most preferred post mining land use in order of decreasing capacity to prevent or minimise environmental harm. The rehabilitation hierarchy is:

- Avoid disturbance that will require rehabilitation.
- Reinstate a 'natural' ecosystem as similar as possible to the original ecosystem.
- Develop an alternative outcome with a higher economic value than the previous land use.
- Reinstate the previous land use (e.g., grazing or cropping).
- Develop a lower value land use.
- Leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.

Consideration has been given to the feasibility of achieving these top levels of the rehabilitation hierarchy when proposing the final land use for the site.

3.19.4 Regulatory Requirements

The relevant legislation for rehabilitation and decommissioning of a mine and mining infrastructure under a mining tenement is the EP Act. The EP Act defines environmental values as *'characteristics of the environment that are conducive to environmental health or public amenity or safety, as well as qualities of the environment declared to be environmental values by an environmental protection policy (EPP) or a regulation.*'

Closure planning and rehabilitation aims to protect environmental values and human health and wellbeing which include the environmental values listed in the EPP for water, air, noise and waste management. The specific environmental values identified for the Project are provided in Sections 6.0 to 17.0 are also relevant.

Section 125 (l) of the EP Act requires that an EA amendment application (this report) must provide details of how the land the subject of the application will be rehabilitated after each relevant activity ceases. Rehabilitation requirements are also outlined in the guideline '*Application requirements for activities with impacts to land*' (DEHP, 2017c).

The Environmental Management Plan (EMP) (required under the EP Act) must also contain details of rehabilitation and decommissioning. The DES is the responsible agency for administering the Act.

DES sets out the amount of Financial Assurance (FA) that must be lodged before commencing operations. During operations DES has the authority to certify that an area within the mining lease has been rehabilitated appropriately (progressive certification). The current guideline for this is the DEHP Guideline, Financial assurance under the Environmental Protection Act 1994 (2016) Version 3 (DEHP, 2016b).

Once mining is complete, the EP Act provides the provision to surrender an EA. An application to surrender the EA and a final rehabilitation report must be submitted to the DES who decides if rehabilitation has been carried out satisfactorily. The final rehabilitation report must demonstrate activities undertaken for rehabilitation and closure meet requirements of the EA.

DES also assesses any applications for the discharge of FA, either during, or at the end, of the mine life.

DEHP (now DES) developed the Rehabilitation Requirements for Mining Resource Activities (DEHP, 2014), to assist the mining industry to develop conceptual closure plans which include closure objectives and completion criteria. The guideline has been used in developing this conceptual closure plan.

The 'Strategic Framework for Mine Closure' (ANZMEC, 2000) and the Australian best practice guidelines 'Mine closure and completion' (DITR, 2006) have been used in the development of this conceptual mine closure plan.

3.19.5 Objectives

Rehabilitation objectives provide a clear description of proposed rehabilitation outcomes within the individual domains in the mine site.

These objectives are as follows:

- Site is safe for humans and animals now and in the foreseeable future.
- Provide for chemically stable and non-polluting final landforms post mining.
- Provide for geotechnically stable final landforms post mining.
- Provide self-sustaining vegetation and landscape function on land disturbed by mining.
- Provide the land owners with long-term, sustainable land use opportunities following mine closure.

3.19.6 Pre-Mining Land Use

The land systems of the regional area have been mapped by the CSIRO (1954). The land system mapping considers the topography and land forms, soils, vegetation, and climate and categorise the land suitability. The Project area is mapped as 'Pasture land – native pastures', which is in line with what the land is currently used for. The current land use is grazing and native vegetation which is mostly and rocky in places (Plate 2 and Plate 3).

An understanding of the existing environment prior to mining is important to obtain baseline characteristics of the site. This baseline can then be used for a comparison to the post mining environment and assist in developing suitable completion criteria. Further detail of the existing environment is included in Section 6.

3.19.7 Pre-Mining Environment

The groundwater, surface water, soil, geology and geochemistry properties play an important role in the mine planning and closure processes. The baseline characteristics of the area, such as the physical and chemical properties of the soil can be used to consider potential impacts of the differing soil properties on rehabilitation (e.g., saline soil, limited top soil).

The geology and geochemistry properties need to be understood to plan the mining sequence and determine if there is potential for any acid generating material over the life of the mine and post closure.

The existing soil to be disturbed by mining is mainly chromosols and kandosols, with the Project area dominated by chromosol soils. This soil is characterised by saline and high electrical salinity and elevated concentrations of chloride. The topsoil layer is either not existent or very narrow with limited humus organic matter present. Two of the three test sites have high concentrations of sulphates in the subsoils, with gypsum the likely source at these locations. These characteristics are important to understand to assess potential problems with planned rehabilitation and vegetation establishment.

The geochemistry properties of the rock to be disturbed have been assessed and there are no predicted problems such as acid mine drainage from the storage of overburden over the life of the mine or closure (Appendix B).

Baseline flora and fauna surveys recorded both feral and pest animals and flora species. There are important areas of vegetation and habitat that will not be disturbed by mining such as the Purple-necked Rock-wallaby rocky outcrop habitat located to the northwest of the Project area.

The existing environment provides baseline information for development of the mine closure plan and proposed land use. The existing interrelationships between the land, flora, fauna and water resources will be incorporated into the closure plan as far as possible. The existing environment does not highlight any major restrictions for post mining land use.

3.19.8 Proposed Post-Mining Land Use

The mine has been designed to manage overburden, topsoil, subsoil to enable rehabilitation should the Full-scale Operation not proceed. The total area that will be disturbed by the Project is approximately 16 hectares (including buffer around mining activities). The landowner intends to keep ownership of the land post mining (as pastoral lease tenure). The proposed post-mining land use will be the same as the pre-mining land use; grazing on native pastures.

3.19.9 Progressive Rehabilitation and Mine Closure

Progressive rehabilitation of areas impacted by mining activities will occur as soon as practical to a stable landform with a self-sustaining vegetation cover. As detailed in Section 3.0 the short-term mining method proposes to extract ore from a 10 m deep pit. The overburden will be stored to the west of the pit with subsoil and topsoil stored separately. As the mining campaign duration is short, progressive rehabilitation and mine closure will not occur until the after a decision is made whether Centrex will proceed with the Full-scale Operation (likely to be within six months of the completion of the Project).

Assuming the Full-scale Operation does not proceed and the Project is not within a Care and Maintenance phase the disturbed areas will be rehabilitated as follows:

- **Pit**. Stockpiled overburden will be used to backfill the pit. The backfilled pit will be covered with sub-soil and topsoil will be spread. It will potentially be direct seeded to encourage revegetation with native species of local provenance. It will result in a remnant depression over the mined areas in the order of 2-3 metres depth.
- **Tailings Storage Facility.** The TSF will be backfilled with material from the TSF bund. The lining will be left in-situ and the surface will be rehabilitated with stockpiled sub soil and topsoil.



Plate 2: Pre-mining land use – ROM pad area



Plate 3: Pre-mining land use – Processing Plant area

- **Overburden storage facility and indurated storage facility**. Overburden will be separated and stored. If the Full-scale Operation does not proceed the overburden will be placed back into the pit and stockpiled ore from the indurated storage facility will also be used to backfill the pit. The surfaces will be returned to the original topographic level and it will be spread with topsoil and direct seeded to encourage revegetation with native species.
- **ROM**. The ROM material will be used to backfill the pit.
- **Mine infrastructure areas.** The demonstration plant and infrastructure will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated, and the areas will then be revegetated with native grass species.
- **Roads**. The access tracks will remain in place post mining with agreement from the landowner.

Figure 8 shows cross-sections of the proposed final landform for the Project.

3.19.9.1 Material Management

There is no acid forming material expected within the overburden, however further testing will be undertaken during the course of mining to continually monitor. If any acid forming or potentially acid forming material is located, it will be encapsulated inside the backfilled pit to ensure material is managed appropriately and potential for surface and groundwater impacts minimised prior to closure.

Prior to mining the vegetation, topsoil and subsoil will be stripped and stockpiled close to the areas where it has been removed from or will be eventually replaced. If the Full-scale Operation does not proceed, the stockpiles will be used at a period following the initial clearance during rehabilitation activities.

Topsoil is thin to non-existent at the site (<10 cm), however where it is recoverable, it will be stockpiled separately for use in rehabilitation activities. It will be stored no higher than 2 m and will be formed in shapes that aid the capture of incident rainfall and encourage continuing biological activity within the soil.

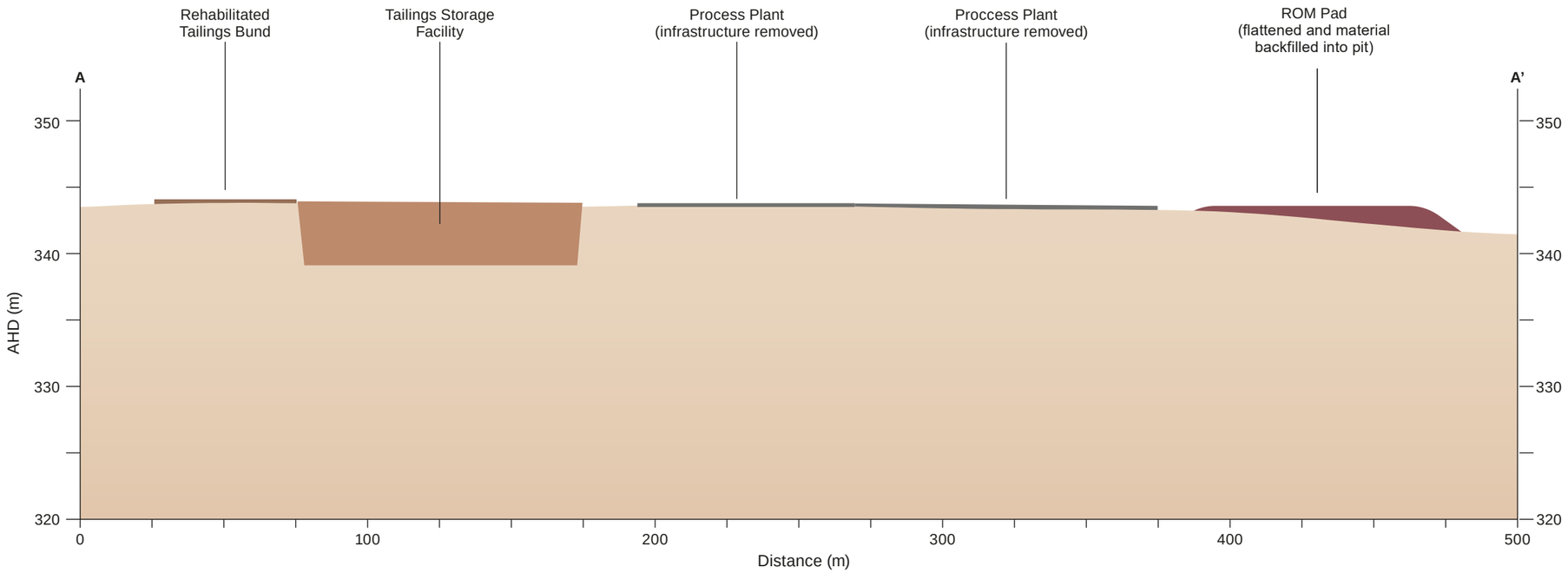
Over the life of the mine, priority will be given to topsoil and subsoil recovery to be available for use during rehabilitation.

3.19.9.2 Revegetation

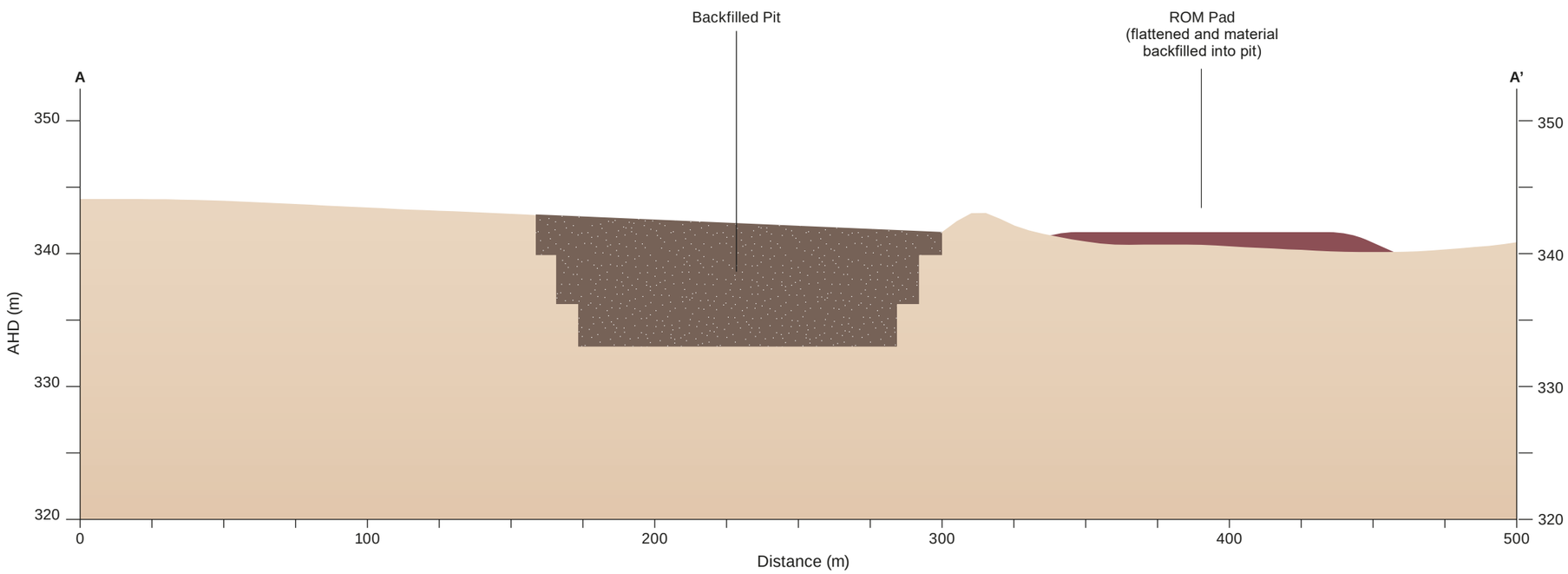
Revegetation will be undertaken by direct seeding of native species within the areas of disturbance. The key benefits of revegetation include:

- Stabilisation of the land to minimise erosion and release of sediment into water.
- Improvement of visual amenity.
- Replacement of habitat lost from vegetation clearance.
- Reduce the likelihood for establishment and proliferation of weeds.
- Develop site to a grazing post mining land use.

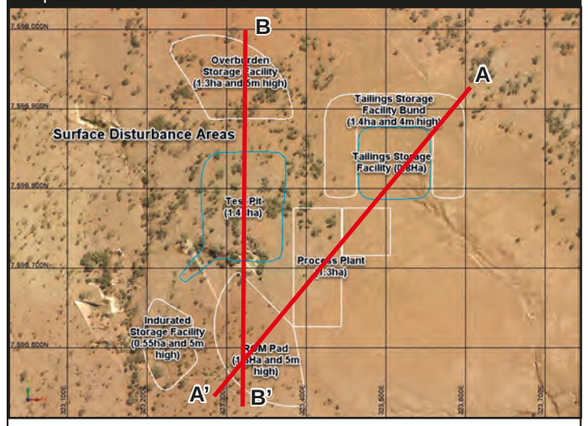
Section A-A’



Section B-B’



Proposed Mine Infrastructure



NOTES

1. Schematic only, not to be interpreted as an engineering design or construction drawing.
2. Figure not to scale.
3. Figure must be printed in colour.

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CLIENT
CENTREX

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
CROSS SECTION OF SITE AT CLOSURE

CONSULTANT
GOLDER

YYYY-MM-DD	2018-07-05
PREPARED	AA
REVIEW	RK
APPROVED	JR

PROJECT NO.	REPORT	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: A3

25 mm
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3.19.10 Completion Criteria

The completion criteria are the basis on which successful rehabilitation and mine completion is determined. It provides for a broad agreement on final land use outcomes and a basis for measuring the achievement of that outcome. The criteria are designed to be flexible enough to adapt to changing circumstances without compromising the end outcome. DES will use the completion criteria to sign off that the site has been adequately rehabilitated or closed. The proposed completion criteria for each domain are provided in Table 15 to Table 18.

3.19.11 Closure Domains

Closure domains are an easy way to dissect the site into like areas and plan for rehabilitation and closure. Proposed closure domains for the Project are:

- Pit (Table 15).
- Tailings Storage Facility and bund (Table 16).
- Overburden storage facility, indurated storage facility and ROM (Table 17).
- Mine infrastructure areas (processing plant, infrastructure and access roads) (Table 18).

Table 15: Closure Domain - Pit

Item	Description	
Description	Project pit will be approximately 100 m x 140 m x 10 m deep.	
Area of disturbance (ha)	Direct disturbance of the pit is 1.4 ha, with a buffer area distance of 10 m surrounding the pit. Disturbance for borrow pits (rock and sand) is approximately 1 ha.	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision.	
Decommissioning activities	The pit will be backfilled with overburden material and it will be approximately 2 – 3 m below ground level. It will have a slightly concave top which will retain water and assist in natural vegetation growth. The pit will be covered with a thin layer of topsoil (0.10 m), as available and subsoil if required. Soil will be ripped or scarified to aid water retention and seed capture. Borrow pits used to extract rock will be re-spread with subsoil or topsoil. The borrow pit for sand will be contoured to a similar profile to the pre-disturbance condition.	
Infrastructure to be retained	The existing access track to the pit will be retained and the access track constructed along the water supply pipeline from the pit to the groundwater supply bores	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Closure indicators**	**Completion criteria**

Item	Description	
Safe: Site is safe for humans and animals now and in the foreseeable future.	Safety assessment on backfilled pit.	Evidence that the pit has been backfilled to ensure a safe, non-polluting, stable landform.
Non-polluting: No groundwater or surface water contamination post closure (no connection to groundwater systems).	Physical properties of soil and presence of limited vegetation species, such as gidgee trees with grasses.	
Stable landform: Pit backfilled and stable, with no benches or high walls remaining.		
Sustains agreed land use: Pre-mining land use of grazing and limited native grasses re-instated.		Evidence that the backfilled material is re-instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition.
Closure material sources	Overburden dump (63,000 m^3), indurated rock material (25,000 m^3) and ROM (55,300 m^3). A thin layer of topsoil between zero (gravel / rocks at surface) and 10 cm.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure).	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The likelihood of the failure depends upon the future grazing regime and timeframe between adequate rainfall. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	
Closure control strategies to lower residual risk	A slightly concave structure on the backfilled pit will assist in retaining rainfall to aid in some vegetation growth.	

Table 16: Closure Domain - Tailings Storage Facility

Item	Description
Description	A geofabric-co-polymer lined Tailings Storage Facility 90 m x 90 m x 5 m deep.
Area of disturbance (ha)	Direct disturbance of the TSF is 0.79 ha, with a buffer area of 1.38 ha surrounding the TSF.

Item	Description	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision.	
Decommissioning activities	The TSF will be backfilled with material from the TSF bund. The lining will be left in-situ and the surface will be rehabilitated with stockpiled sub soil and topsoil. Capping on the TSF will be slightly concave to retain rainfall and aid vegetation growth.	
Infrastructure to be retained	The TSF liner will remain in-situ. The liner is UV stable, non-toxic and non-leaching.	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Closure indicators**	**Completion criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future.	Safety assessment on backfilled TSF.	Certification that the TSF is backfilled and is a safe, non-polluting, stable landform.
Non-polluting: Rainfall retained on the TSF to aid vegetation growth and surface water runoff limited. Runoff will be unlikely to affect known environmental values.	Physical properties of soil and presence of limited vegetation species, such as gidgee trees with grasses. The current vegetation is low to barren in the area of the mine site with naturally occurring rocky outcrops at surface with limited topsoil available.	
Stable landform: TSF backfilled and physically and chemically stable.		
Sustains agreed land use: Pre-mining land use of grazing and limited native grasses re-instated.		Evidence that the backfilled material is re-instated in the correct soil horizon order to ensure the soil profile available for vegetation regrowth is similar to that of the pre-mining condition. Rehabilitated areas meet the agreed end land use, and these areas can be managed without significant external inputs and ongoing management. Vegetation is minimal but resilient without additional inputs.
Closure material sources	The TSF bund (43,000 m^3) will be used to backfill the TSF.	

Item	Description
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure).	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.
Closure control strategies to lower residual risk	A slightly concave structure on the backfilled TSF will assist in retaining rainfall to aid in vegetation growth. The initial backfill is likely to be convex due to the reduction in void volume by tailings but the remaining overburden could be used in the pit to ensure a concave landform.

Table 17: Closure Domain - Overburden Storage Facility, Indurated Storage Facility and ROM

Item	Description	
Description	Overburden storage facility, indurated storage facility and ROM.	
Area of disturbance (ha)	2.95	
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision.	
Decommissioning activities	Overburden and indurated material will be used to backfill the open pit. The surfaces will be returned to the original topographic level and it will be spread with topsoil and direct seeded to encourage revegetation with native species of local provenance. The ROM pad will be built with overburden so the pad can be removed and used to fill the pit.	
Infrastructure to be retained	Nil	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Closure indicators**	**Completion criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future.	Safety assessment of domain area.	Safety assessment that demonstrates that all overburden, and ROM material has been used to backfill the pit and that the site is stable and safe.
Non-polluting: No groundwater or surface water contamination post closure (no connection to	Presence of limited vegetation species, such as gidgee trees with grasses.	Certification that vegetation for grazing purposes is similar to pre-mining reference sites.

Item	Description	
groundwater systems). Limited vegetation cover is present and land formed to minimise erosion.		Rehabilitated areas meet the agreed end land use, and these areas can be managed without significant external inputs and ongoing management.
Stable landform: Material is used to backfill the pit leaving a relatively flat post-mining landscape.	Safety assessment of domain area.	Safety assessment that demonstrates that the area is stable and safe.
Sustains agreed land use: Pre-mining land use of grazing and limited native grasses re-instated.	Physical properties of soil and presence of limited vegetation species, such as gidgee trees with grasses.	Certification that soil is re-instated in the correct soil horizon order and that the natural vegetation for grazing purposes is similar to pre-mining reference sites, which has limited ground cover. Rehabilitated areas meet the agreed end land use, and these areas can be managed without significant external inputs and ongoing management.
Closure material sources	Topsoil and subsoil stockpiled from initial pre-stripping. Vegetation originally cleared and stored with topsoil and seeds of local species.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure).	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	
Closure control strategies to lower residual risk	Ripping or scarifying of the land during rehabilitation will encourage water capture.	

Table 18: Closure Domain - Mine Infrastructure Areas

Item	Description
Description	Mine infrastructure areas (processing plant, infrastructure and access roads).
Area of disturbance (ha)	5.56
Closure date	If there is a decision to not proceed with the Full-scale Operation, the mine closure plan will commence within 6 months of the decision.

Item	Description	
Decommissioning activities	The demonstration plant and infrastructure will be removed from site. Once infrastructure has been removed, any areas of contamination will be remediated and the areas will then be revegetated with native species. The access tracks and haul roads will remain in place post mining with agreement from the landowner.	
Infrastructure to be retained	An access track will remain to enable future maintenance access to the land.	
Post mining land use	Grazing and native pastures	
Rehabilitation outcomes	**Closure indicators**	**Completion criteria**
Safe: Site is safe for humans and animals now and in the foreseeable future.	Removal of infrastructure. Physical properties of soil and presence of limited vegetation species, such as gidgee trees with limited grasses.	Evidence that the mine infrastructure has been removed and the area is safe, non-polluting and stable. Evidence that the land is spread with soil to promote vegetation regrowth for a grazing post mining land use. Rehabilitated areas meet the agreed end land use, and these areas can be managed without significant external inputs and ongoing management.
Non-polluting: After removal of infrastructure - runoff and seepage will be good quality water that is unlikely to affect known environmental values.		
Stable landform: Remove infrastructure and establish a stable landform.		
Sustains agreed land use: Pre-mining land use of grazing and limited native grasses re-instated.		
Closure material sources	Topsoil and subsoil stockpiled from initial pre-stripping. Vegetation originally cleared and stored with topsoil and seeds of local species.	
Residual risks (rehabilitation most likely to fail, likelihood of failure and consequence of failure).	Vegetation growth is unlikely to occur due to the naturally occurring lack of groundcover, indicating that the natural environment is not conducive to prolific vegetation growth. The consequence of the failure is that the land will be void of vegetation and will take a longer time before vegetation growth occurs. The land in the region is naturally bare of vegetation in places, so it should not prevent the use of the land post mining for grazing.	
Closure control strategies to lower residual risk	Ripping or scarifying of the land during rehabilitation will encourage seeds and water capture.	

3.19.12 Post Closure Monitoring

Post closure monitoring aims to demonstrate that the completion criteria has been met and that the key post closure residual risks have been effectively managed. Monitoring will also enable any unforeseen issues to be identified and further management implemented.

It has been assumed that closure monitoring will be required for a minimum period of one (1) year after decommissioning. The duration of further closure monitoring will be determined on a risk basis, with additional monitoring and rehabilitation activities being required if the monitoring results do not demonstrate that closure criteria have been achieved.

Monitoring at the site will focus on the public safety, stability of backfilled landforms and the establishment and a stable landform with limited vegetation groundcover as is present prior to mining. Achievement criteria for the safety, non-polluting and stable landform aspects is expected to be evident within one (1) year post closure.

3.19.13 Closure Costs and Financial Assurance

The closure costs and financial assurance calculations will be provided to DES separately.

4.0 STAKEHOLDER ENGAGEMENT / CONSULTATION

Centrex is committed to developing and maintaining a mutually beneficial relationship with the local community. This section identifies the relevant stakeholders, describes the objectives of the consultation process, what engagement has been undertaken to date, and the strategy for future engagement.

Consultation activities by Centrex for the Project commenced in 2017 and will be ongoing throughout the life of the Project. Centrex Metals Ltd has in place a Community and Landowner Liaison Program (CLLP) that provides a roadmap for:

- Identifying which stakeholders may be affected by the proposed activities.
- Identifying the potential benefits to the local community from the Project.
- Ensuring the relevant stakeholders are fully informed of the proposed activities and that Centrex is engaged with the community concerns and issues.

It is Centrex's commitment that all stakeholders must be provided with and encouraged to take the opportunity to communicate any concerns or interests that they may have on the Project.

4.1 Consultation Objectives

The objectives of the stakeholder consultation process are to inform key stakeholders of the proposed Project activities, to provide an overview of potential socioeconomic and environmental impacts, and to provide the community a platform by which to voice their interests and concerns. Therefore, in conformance with the CLLP, the objectives of the consultation process are to:

- Identify all relevant stakeholders and establish and maintain relationships with interested parties.
- Provide information about proposed activities in an open and transparent manner.
- Document, understand, and respond to stakeholder key issues and interests.
- Develop and implement strategies to address identified issues, interests and benefits.
- Provide opportunities for stakeholders input into the Project development.
- As a minimum, comply with the legislative mandatory requirements relating to community engagement.

It is incumbent on Centrex to respond to all concerns and depending on the stage of the activities to communicate those concerns in person, community meetings, focus groups and newsletters.

4.2 Stakeholder Identification

Centrex has prioritised stakeholders in the local area including the two directly affected neighbouring landholders, local government and local business interests in the nearest town of Dajarra. Centrex has also consulted with relevant State Government departments including the Department of Natural Resources, Mines & Energy (DNRME), the DES regarding the Project EA application, underground water rights, water supply assessments, noise and air assessments and the Department of Transport and Main Roads regarding road use and impacts.

Key stakeholders associated with the Project (both the Start-up Operation and Full-scale Operation) are listed in Table 19.

Table 19: Key Stakeholders and Issues Discussed

Stakeholder	Issues discussed
Directly and indirectly affected landholders	■ Project schedule and progress; ■ Economic and social benefits of Project; ■ Activities within and adjacent to their property; ■ Identification of concerns and interests; ■ Potential impacts and mitigation measures; and ■ Mechanisms for feedback, involvement and advocacy.
Regulatory bodies	■ Introduction to Project; ■ Provide personal contact for Project duration and ability for direct contact; ■ Project schedule and progress; ■ Identification of concerns and interests; ■ Potential impacts (beneficial and adverse) of the Project infrastructure; ■ Provide information and mechanisms for public discussion; ■ Short term and long-term impacts, economic and social benefits; and ■ Mechanisms for feedback, involvement and advocacy.
Residents and businesses at Dajarra	■ Project schedule and progress; ■ Identification of concerns and interests; ■ Potential impacts and mitigation measures; and ■ Mechanisms for feedback, involvement and advocacy.
Local government agencies and councillors	■ Project schedule and progress; ■ Social infrastructure requirements; ■ Potential impacts (beneficial and adverse) of the Project on social infrastructure; ■ Identification of concerns and interests; ■ Potential mitigation measures; and ■ Mechanisms for feedback, involvement and advocacy.
Native Title & Cultural Heritage representatives	■ Potential impacts (beneficial and adverse) of the Project; ■ Identification of concerns and interests; ■ Negotiation of agreements; ■ Opportunity to be included in Project planning / service identification / supply logistics; ■ Project benefits; and ■ Provide information and mechanisms for public discussion.
Media	■ Project schedule and progress; ■ Provide mechanism for feedback; ■ Provide an indication of public opinion; and

Stakeholder	Issues discussed
	■ The ability to fill information void and to correct misconceptions.
Resource Industry, Peak Bodies and Service Providers	■ Project schedule and progress; ■ Potential impacts (beneficial and adverse) of the Project; ■ Opportunity to be included in Project planning / service identification / supply logistics; ■ Provide information and mechanisms for public discussion.
Financial Institutions and Shareholders	■ Project schedule and progress (including Project milestones); ■ Project financing; ■ Maintenance of realistic expectations; and ■ Provide information and mechanisms for public discussion.

The key issues raised by stakeholders during the community consultation activities are discussed below in Section 4.4.

4.3 Stakeholder Engagement

Stakeholder engagement has been undertaken via a number of methods and media platforms and include the following:

4.3.1 Project Stakeholder Database

Centrex has established a Project database of affected and interested stakeholders for reference during the Project. It lists the latest stakeholder and property owner contact information, acts as a central repository for all highlighted issues during the consultation process and summarises the response to all received submissions.

4.3.2 Contact with Directly Affected Landholders

Centrex initiated contact with directly affected landholders and property managers during the initial exploratory phase of the Project. Landholders and property managers were provided with information on the Project and have been briefed on Project outcomes, timelines, and proposed activities within their respective properties. Centrex continues to maintain regular contact with landholders and property managers via letters, emails, phone conversations, and face-to-face discussions.

4.3.3 Community Information Session

A community information session was held on Tuesday 15th May 2018 at the Jimberella Hall, Dajarra, where provisions were made for interested stakeholders to attend a ‘walk-in’ consultation session. The purpose of the community information session was to generate awareness and provide a platform to discuss the Project in detail, encouraging a mechanism to engage key stakeholders and incorporate community input into the Project. The information session was advertised using flyers displayed in local businesses (Dajarra Roadhouse, Hotel, etc), local Councils and in local print media (The North West Star) on Saturday 5th May, Thursday May 10th, and Tuesday 15th May 2018, and by direct contact to advise the community of the session and to encourage attendance and participation.

The four-hour information session was attended by approximately 35-40 local representatives (the number is approximate as it was not mandatory for attendees to record their names with Centrex), with three (3) Centrex and two (2) Golder staff directly addressing the forum.

4.3.4 Meeting with Regulatory Agencies

Project representatives from Centrex and Golder met with DES on 24th May 2018 to introduce the Project and to inform the regulatory body on the expected benefits and outcomes of the Project.

DES outlined the regulatory approvals pathways under the EP Act including the associated statutory timeframes for approval and confirmed their preference to assess the Project as a major amendment to the existing EA currently held by Centrex.

Discussions were held regarding the rail siding at Duchess and it was agreed between DES and Project representatives that QR held the responsibility of assessment and approval for this aspect of the Project. The potential for other ERAs were discussed including requirements for Bulk Handling at the rail siding.

DES provided advice regarding a number of other environmental aspects to the project including the proposed infrastructure layout, the water pipeline route and the ESAs identified within the ML. DES recommended a draft application be provided to their department for review prior to a formal application submission.

Meetings have also been held with DTMR at Cloncurry including on 19th June 2018 to discuss the Project and the broader Full-scale Operations with respect to road impacts.

4.3.5 Information Sheets and Media

A newsletter describing the Project and introducing Centrex Metals Ltd was distributed to the identified key stakeholders. The newsletter highlighted recent Project milestones, the current work program and future activities. An information sheet containing the above information along with a summary of the approvals process and a map of the proposed Full-scale Operations footprint was also distributed. The information sheet outlined Centrex's commitment to ongoing community involvement and engaging stakeholders throughout the term of the Project. The information sheet was made available at the community information session to each person in attendance.

Both the newsletter and information sheet provided a link to the Centrex website which will be maintained with periodic public updates on Project milestones and current activities. The website also provides the means for interested parties to contact Centrex directly with concerns or enquiries. The Centrex website further provides a multi-media overview of the Project and includes a description of the Project benefits. A summary of the Project ASX Announcement Scoping Study is also available for download by interested parties.

4.4 Outcomes of Community Engagement

Feedback obtained from key stakeholders and members of the community during the consultation session in Dajarra outlined three core themes:

- Employment and other potential benefits to the community
- Road traffic (dust and noise)
- Water availability and quality.

The main topic of interest raised by residents was the potential for employment and business opportunities for their community, with an emphasis on preferential hiring from within the local workforce and potential future opportunities for the town's youth at the forefront of the discussion.

Representatives from the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) indicated a willingness to collaborate with Centrex and the community for the Full-scale Operation mine, aiding with indigenous gateway training and upskilling with the provision of employment pathway and operational plans from Centrex outlining their employment needs (e.g. details around skilled, semi-skilled and entry level roles).

The increase in road traffic between the mine and Duchess was discussed and it was acknowledged there would be a requirement for associated road maintenance as a result of the accelerated rate of road degradation due to traffic increase at the Full-scale Operations stage. Increased dust, noise and road safety were also concerns raised.

It was recognised the Project would have water requirements associated with the road upgrades and dust suppression, in addition to mine operation requirements, and concerns were raised around the availability and quality of water, an already scarce resource in the region of which the quality is considered very poor.

Other feedback from the community identified increased pressures on community emergency services (police and health clinic) and the value in coordinating with each respective service on incident response planning, and a desire for community support programs and initiatives (e.g., community bus upgrades/maintenance, improved water quality at primary school, etc.). The community also expressed a desire for continued consultation throughout Project progression.

4.5 Future Activities

There is a statutory public notification obligation under the EP Act 1994 (see Section 2.1) still to be completed. Centrex will advertise in local printed newspapers and invite interested parties to provide submissions on the Project for a period of 20 business days. Each submission will be recorded and a response provided to each individual submission. In the event that the Project phase is approved then Centrex will provide additional updates in printed media, newsletters and on their website as to the Project status.

Following successful completion of the Project, Centrex intends to undergo further stakeholder consultation and advertisement (via website, printed media, and information sheets) prior to full scale operations.

5.0 ENVIRONMENTAL IMPACT ASSESSMENT METHOD

The following sections present the environmental and social aspects and potential impacts of the Project. Section 226 of the EP Act requires that the application includes an assessment of the likely impact of each relevant activity on the environmental values, including:

- A description of the environmental values likely to be affected by each relevant activity.
- Details of any emissions or releases likely to be generated by each relevant activity.
- A description of the risk and likely magnitude of impacts on the environmental values.
- Details of the management practices proposed to be implemented to prevent or minimise adverse impacts.
- Details of how the land the subject of the application will be rehabilitated after each relevant activity ceases.

The EP Act also requires that the application includes a description of the proposed measures for minimising and managing waste generated by each relevant activity and details of any site management plan that relates to the land the subject of the application. To meet the requirements of the EP Act, the following information is provided for each aspect:

- **Relevant legislative context for the aspect.** A description of the legislation, regulations, policy and guidelines for the environmental values and management of impacts.
- **Description of the existing baseline environmental values.** This is based on desktop assessments, baseline surveys and monitoring. Where applicable, a description of the sensitivity of baseline environment is also provided. Section 5.2 provides more information.
- **Description of the potential, credible environmental and social impacts,** both positive and negative, that may be a result of the Project. Identification of the potential impacts has been undertaken by technical specialists of the discipline and is based on knowledge of the existing environment, and experience with similar operations elsewhere. This description of impacts takes into account the proposed Project design (Section 3.0) and considers the measures built into how the Project will be constructed and operated using good practise mining techniques (e.g., TSF constructed with a geo-fabric polymer liner, locating the overburden stockpiles to avoid drainage lines, etc).
- **Avoidance, mitigation and/or management measures**. These reflect Centrex's commitment to good practice mining and environmental management and aim to further reduce identified potential impacts from the Project on environmental values. The proposed measures are technically and economically feasible within the context of the Project's setting.
- **Residual impact assessment** associated with the various potential impacts, assuming the effective implementation of the proposed mitigation and management measures.
- **Environmental protection objectives**. Describe the commitment to protect the identified environmental values from potential impacts. More information is provided in this Section 5.6.

5.1 Impact Assessment Methodology

Section 226 of the EP Act specifies the requirements for environmental authority amendment applications, which includes a requirement for an impact assessment.

The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as *'the process of identifying the future consequences of current or proposed actions'* and further states that the impact assessment is a tool that provides for environmental quality and social equity (IAIA 2015). The environmental impact assessment should therefore predict the nature, spatial extent, duration, intensity or severity, and the effects on the environment, whether such effects are positive (beneficial) or negative (detrimental).

The Department of Environment, Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (DOE, 2013) provides guidelines on what determines a 'significant impact' on matters of National environmental significance. Although the Project does not trigger an EPBC Act referral, the guidelines are useful to assist in describing and assessing significance. DOE, (2013) state the following regarding the significance of impacts:

> *'A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts'.*

The impact assessments have followed guidance on the items to be addressed and the potential impacts to be considered for the Project as described in the Technical Guidelines for each discipline published by the Qld Department of Environment and Science (listed in Section 2.2.1).

Sections 6.0 to 17.0 summarises the findings of technical studies (provided within Appendices A to G) and provides the identified potential impacts from mining to environmental values. These steps are deliberately kept transparent so that the impact assessment process can be readily understood by stakeholders.

5.2 Environmental Values

Integral to the impact assessment is an understanding of the environmental values potentially affected by the proposed Project. Environmental values encompass the qualities, characteristics and conditions of the physical, biological, social, cultural and economic environments.

The environmental values for each environmental aspect were determined by stakeholder engagement or recognised legislation or other standards, or by the technical specialists, having regard to the definition provided in Section 9 of the *EP Act 1994* (Qld), which states that an environmental value is:

> *(a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or*
>
> *(b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.*

5.2.1 Describing the Sensitivity of Values

Where relevant the sensitivity of values has been described. The sensitivity of a value is based on their worth or importance to people and their resilience of the receptor to change. The elements used to describe the sensitivity or quality of the value include (where relevant) intrinsic worth (e.g., conservation status or values prescribed in legislation, policy or guidelines), intactness (a measure of the existing condition or representativeness), uniqueness or rarity (the occurrence, abundance or distribution), adaptability and recovery potential (the extent a value can recover from change and return to its original state), and replacement potential.

The sensitivity of an environmental value is therefore an assessment of the degree to which the attributes of the value allow it to adapt or recover from change without adversely affecting its intrinsic worth, intactness, uniqueness or rarity. Table 20 provides example definitions for sensitivity ratings.

Table 20: Example Definitions for Sensitivity of Environmental Values and Ranking

Sensitivity	Description
Negligible	■ The environmental value is highly disturbed and the natural recovery of the impacted area to a pre-project condition is expected within >1 year.
Not sensitive	■ The environmental value is not sensitive to change or disturbance and is able to fully recover. ■ Where natural recovery of the impacted area to the baseline or pre-project condition is expected in the short-term (1-2 years), or where the potentially impacted area is already disturbed by non-project related activities occurring on a scale similar to or larger than the proposed activity. ■ A landscape, ecosystem or focal habitat, of local importance. A common species of local cultural importance. Ecosystem service is readily substitutable or replaceable. ■ The landscape feature supports moderately well-developed fertile soils, with moderate organic matter content. It is stable with very low erodibility and the soils are robust. ■ Groundwater systems with high recharge rates and short recovery periods. It provides an unreliable water supply (flow and/or water quality are very poor). ■ There are numerous local water features (surface water or groundwater) that could provide alternative water sources.
Moderately sensitive	■ The environmental value is able to recover from or adjust to some change or disturbance.

Sensitivity	Description
	■ Where natural recovery to the baseline condition is expected in the medium term (2-5 years), and where marginal disturbance or modification of the receiving environment by existing activities is present. ■ A landscape, ecosystem or focal habitat, of regional importance, but not national importance. Ecosystem service is substitutable or replaceable. ■ The landscape feature supports developed soils, with some organic matter. It is relatively stable with low erodibility and the soils are relatively robust. ■ Groundwater systems with moderate recharge rates and medium-term recovery periods. It provides reliable water supply some of the time and reduced supply at other times (flow and/or water quality are fair). There are limited local water features (surface water or groundwater) that could provide alternative water sources.
Very sensitive	■ The environmental value is unable to recover from or adjust to change or disturbance. ■ Where natural recovery of the receiving environment is expected in the long-term (>5 years) or cannot be readily predicted due to uncertainty over the nature of the potential impact, and where unique or highly valued ecological, social or cultural resources could be adversely affected. ■ A landscape, ecosystem or focal habitat, of at least national and possibly international importance. Ecosystem service is not substitutable and/or irreplaceable. ■ The landscape feature supports nutrient poor soils, with no organic matter. It is unstable and very erodible, and the soils are very friable and thin. ■ The water feature provides reliable water supply all the time (flow and/or water quality are very good). There are no local water features (surface water or groundwater) that could provide alternative water sources. ■ The water feature has very low or no capacity to adjust to changes or disturbance. ■ Groundwater systems with low recharge rates and longer recovery periods.

5.3 Intensity of Potential Impacts

Intensity or magnitude of impacts have been described with consideration of the geographic extent of the potential impact, duration of the effect of impact and reversibility of the impact. These descriptions are based on guidance in the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (DoE, 2013). More information on the descriptors of intensity of impact are provided below and the related ranking in Table 21.

5.3.1 Geographic Extent of Potential Impact

Geographic extent describes the quantitative measurement of the area within which an effect occurs. Effects are described in terms of whether they are limited to the local, regional or a larger area beyond the regional extent.

5.3.2 Duration of Effect

Duration refers to how long an effect lasts. Duration is described in relation to the phases of the development of the Project within the area, although effects may last longer than the phases of the Project for some valued components. The following framework was used: construction, operations, decommissioning, and far-future.

For the purposes of this impact assessment, the far-future is a duration criterion that is meant to capture effects lasting several generations after decommissioning and rehabilitation. This relates to effects that the Project may have on the area's environmental and social sustainability (or not), including cumulative impacts. The following terminology is considered when determining the duration of an effect:

- Short-term – effect is limited to the construction period (~2 years), or the period of decommissioning activities (~2 years).
- Medium-term – effect extends throughout the Project operations, that is, 25 years.
- Long-term – effect extends beyond the 25 years of operation.
- Far future – effect extends more than 30 years after closure.

5.3.3 Reversibility

This criterion describes whether the effect is reversible or not. This can be associated with duration, as many effects eventually could be considered to be reversible (that is, in geological time). However, the extinction of a species can be considered as irreversible.

Table 21: Intensity Ranking

Intensity	Description
Negligible	■ Where the impact affects the environment in such a way that natural, and /or cultural and social functions and processes are negligibly affected and valued, important, sensitive or vulnerable systems or communities are negligibly affected.
Low	■ The impact is local, temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.

Intensity	Description
	■ Where the impact affects the environment in such a way that natural, and/or cultural and social functions and processes are minimally affected and valued, important, sensitive or vulnerable systems or communities are minimally affected. No obvious changes prevail on the natural, and / or cultural/ social functions/ process as a result of project implementation.
Moderate	■ Where the affected environment is altered but natural, and/or cultural and social functions and processes continue albeit in a modified way, and valued, important, sensitive or vulnerable systems or communities are moderately affected. Near the limits of the ability of the environmental value to adapt. ■ The impact extends beyond the area of disturbance to the surrounding area. ■ The impacts are short term and result in changes that can be ameliorated with specific environmental management controls.
High	■ Where natural and/or cultural or social functions and processes are altered to the extent that they will temporarily or permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. The changes to the natural and/or cultural / social- economic processes and functions are drastic, widespread, long lasting, and commonly irreversible.

5.4 Overall Impact Severity

Sensitivity is combined with the intensity classification to obtain an overall impact severity using the 4 x 4 matrix presented in Table 22. Descriptors of the overall impact severity levels are presented in Table 23.

Table 22: Overall Impact Severity Matrix

		Sensitivity of value			
Intensity of potential impact		**Negligible**	**Not sensitive**	**Moderately sensitive**	**Very sensitive**
	Negligible	Negligible	Minor	Minor	Minor
	Low	Minor	Minor	Moderate	Moderate
	Moderate	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Major	Major

The overall impact severity is derived for each identified potential impact event. For example, a high impact intensity scored against a high-ranked sensitivity for a valued component would result in a major overall impact severity.

A major overall impact severity level would necessitate one or more of: a complete design change; additional mitigation; or additional understanding of baseline conditions that may lower the expected environmental value sensitivity.

Table 23: Descriptors of Overall Impact Severity

Ranking	Description
Negligible	■ No predicted adverse impacts to environmental values from the Project. Typically occurs where the activities occur in highly disturbed areas.
Minor	■ Impact level is acceptable to viability or integrity of valued components. Mitigation is adequate and achievable.
Moderate	■ Impact level requires follow up action, including the possibility of offsetting. ■ Monitoring necessary to evaluate continued viability or integrity of valued components and provide opportunities for adaptive management. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Major	■ Arises when an impact will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. ■ Depending on valued component, impact level requires careful, specific, higher-level mitigation design (e.g., offsetting). Resilience of valued components stressed to the extent that recovery may not be considered possible. Exceedance of legal standards and widely-accepted conservation good practice. Implies proximity to, and uncertain risk of exceedance of, project design thresholds.

5.5 Avoidance, Mitigation and Management Measures

Avoidance, mitigation and management measures will be identified to reduce the intensity of potential impacts. Avoidance measures aim to avoid potential for impact, mitigation measures and management measures may include engineering outcomes or procedural measures.

5.6 Environmental Objectives and Performance Outcomes

The overarching EP Act defines how the objective of the Act (to protect Queensland's environment while allowing for development) will be achieved. The Project is required to comply with the regulatory requirements for an environmental management decision under the EP Act relating to a resource activity.

In making an environmental management decision, an environmental objective assessment against the environmental objective and performance outcomes in Schedule 5, Part 3, Table 1 and 2 of the *Environmental Protection Regulation 2008* will be carried out. The following sections will outline how the Project meets the environmental objectives and performance outcomes for each environmental value.

5.7 Environmental Management Plan

The Environmental Management Plan (EMP) has been prepared to support the EA amendment application and provides the proposed mitigation and management measures that are applicable to the protection of environmental values during construction, operation and decommissioning of the Project. The EMP is provided in Appendix H of this supporting report.

6.0 GENERAL DESCRIPTION OF ENVIRONMENT

This section describes the topography, climate and weather of the Project area which provides context to the impact assessment.

The Project lies within range country on the eastern margin of the Barkly Tableland. Relief throughout the area is low, though rugged with nearby hills being up to 50 m above the valley bases. The surface overlying both the north and south deposits is relatively flat with the highest point of 350 m Australian Height Datum (AHD) being in the southern area and the lowest 310 mAHD in the north (Figure 9).

The region is best described as sparsely vegetated with low, very open woodland on gravelly plains and slightly undulating areas primarily around rock outcrops. Denser vegetation occurs along ephemeral watercourses however all areas have been significantly impacted by cattle grazing and pest plant species invasion is evident, particularly throughout all riparian areas.

6.1 Sensitive Receptors

A sensitive receptor is a person, area or structure or environmental value that may be harmed at an exposure point such as a site visitor; dwelling or area used by people; a protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the NC Act.

The Project area is sparsely populated, with the closest permanent resident from the mine site being the Ardmore homestead, located approximately 15 km west of the proposed Project site.

The next closest permanent sensitive receptors are the residents living in the town of Dajarra located 23 km east and motorists of the Boulia-Mount Isa Highway. The township of Duchess is located 88 km from the site. There are also two homesteads (Ashover Station and Stanbroke Homestead) adjacent to the road between Dajarra and Duchess located along the haul road route (Figure 10).

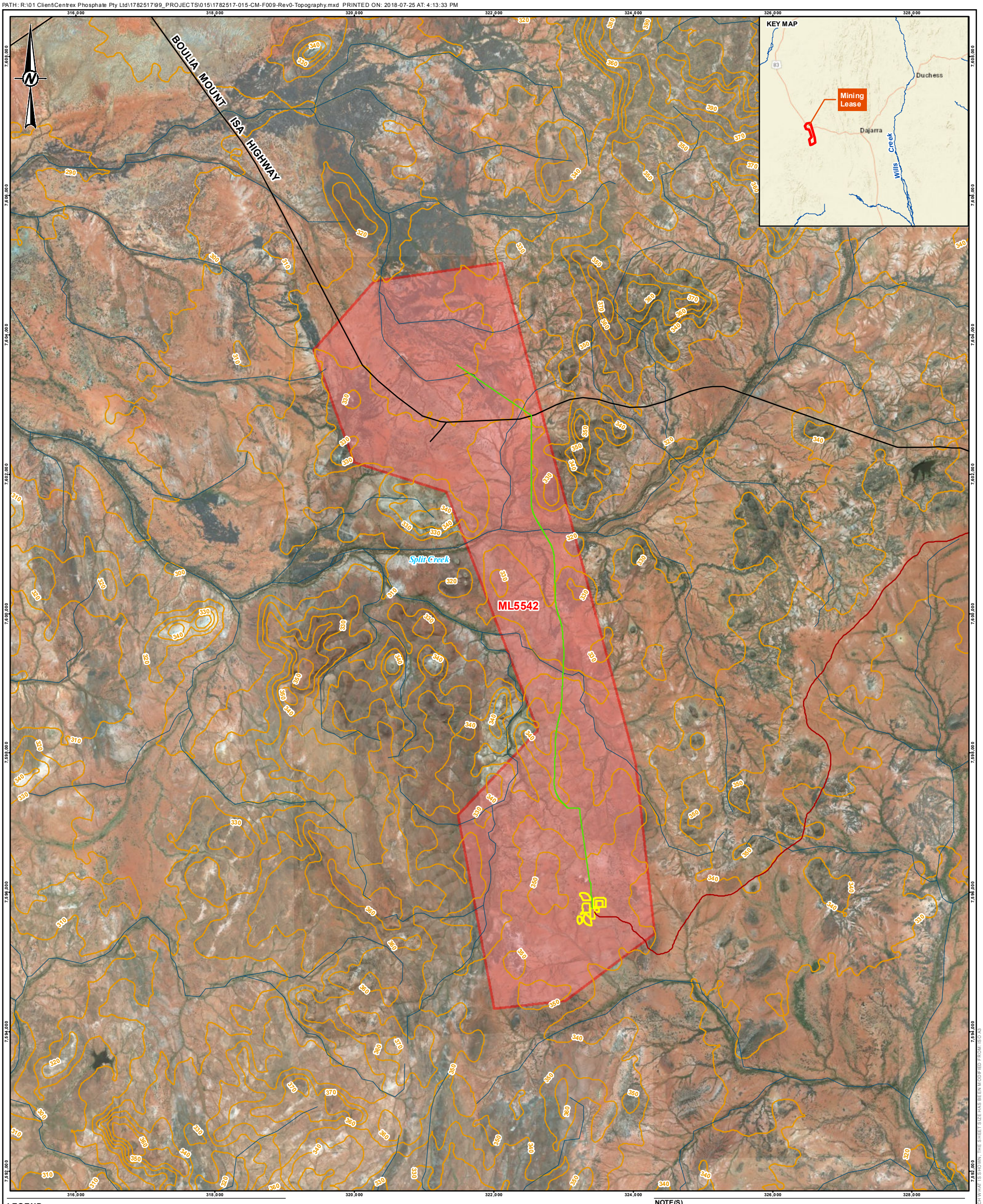
There are no areas identified as critical habitat under a conservation plan or areas of major interest under the NC Act within the vicinity of the site.

6.2 Temperature and Rainfall

The Bureau of Meteorology (BOM) weather station at the Monument Airport (ID: 037034) is located approximately 75 km east from the site and is the closest BOM station to obtain meteorological data. The Monument Airport station is considered a suitable representation of the local meteorology at the site for the purposes of this assessment.

The temperature data from the BOM Monument Airport Station (ID: 037034) over a four-year period (2012 – 2015) indicates that the warmest average monthly temperatures were from November to February, all above 30°C. January was consistently warmest month over the four-year data period, averaging 31.8°C. The winter months of June, July and August had the lowest temperatures during 2012 to 2015, averaging 16.5°C, 15.9°C and 18.0°C respectively (Figure 11).

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LEGEND

- 10m Contours
- Major Watercourse
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 500 1,000 1,500 2,000
1:50,000 at A3 METRES

CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

NOTE(S)
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REFERENCE(S)
Roads, Major Watercourses: © State of Queensland (Department of Natural Resources and Mines) 2017
Contours: © State of Queensland (Department of Natural Resources and Mines) 2012
Mining Lease: © State of Queensland (DNRM) 2018
All other data: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
TOPOGRAPHY

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25mm
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PATH: R:\01 Client\Centrex Phosphate Pty Ltd\1782517\99_PROJECTS\015\1782517-015-CM-F010-Rev0-Sensitive-Receptors-and-Viewpoints.mxd PRINTED ON: 2018-07-25 AT: 4:15:26 PM

KEY MAP

Gulf of Carpentaria

Northern Territory

Queensland

Study Area

CLONCURRY DUCHESS ROAD

DUKE STREET

Duchess Township

CLONCURRY/DUCHESS ROAD

0 0.2 0.4 0.6 0.8 1

1:27,500 at A3 Km

Ashover Station

DUCHESS DAJARRA ROAD

(DIAMANTINA DEVELOPMENT ROAD - NORTH)

BOULIA MOUNT ISA HIGHWAY

Viewpoint 1 - Urandandie South Road to Ardmore Homestead

Viewpoint 3 - Split Creek

Ardmore Homestead

Viewpoint 2 - Boulia-Mount Isa Highway in the north of ML

ML5542

Dajarra Township

DUCHESS DAJARRA ROAD (CLONCURRY DAJARRA ROAD)

Stanbroke Homestead

(DIAMANTINA DEVELOPMENT ROAD - SOUTH)

BOULIA MOUNT ISA HIGHWAY

URANDANGI ROAD

Ardmore Homestead

0 0.2 0.4 0.6 0.8 1

1:27,500 at A3 Km

Dajarra Township

DAJARRA ROAD

DUCHESS (CLONCURRY DAJARRA ROAD)

BOULIA MOUNT ISA HIGHWAY (DIAMANTINA DEVELOPMENT ROAD - SOUTH)

0 0.2 0.4 0.6 0.8 1

1:27,500 at A3 Km

Stanbroke Homestead

0 0.2 0.4 0.6 0.8 1

1:27,500 at A3 Km

310,000 320,000 330,000 340,000 350,000 360,000 370,000 380,000

7,630,000 7,620,000 7,610,000 7,600,000 7,590,000 7,580,000 7,570,000 7,560,000

LEGEND

- Sensitive Receptors
- Visual Assessment Viewpoints
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 2 4 6 8 10

1:300,000 at A3 Km

CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

NOTE(S)

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REFERENCE(S)

Sensitive Receptors: © State of Queensland (Department of Natural Resources, Mines and Energy) 2018
Roads: © State of Queensland (DNRM) 2017.
Mining Lease: © State of Queensland (DNRM) 2018 .
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
SENSITIVE RECEPTORS AND VIEWPOINTS

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	10

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25mm

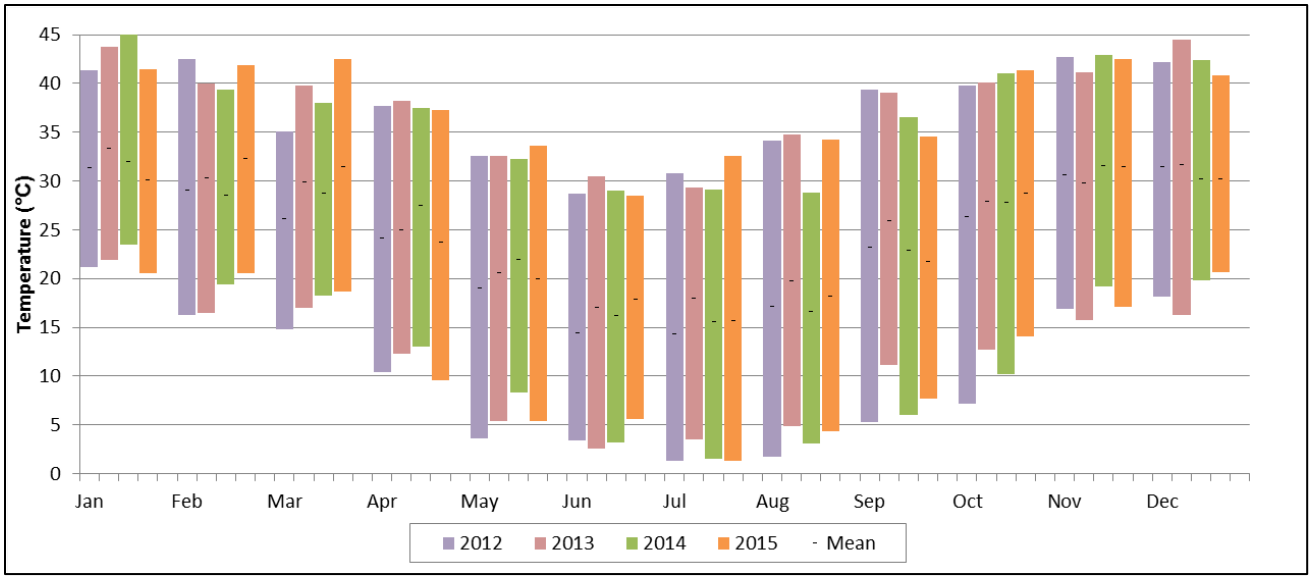


Figure 11: Temperature Statistics - BOM Monument Airport Station (2012 – 2015)

The hourly rainfall data obtained from the BOM Monument Airport Station (ID: 037034) over a four-year period (2012 – 2015) indicates that the heaviest rainfalls have occurred between November and March of each year with an average of over 30 mm in every month. December averaged the highest monthly rainfall of 84 mm over the four-year period (Figure 12). The average annual rainfall is 464 mm, predominantly in summer.

June through to October had consistently low rainfall across the four years of data, with each of these months recording zero rainfall at least once between 2012 and 2015. The lowest average rainfall month was August with 0.8 mm.

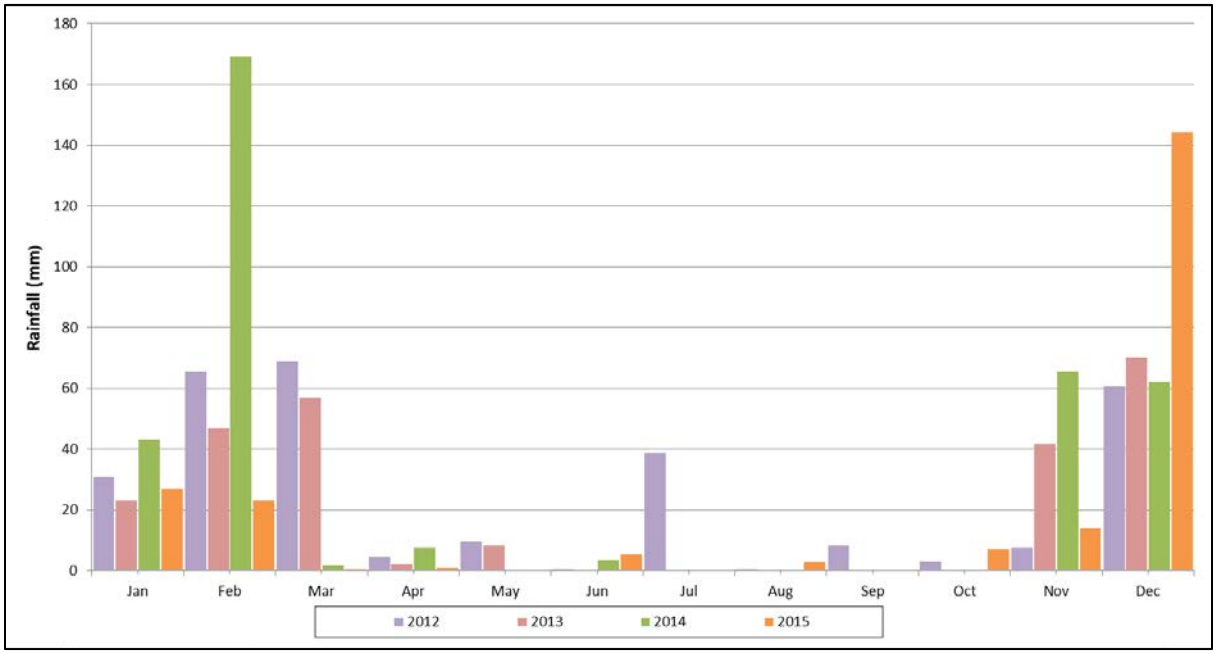


Figure 12: Rainfall Statistics - BOM Monument Airport Station (2012 – 2015)

6.3 Wind

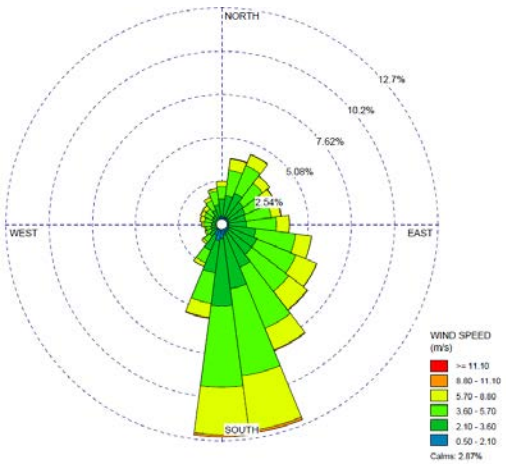
Wind data was also obtained from the BOM Monument Airport Station (ID: 037034). The seasonal wind patterns are displayed as wind rose plots for each season over a combined four-year period (2012 – 2015). Each wind rose details the wind speed and direction that occurred in that particular period (Figure 13).

A summary of the meteorological data measured is presented below:

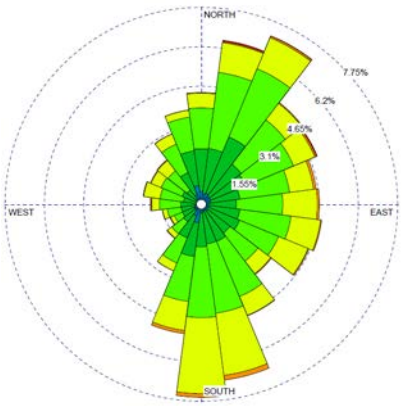
- The prevailing wind direction for Autumn, Winter and Spring is south to south easterly.
- The prevailing wind directions for Summer are north east and southerly.
- The average wind speed is varies marginally across the seasons from a low of 3.7 m/s in winter to a high of 4.3 m/s in summer.
- Strong winds (above 8.8 m/s) are infrequent and more likely to occur in Summer.
- Calm winds occur at a low frequency of 1.5% in Summer and peak in Winter at 4.1%.

The wind rose plots indicate that the prevailing wind condition is blowing from a south, south-easterly direction, towards the nearest sensitive receptor (Ardmore homestead) See Figure 13.

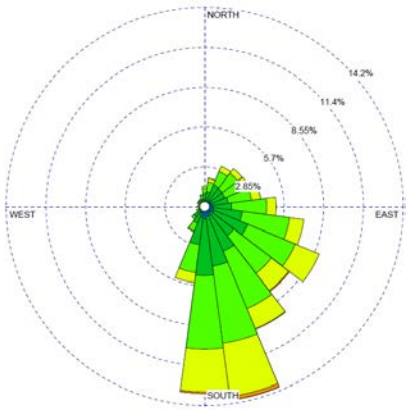
Annual



Summer (December – February)



Autumn (March – May)



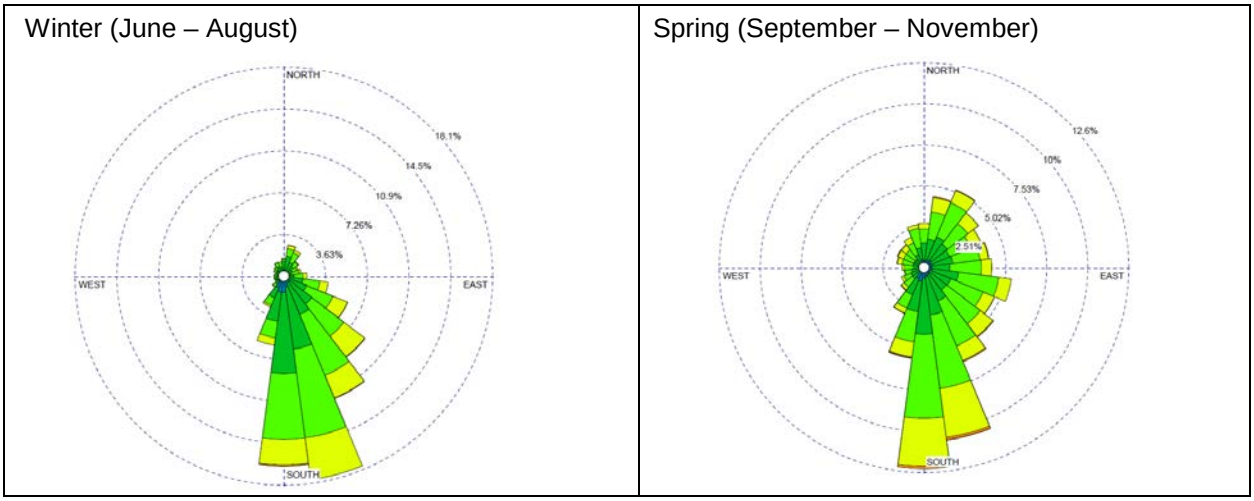


Figure 13: Wind Rose Plots - BOM Monument Airport Station (2012 – 2015)

6.4 Floods

For each Annual Exceedance Probability (AEP) a range of durations and an ensemble of 10 rainfall temporal patterns per duration was modelled to assess the critical duration and corresponding peak flow (see Appendix E - Surface Water Technical Report). AEPs from 1:5 or rarer were modelled (1:5, 1:10, 1:20, 1:50, 1:100 AEP). Figure 14 includes the potential flooding extent of waterways within and adjacent to the ML catchment, using a 1:100 year AEP. The area of the Start-up Operation is not within an area likely to flood.

ARR (2016) provides guidance about peak flow estimation. Flow representative of the median is determined for each storm duration ensemble. The storm duration associated with the highest median flow is considered the peak flow from the catchment.

The catchment area and calculated peak flow from each catchment is presented below in Table 24. Figure 20 in Section 12.1 visually depicts the catchment areas (A to F) of the site.

Table 24: Peak Flow Results - Baseline Catchments

Catchment	Area (ha)	Catchment Slope (m/m)	AEP (1:x)				
			5	10	20	50	100
A	7 810	0.005	29	58	93	148	194
B	860	0.014	20	20	27	35	43
C	700	0.008	13	13	19	25	31
D	730	0.006	12	12	17	24	30
E	180	0.011	5	5	6	8	30
F	460	0.014	12	12	16	20	24

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316,000 318,000 320,000 322,000 324,000 326,000 328,000

7,608,000 7,606,000 7,604,000 7,602,000 7,600,000 7,598,000 7,596,000 7,594,000 7,592,000

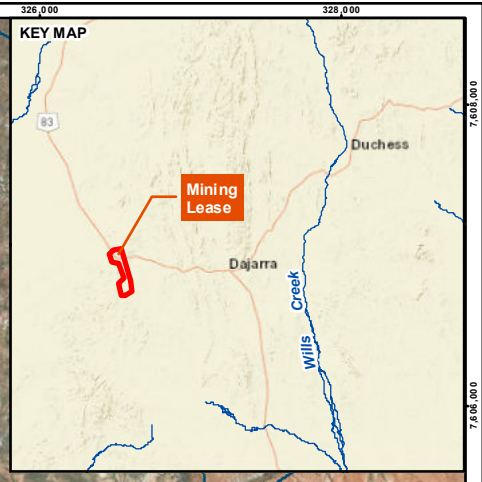
BOULIA MOUNT ISA HIGHWAY

Split Creek

ML5542

Sellheim Creek

KEY MAP



LEGEND

Flood Depth (m)

- High : 2.8
- Low : 0

- Watercourses
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation
- Model Extent
- Dams

Centrex Mining Lease

- ML5542

0 500 1,000 1,500 2,000

1:50,000 at A3 METRES

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

NOTE(S)

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.

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CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
SURFACE WATER FLOODING EXTENT (1:100 YEAR)

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	14

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7.0 AIR

This section describes the existing air quality conditions and potential impacts to air quality from the proposed mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

In Queensland, environmental impacts associated with air emissions are regulated under the EP Act, EP Regulation and the Environmental Protection (Air) Policy 2008 (EPP Air). The EPP Air identifies the environmental values for the air environment and outlines the air quality objectives for different types of sensitive receptors.

This assessment has been conducted in accordance with the requirements of the DEHP Guideline, *Application requirements for activities with impact to air* (DEHP, 2017a). A supporting specialist report prepared by Golder is provided in Appendix C - Air and Noise Technical Report.

7.1 Baseline Environment

Existing air quality is characteristic of a remote rural area, with no significant anthropogenic sources of air quality emissions at the site. Due to the semi-arid climate, wind-blown dust is expected to be generated from exposed surfaces typical of the local area. Bushfires could also alter the air quality in the region.

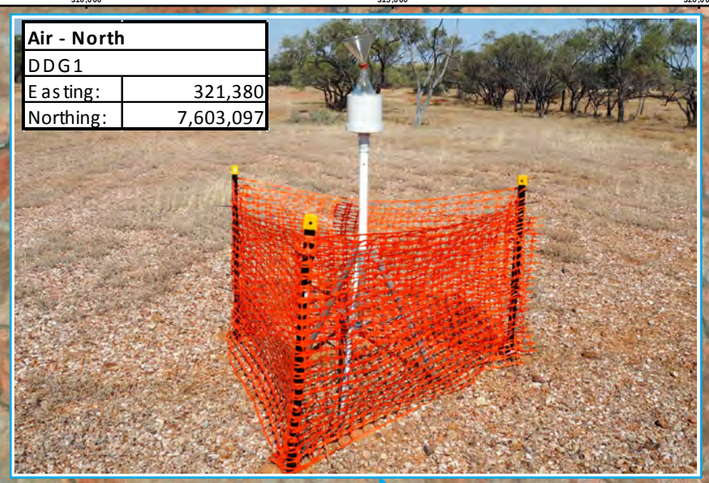
The sensitive receptors that may be affected by dust emissions from the Project are the residents along the haul road from the mine site to Duchess, including the Dajarra residents, motorists of the Boulia-Mount Isa Highway and residents of Ashover Station and Stanbroke Homestead (see Figure 10 and Section 6.1).

7.1.1 Baseline Deposited Dust

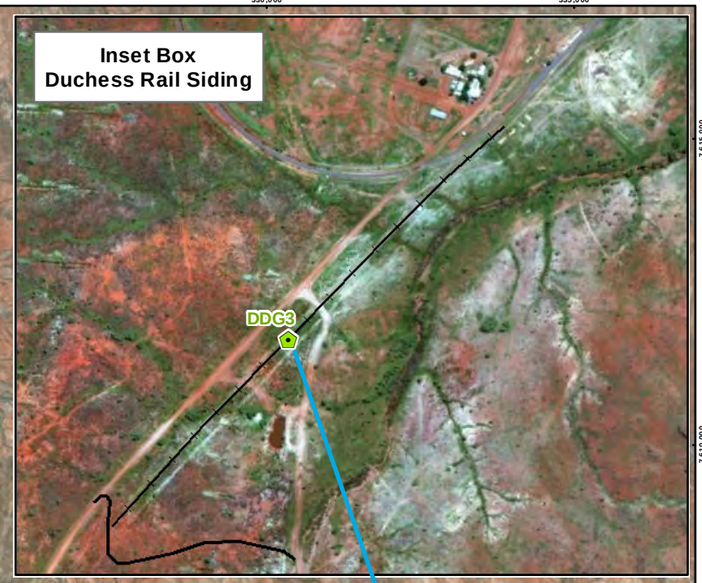
Baseline deposited dust monitoring was conducted by Golder from September 2017 – March 2018 at three locations to characterise existing baseline conditions at the site.

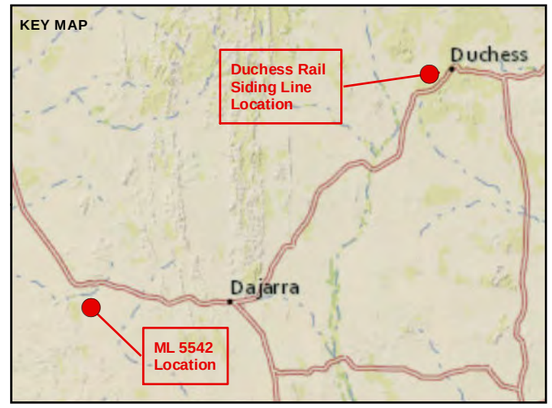
Monitoring locations are presented in Figure 15 and were selected to represent the northern and southern areas of the Mining Lease. Monitoring was also conducted near the township of Duchess at the rail siding line. Monitoring sites were selected in accordance with the requirements of Australian/New Zealand Standard AS/NZS 3580.1.1:2007 "Methods for Sampling and Analysis of Ambient Air. Part 1.1: Guide to Siting Air Monitoring Equipment". Sampling and analysis was conducted in accordance with Australian/New Zealand Standard AS/NZS 3580.10.1 "Determination of Particulate Matter - Deposited Matter - Gravimetric Method". Analysis was conducted by ALS Environmental (NATA Accreditation No. 825).

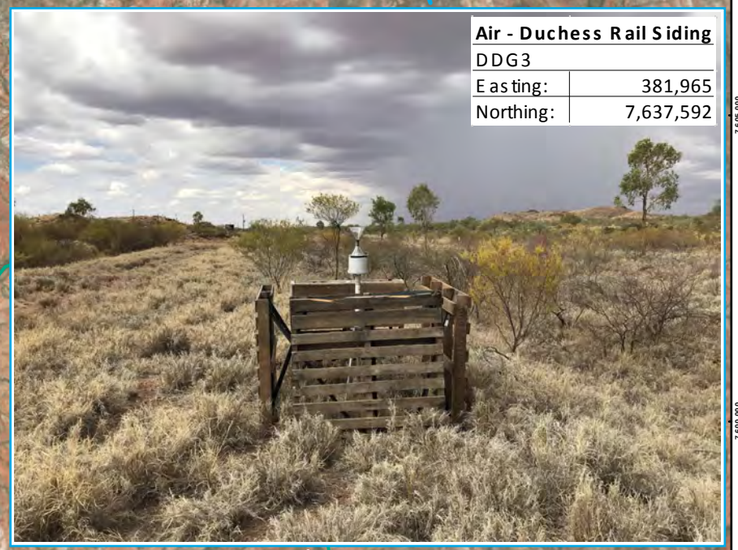
The results of the dust monitoring are presented in Table 25. Average dust concentrations were similar at each location and were measured between 20 – 30 mg/m^2/day.



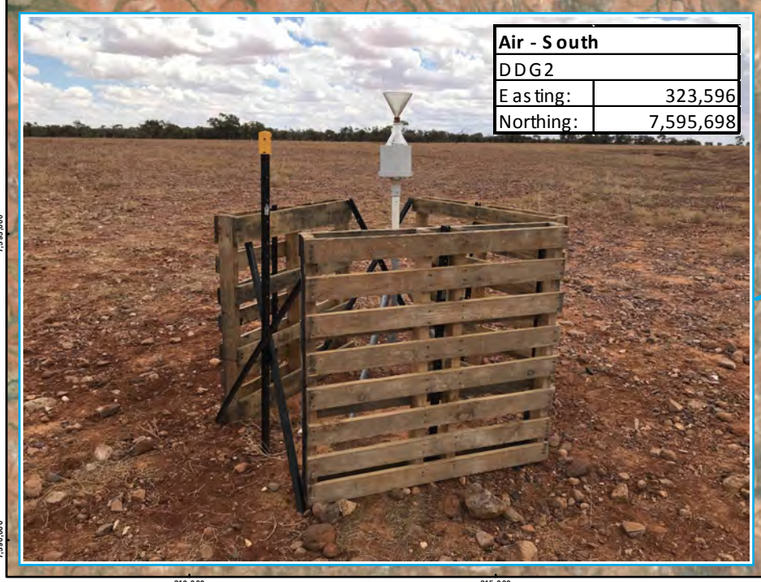
Air - North	
DDG1	
Easting:	321,380
Northing:	7,603,097







Air - Duchess Rail Siding	
DDG3	
Easting:	381,965
Northing:	7,637,592



Air - South	
DDG2	
Easting:	323,596
Northing:	7,595,698

LEGEND

- Air Monitoring Locations
- Duchess Rail Siding Air Monitoring Location
- Homestead Noise Monitoring Location
- Watercourse

Duchess Rail Siding Line

- Proposed Rail Diversion Track
- Duchess Road Diversion
- ML 5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 1 2 3 4 5
1:100,000 @ A3 KM

NOTE(S)

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SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

REFERENCE(S)

Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Proposed Rail Diversion Track, Duchess Road Diversion: Provided by Centrex 2018
Mining Lease: © State of Queensland (DNRM) 2018

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PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
DEPOSITED DUST MONITORING LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	25/07/2018
DESIGNED	SD
PREPARED	SD
REVIEWED	DP
APPROVED	DP

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	15

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Table 25: Dust Deposit Gauge Results

	Start date	End date	Insoluble solids (mg/m²/day)	Project criteria (mg/m²/day)
DDG 1 (Ardmore North)	20/10/2017	21/11/2017	13	120
	22/11/2017	20/12/2017	17	
	20/12/2017	19/1/2018	17	
	19/01/2018	20/2/2018	57	
	20/2/2018	21/3/2018	17	
DDG 1 (Average)			**23**	
DDG 2 (Ardmore South)	20/9/2017	20/10/2017	13	
	20/10/2017	21/11/2017	3.3	
	22/11/2017	20/12/2017	30	
	20/12/2017	19/1/2018	33	
	19/01/2018	20/2/2018	13	
	20/2/2018	21/3/2018	20	
DDG 2 (Average)			**20**	
DDG 3 (Duchess)	20/10/2017	21/11/2017	20	
	22/11/2017	20/12/2017	27	
	20/12/2017	19/1/2018	73	
	19/01/2018	20/2/2018	27	
	20/2/2018	21/3/2018	3.3	
DDG 3 (Average)			**30**	

7.1.2 Particulate Matter (PM_{10} and $PM_{2.5}$)

Particulate matter (PM) with an aerodynamic diameter of less than 10µm (PM_{10}) is small enough to be inhaled into the lower respiratory tract. Epidemiological studies have demonstrated that both PM_{10} and $PM_{2.5}$ have public health impacts for both short and long-term exposures according to the World Health Organization (WHO) Air Quality Guidelines (WHO, 2006).

Representative background concentrations of particulate matter at the site are not available. The closest publicly available data is from The Gap ambient air quality monitoring station (AQMS), operated by the

Department of Science, Information Technology and Innovation (DSITI) and located in the township of Mount Isa.

The Gap AQMS is situated approximately 100 km from the site in an industrial/residential area. Using data from this station to represent the site is considered conservative, as the Project area is located in a remote rural area surrounded by less emission sources than found in Mount Isa.

Site specific data is not a requirement of the DEHP guidelines, however, in the absence of any other data, The GAP AQMS has been used. Table 26 represents a summary of PM_{10} concentration data from this station in 2016 (DSITI 2017). The 75th percentile concentration of PM_{10} at The GAP AQMS in 2016 (19.5 µg/m^3) has been used to characterise the existing air environment at the Project area.

$PM_{2.5}$ concentrations have not been recorded at The GAP AQMS, however the assessment has used a $PM_{10}/PM_{2.5}$ ratio of 0.15 for estimating emission rates using the NPI emission estimation technique manual for mining and processing of non-metallic minerals (Environment Australia, 2014).

Table 26: The GAP AQMS – Summary of Results for PM_{10} in 2016

Monitoring Station	Maximum (µg/m^3)	PM_{10} Concentration percentiles (µg/m^3)						Project criteria (µg/m^3)
		99th	98th	95th	90th	75th	50th	
The Gap	351	43	41	32	27	20	15	50

7.1.3 Environmental Values

In accordance with the EPP (Air), the environmental values in and around the Project area include:

- The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems.
- The qualities of the air environment that are conducive to human health and wellbeing.
- The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property.
- The qualities of the air environment that are conducive to protecting agricultural use of the environment.

The EPP Air prescribes objectives for a number of pollutants which aim to protect environmental values. For the Project the relevant indicators are PM_{10} and $PM_{2.5}$ and dust deposition. Table 27 provides the Project air quality criteria based on the EPP Air environmental objectives and recommendations from the DEHP for dust deposition.

Table 27: Project Air Quality Criteria

Indicator	Air quality criteria	Period	Days	Environmental value
PM_{10}	50 µg/m^3	24 hours		Health and wellbeing
$PM_{2.5}$	25 µg/m^3	24 hours	5 days each year	Health and wellbeing

Indicator	Air quality criteria	Period	Days	Environmental value
$PM_{2.5}$	8 µg/m^3	1 year		Health and wellbeing
Dust deposition *	120 mg/m^2/day	1 month	NA	NA

* A dust deposition guideline of 120 mg/m^2/day is widely used in Queensland to avoid the impacts of nuisance dust and has been recommended by the DEHP as a suitable design objective.

7.2 Impact Assessment Method

Due to the remote location of the Project and the nearest sensitive receptor, dispersion modelling has not been undertaken for this assessment.

The impact assessment methodology comprised of the following:

- Identify emission sources.
- Qualitatively assess potential impacts to sensitive receptors.
- Compare against air quality objective parameters prescribed within the EPP Air.
- Determine the residual impact to receptors.

7.3 Emission Sources

Project activities that could cause increases to air emissions (dust) from construction, operation and decommissioning are provided in Table 28.

Dust emissions are categorised into three main classifications:

- Total suspended particulate matter (TSP) generally less than 50 µm.
- Particulate matter with an equivalent aerodynamic diameter of 10 µm or less (PM_{10}).
- Particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$).

Table 28: Project Related Air Emission Dust Sources

Project activity	Phase
Clearance of vegetation	Construction
Exposed surfaces generating wind erosion (roads, stockpiles, dumps)	Construction and Operation
Preparation of roads and laydown areas	Construction
Pre-stripping waste and loading onto trucks	Construction
Loading waste and ore onto trucks	Operation
Hauling of waste to waste rock dumps	Operation

Project activity	Phase
Ore stockpiling at ROM	Operation
Crushing and screening of ore at the Project processing plant	Operation
Vehicle movement along mine access and hard roads	Operation
Power generation by diesel generators	Operation

7.4 Potential Impacts

This section provides a discussion of potential impacts to air quality as a result of the construction and operation of the Project. The emission sources will be dust and the activity causing the dust is provided in Table 28.

The main potential air quality issue that will result from construction and operation of the Project will be the generation of airborne dust (particulate matter).

To assess the potential impacts from airborne dust, the Project operating parameters and the environmental conditions at the site were taken into account.

Project specific operating parameters used to develop the emission inventory are presented in Table 29. The approximate dimensions for each vehicle type and road width were included in emission rate calculations.

Table 29: Operating Parameters

Parameter	Quantity
Operating hours (time)	24 operational hours per day
Extraction rate (tonnes per hour)	70
Product (concentrate) handled (tonnes per hour)	46
Tailings handled (tonnes per hour)	24
Site speed limit (km/hour)	40
Truck movements per day	7
Road Width	3 m

Particulate matter emission factors include values for moisture and silt content of materials handled, worked or subject to wind erosion. The moisture content of excavated material has been provided by Centrex. Silt content has been selected from measurements recorded at a number of industry sites and road types as published in United States Environmental Protection Agency (USEPA) Guideline, *AP-42 Section 13.2.2, Unpaved Roads* (USEPA 2006).

Rainfall events are a source of natural mitigation for particulate matter. For dust generated from unpaved roads, the number of rainfall events above 0.25 mm may be taken into consideration (USEPA, 2006). Average wind speeds are used to calculate emission factors for erosion from stockpiles.

7.4.1 Decrease in Air Quality at Sensitive Receptors

Dust emissions from the Project are unlikely to impact the Ardmore homestead 15 km to the northwest and Dajarra residents and motorists of the Boulia-Mount Isa Highway. There may be limited dust emissions at the Ashover Station that is located approximately 750 m from the road between Dajarra and Duchess (see Figure 10). However, the limited number of trucks during the Start-up Operation and the 750 m separation distance means there is unlikely to be a significant impact.

7.4.2 Decrease in Air Quality Due to Ore Transport to Duchess Railway Siding

Motorists of the Boulia-Mount Isa Highway and an unnamed State controlled single lane gravel road between Dajarra and Duchess may be affected by dust due to haulage of ore to through Duchess to Cloncurry. Motorists that travel on the section of these roads are transient receptors, would have short-term exposure to any emissions from the Project and may experience temporary dust nuisance and amenity impacts such as reduced driving visibility.

7.4.3 Decrease in Air Quality Due to Combustion

Vehicles and equipment using fuel emit combustion emissions (CO, SO_2, NO_2 and PM) from fuel consumption. As the site is remote from receptors, the potential health impacts to residents from mine vehicles has not been considered further.

7.5 Avoidance, Mitigation and Management Measures

The Queensland State Planning Policy, *Mining and extractive resources* (DILGP, 2016) provides guidance in determining appropriate separation distances between extractive resource processing areas and sensitive land uses (i.e., residence, schools etc.). The minimum separation distance recommended by the guideline are 1000 m where the extraction or processing of the extractive resource involves blasting or crushing.

To further support this recommendation, EPA Victoria publication 1518, *Recommended separation distance for industrial residual air emissions,* (EPA VIC 2013) prescribes recommended minimum separation distances with the purpose of minimising air quality impacts (dust or odour) at off-site sensitive land uses from '*industrial residual air emissions*' (IRAE) i.e., unintended or upset industrial emissions that may occur intermittently. Unintended emissions are defined in the guideline as 'emissions emanating from an industrial site as a result of non-routine events, including equipment failure, accidents or abnormal weather conditions'.

Based on these guidelines the recommended separation distances for a mine that includes crushing, screening stockpiling and conveying of other minerals is 250 m.

The nearest sensitive land use to the Project is located approximately 15 km from the site.

Emission factors were applied together with the Project specific operating parameters, meteorological data and geology to estimate emission rates. The NPI Emission Estimation Technique Manuals for Mining and Mining and Processing of Non-Metallic Minerals were used to calculate emission rates for particulate matter emissions to air (Australian Government 2012 and 2014). The selected equations from the NPI

and adopted control measures used in the inventory are provided in Appendix C. The proposed measures to reduce impacts for the Project will include:

- Maintaining adequate separation distance from sensitive receptors.
- Water or polymer spraying on roads and stockpiles only if required, to reduce dust emissions when appropriate.

7.6 Residual Impact

To assess the potential impact to air quality at sensitive receptors the predicted emissions from the Project were assessed. The emission inventory for the Project is presented in Table 30.

The total estimated PM_{10} and $PM_{2.5}$ emission rate from the site (including haulage route) is 30 and 3.7 kg/hr respectively.

Emission rate calculations included water spray and pit retention control measures and used the following conservative assumptions:

- All equipment and heavy plant operating continuously 20 hours per day.
- The total surface area of the pit, ROM pad and overburden storage facility was assumed to be exposed.

Table 30: Emission Inventory

Item	Emission rates (g/s)		Model information and assumptions
	PM10	PM2.5	
Excavator	0.11	0.017	CAT 385 C 85 t excavator handling 70 tonnes/hour
Bulldozer	0.31	0.15	CAT D10 bulldozer working at 100% capacity
Ejector truck x3	0.025	0.0039	CAT Ejector trucks 40 t handling 70 tonnes/hour each
Front end loader	0.11	0.017	Front end loader handling 70 tonnes/hour
Grader	0.058	0.0042	Grader working at 100% capacity (assumed to be travelling on average, 5 km in a 1-hour period over 24 hours)
Service truck	0.089	0.0081	100% capacity (assumed to be travelling on average, 2.5 km in a 1-hour period over 24 hours)

Item	Emission rates (g/s)		Model information and assumptions
	PM10	PM2.5	
Light vehicles	0.044	0.0042	Intermittent use (50% capacity, assumed to be travelling on average, 5 km in a 1-hour period over 24 hours)
Road Train x 2	2.3	0.23	Road trains (double or triple) (assumed to be travelling on average 9 km in a 1-hour period over 24 hours on unpaved roads. 10 x 11 km trips per 12-hour shift)
Process Plant	0.31	0.072	Handling 70 tonnes/hr and includes: ■ Primary crusher ■ Secondary impact Crusher ■ Screens for crushers ■ Conveyors (handling and transferring)
Pit	2.6E-06/m^2/s	4.0E-07/m^2/s	Total surface area of 1.4 ha (Pit retention)
ROM Pad	2.8E-06/m^2/s	4.2E-07/m^2/s	Total surface area of 1.26 ha
Overburden Storage Facility	5.3E-06/m^2/s	7.9E-07/m^2/s	Total surface area of 1.26 ha
Total (kg/hr)	**30**	**3.7**	
Total (kg/day)	**396**	**55**	
Total (tpa)	**145**	**20**	

As a screening assessment, the AUSPLUME model was used to predict the ground level concentration (GLC) of PM_{10} at the nearest sensitive receptor (Ardmore homestead). AUSPLUME is a steady-state Gaussian dispersion model, and was run in regulatory mode using the estimated emission rate for the site of 30 kg/hr. As a conservative measure, worst-case meteorological data-set was used and emission sources (including the haulage route) were not separated (single-point calculation). The results of this screening assessment are presented in Table 31.

Table 31: Maximum Predicted PM10 GLC Concentration at Receptor (AUSPLUME)

Averaging Period	Distance from Source (m)	Background Concentration (µg/m^3)	Predicted contribution from Project (µg/m^3)	Project Criteria
1 hour	15 000	19.5	Nil	50

The PM_{10} screening assessment predicted no impacts from mining operations at the sensitive receptor.

The proposed methods that Centrex will implement will reduce the intensity of potential impacts on the air quality baseline environment. The changes to air quality as a result of mining are not expected to exceed the thresholds of the ground level EPP (Air) objectives for PM_{10} and $PM_{2.5}$ in the region. Table 32 provides a summary of the potential residual impacts. The potential impacts to air quality results in a minor residual impact.

Table 32: Summary of Air Quality Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
01	Decrease in air quality at sensitive receptors	Moderate	Negligible	Minor
02	Decrease in air quality due to ore transport through Duchess	Moderate	Negligible	Minor

7.7 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant EPP, including the EPP (Air).

This section provided an assessment of potential impact to air and describes how the following environmental objective and performance outcome (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity will be operated in a way that protects the environmental values of air.
- **Performance Outcome:**
  - There is no discharge to air of contaminants that may cause an adverse effect on the environment from the operation of the activity.

7.8 Greenhouse Gas

This section presents a summary of the predicted Project-related processes which will result in an increase of greenhouse gas emissions. A detailed greenhouse gas assessment has not been undertaken for the Project.

A description of what constitutes Scope 1, 2 and 3 greenhouse gas emissions are:

- **Scope 1 emissions.** Directly result from Project activities including combustion of fuels due to the on-site self-generation of power and vehicle movement.
- **Scope 2 emissions.** These are indirect emissions and are a result from the generation of electricity, heating, cooling or steam by a third-party that is supplied to the Project. As the Project does not consume electricity from the grid, Scope 2 emissions are negligible.
- **Scope 3 emissions.** Generated in the wider economy as a consequence of the Project but, similar to Scope 2 emissions, are not generated by the Project i.e., indirect emissions.

The Project will be constructed and operated over a time frame of 2-3 months for mining and additional 2-3 months for processing where greenhouse gas emissions will arise from combustion of diesel by plant, equipment and vehicles (Scope 1) and by the transport of concentrate and mine related equipment to and from the site (Scope 3). The greenhouse gas emissions will result from:

- Electricity production. CO_2 will be generated from burning fossil fuels for the on-site electricity generation by combustion of diesel. The average operating power requirement for the mine is expected to be in the order of 415 V at the processing plant throughput rate of up to 100,000 tonnes of ore. Power for the process plant will account for the majority of the total power requirement for the mine operation with the remaining energy suppling mining infrastructure (office, administration).
- Mobile equipment. Consumption of fuel, oils and greases as lubricants in machinery, equipment and vehicles (mine haul vehicles, light vehicles and trucks).
- Transport of mine related equipment and workers to and from the site (Scope 3 emissions).

There will be negligible Scope 1, 2 and 3 greenhouse gas emissions as a result of the Project due to the short timeframe of operation, minor power requirement from the generator and the small-scale extraction and minimal movement of ore and waste rock.

8.0 NOISE

This section describes the existing noise conditions and potential impacts to the acoustic environment from the proposed mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

In Queensland, environmental impacts associated with noise emissions are regulated under the EP Act, EP Regulation and the Environmental Protection (Noise) Policy 2008 (EPP Noise).

This assessment has been conducted in accordance with the requirements of the DEHP Guideline, *Application requirements for activities with noise impacts* (DEHP, 2017b). A supporting specialist report prepared by Golder is provided in Appendix C - Air and Noise Technical Report.

The EPP Noise identifies the environmental values for the acoustic environment and outlines the acoustic quality objectives for different types of sensitive receptors.

8.1 Baseline Environment

The site is in a remote rural area with no significant sources of existing noise. The Boulia Mt Isa Highway traverses the northern section of the Mining Lease area, however traffic on this road is not considered a significant source of existing noise at the Project site. Vegetation in the area is sparse, and ecological noise (i.e., birds, insects) is likely to be minimal.

Representative background noise measurements within the Tenant Creek to Mount Isa area indicate the median L_{A90}, dB(A) 1-hour averages are:

- Day time (7am – 6pm) = 30 dB(A).
- Evening (6pm – 10pm) = 42 dB(A).
- Night (10pm – 7am) = 32 dB(A).

The sensitive receptors that may be affected by noise emissions from the Project include the Ardmore Homestead 15 km to the northwest, the residents along the haul road from the mine site through Duchess, including the Dajarra residents, motorists of the Boulia-Mount Isa Highway and residents of the Ashover Station and Stanbroke Homestead (see Figure 10).

8.1.1 Environmental Values

The environmental values to be enhanced or protected under this policy are:

- The qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems.
- The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following:
  - (i) sleep
  - (ii) study or learn
  - (iii) be involved in recreation, including relaxation and conversation.
- The qualities of the acoustic environment that are conducive to protecting the amenity of the community.

The EPP Noise proposes objectives which aim to protect environmental values. Table 33 provides the acoustic quality objectives relevant to this assessment for the site. The EPP Noise establishes goal noise levels to be achieved at the noise receptors (dwellings). The EPP Noise does not provide night-time criteria outside of dwellings, which can be useful when screening for noise impacts using noise attenuation calculations. To include an assessment for the health and wellbeing related to sleep, an adjustment of 10 dB[1] has been made by Golder (Appendix C) to the indoor criteria to allow for noise reduction through a typical dwelling facade.

Table 33: Project Noise Criteria

Sensitive Receptor	Time of day	Acoustic quality objectives (measured at the receptor) dB(A)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
Dwelling (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Dwelling (for indoors)	Daytime and evening	35	40	45	Health and wellbeing
	Night-time	30 (+10 dB for outdoor)	35 (+10 dB for outdoor)	40 (+10 dB for outdoor)	Health and wellbeing, in relation to the ability to sleep
Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or area of major interest	Anytime	The level of noise that preserves the amenity of the existing area or place.			Health and biodiversity of ecosystems

8.2 Impact Assessment Method

Due to the remote location of the Project and the nearest sensitive receptor, noise modelling has not been undertaken for this assessment.

[1] EPA NSW guideline, *Noise guide for local government* (EPA NSW 2013) recommends an adjustment of 10 dB for attenuation across a building façade with an open window.

The impact assessment methodology comprised of the following:

- Identify emission sources.
- Qualitatively assess potential impacts to sensitive receptors.
- Compare against air quality objective parameters prescribed within the EPP Noise.
- Determine magnitude of potential residual impact.

8.3 Emissions Sources

Major noise sources at the site are expected to include mobile plant engines (during acceleration and extraction) and the crushing of raw material in the process plant. Extraction activities include face shovel extraction, loading and unloading of dump trucks, movement of mobile plant along haulage routes, site clearing (using bulldozer) and rocking breaking (using an excavator). Blasting is not proposed at the site and is not included in this assessment.

Potential noise generating activities at the process plant include primary crushing, material screening, slurry water pumps, generators and front-end loaders.

Haulage of concentrate is proposed using triple road trains along a 7 km road from the process plant to the Highway during the day, and along the highway through Dajarra to Duchess and then Cloncurry.

To assess potential sources of noise, sound pressure levels (SPL) for representative noise sources were estimated using the Golder internal noise database, and the Department for Environment Food and Rural Affairs (DEFRA) database (DEFRA 2006). This database is widely used in Australia to estimate noise from mining and construction sites, where measured data is not available. Representative sound pressure levels for identified noise sources are provided in Appendix C. The noisiest equipment is likely to be the front-end loader, dump truck and bulldozer with an A-weighted Sound Power Level, L_{Aeq} dB of approximately 118, 116 and 113 at the mine site.

8.4 Potential Impacts

This section provides a discussion of potential impacts to the noise environment at the nearest sensitive receptor as a result of the construction and operation of the Project. The discussion of the potential for noise emissions to disturb native fauna is provided in Section 11.2.5.

8.4.1 Exceedance of Noise Criteria at Sensitive Receptors

The assessment considered the likelihood of noise emissions from the Project contributing to an exceedance of the noise limits at sensitive receptors, which may result in annoyance, stress, sleep disturbance and reduced wellbeing.

The closest sensitive receptor at Ardmore homestead 15 km to the northwest, Dajarra township and the rural residence receptors along the Dajarra Duchess Road (see Figure 10).

A noise attenuation (energy loss of sound) assessment was undertaken to determine the potential impact to the nearest sensitive receptor. The calculated noise level of each source and the total from all noise sources are presented in Table 34. The noise levels have been calculated using geometric distance noise attenuation (including atmospheric adsorption), and are considered conservative for the following reasons:

- All equipment and plant were operating continuously 24 hours per day.
- All equipment and plant were operating simultaneously.
- No separation between equipment and plant noise sources (single point calculation).
- Attenuation of noise by natural and artificial noise barriers (buildings, stock piles, topographical features) was not considered.
- Attenuation of noise by ground adsorption was not considered.
- Noise mitigation measures have not been considered.

Table 34: Estimated Sound Power Levels at Nearest Sensitive Receptor (15 km)

Noise Source	A-weighted SPL, L_{Aeq} dB @ 15 km	Project Criteria (L_{Aeq} dB)		
		Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Excavator (382 kW, 89 t)	20	50	50	40
Bulldozer (250 kW, 35 t)	15			
Dump Truck (287 kW, 40 t) x4	25			
Front End Loader (597 kW, 94 t)	21			
Grader (205 kW, 25 t)	21			
Water Truck (discharging)	14			
Service Truck (242 kW, 32 t)	22			
Road Truck (x2)	20			
Process Plant, including:	30			
Diesel Generators (45 KVA, 30 kW and 450 kW, 600 kVA)	11			
Crushers (310 kW, 90 t) x 2	24			
Electric water pump (120 kW) x 6 (representing tailings and water pumps, hydrocyclones)	16			
Screen stockpiler (17 t) x 2	17			
Field conveyor (rollers) x 2	10			
Total (including background)	**35**			

The total estimated noise level at the Ardmore Homestead 15 km northwest from the mine site is 35 dB, which is below the Project noise criteria for day, evening and night time noise levels. Therefore, at this

residence and other sensitive receptors the estimated noise level is not predicted to exceed the Project criteria.

8.5 Avoidance, Mitigation and Management Measures

Although the risk of noise impact on the environmental values is low prior to implementing mitigation measures, Centrex will consider the use of best practice noise mitigation measures to minimise noise emissions in accordance with the noise management hierarchy outline in the EPP (Noise). This is also important for workplace health and safety for workers at the site. To the extent that it is reasonable to do so, noise must be dealt with in the following order of preference:

a) Firstly-avoid;
b) Secondly – minimise, in the following order of preference –
   (i) firstly - orient an activity to minimise noise;
   (ii) secondly – use best available technology;
c) thirdly – manage.

As discussed, the Project is not located near a sensitive receiver and consequently the risk of noise impacts is expected to be avoided. The mobilisation of road trains is proposed to occur during the day shift only, minimising the potential noise impact during sleeping hours along the proposed truck route.

Centrex intends to employ best practice noise mitigation measures where practicable and appropriate including:

- Reduce vehicle speed on site.
- Mobile equipment is turned off when not in use.
- Equipment maintenance in accordance with manufacturer's specifications.
- Use of mufflers on mobile plant.
- Maintenance of haul roads on the ML.

8.6 Residual Impact

Prevailing wind conditions favour the dispersion of noise towards the Ardmore homestead, however the large separation distance and considerable associated noise attenuation indicates that it is unlikely that there will be any significant noise impact from the proposed site activities. The results of the assessment estimated the noise impact from the site to be 35 dB (including background), below the Project criteria.

It is unlikely that noise emissions from the Project will be experienced at the sensitive receptors and result in annoyance, stress, sleep disturbance and reduced wellbeing. Table 35 provides a summary of the potential residual impacts.

Table 35: Summary of Noise Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
03	Noise levels exceeding noise criteria at sensitive receptors due to mining operations	Moderate	Negligible	Minor

8.7 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant EPP, including the EPP (Noise).

This section provides an assessment of potential impact to the acoustic environment and describes how the following environmental objective and performance outcome (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity will be operated in a way that protects the environmental value of the acoustic environment.
- **Performance Outcome:**
  - Sound from the activity is not audible at a sensitive receptor.

9.0 LAND

This section describes the existing geology, soils and land conditions and potential impacts to the land from the proposed mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

Relevant legislation for this section includes:

- *Nature Conservation Act 1992.* This act relates to the conservation of nature (including all physical and natural resources). This act is relevant to the Project in the event that there are impacts on the geology or soils within protected areas (listed under s. 14).
- *Soil Conservation Act 1986.* Outlines the laws relating to soil conservation and provided landholders management strategies to mitigate soil erosion.
- *Environmental Protection Act 1994***.** Provides the duty of care to prevent environmental harm, including harm to the land and soils

Relevant guidelines include:

- Application requirements for activities with impacts to land (DEHP, 2017c)
- Best Practice Erosion and Sediment Control Manual (IECA, 2008). Outlines how to manage erosion and sedimentation through the planning and construction stages of development.
- Contaminated land guidelines. https://www.qld.gov.au/environment/pollution/management/contaminated-land/assessing

9.1 Baseline Environment

The baseline environment of the land includes a description of the geology, soils, potential for pre-existing land contamination and land use. A combination of desktop assessments and field surveys were undertaken to characterise the land conditions at the site.

9.1.1 Geology

A desktop assessment was undertaken to characterise the geology in the Mining Lease area and outcropping geological features were recorded during a field survey in November 2017.This information is provided in Section 3.1.1 and will not be repeated here.

There were no important geological features or geo-heritage sites identified during the field survey (Golder Associates, 2017)

9.1.2 Soils

A desktop assessment reviewed the regional digital atlas of Australian soils (CSIRO, 2009) and the Australian Soils and Landscapes (McKenzie et al., 2004). The ML area was categorised by the CSIRO (2009) into two different soil classes comprising Chromosols and Kandosols, with the Project located in an area mapped as Chromosol soils.

McKenzie et al. (2004) provided a general description of ‘A non-sodic, text contrast soil with high base status in the red clayed B2 horizon’.

A soils sampling field assessment was undertaken to characterise the shallow soil types, horizons, depths and physical/ chemical properties of within the ML area. The full results are within Appendix A - Soils Technical Report. The field assessment ground truthed the soil conditions described in the desktop assessment.

Ten soil test pit locations (TP01 – TP10) were chosen based on those areas within the Project mining disturbance area, and the future potential Full-scale Operation area. A total of 29 soil samples from the ten test pits were collected for analysis. The test pit sites (Figure 16) varied in depth from 0 to 1.2 meters below ground level (bgl). To assess the onsite soil type and quality, the soil was analysed for the particle size distribution (PSD) and Emerson classification. The samples were also analysed included pH, EC, exchangeable cations, major cations, chloride, Total Kjeldahl Nitrogen (TKN), total phosphorus (P), total potassium (K), sulphur (S), total organic carbon (TOC), sodium adsorption ratio (SAR).

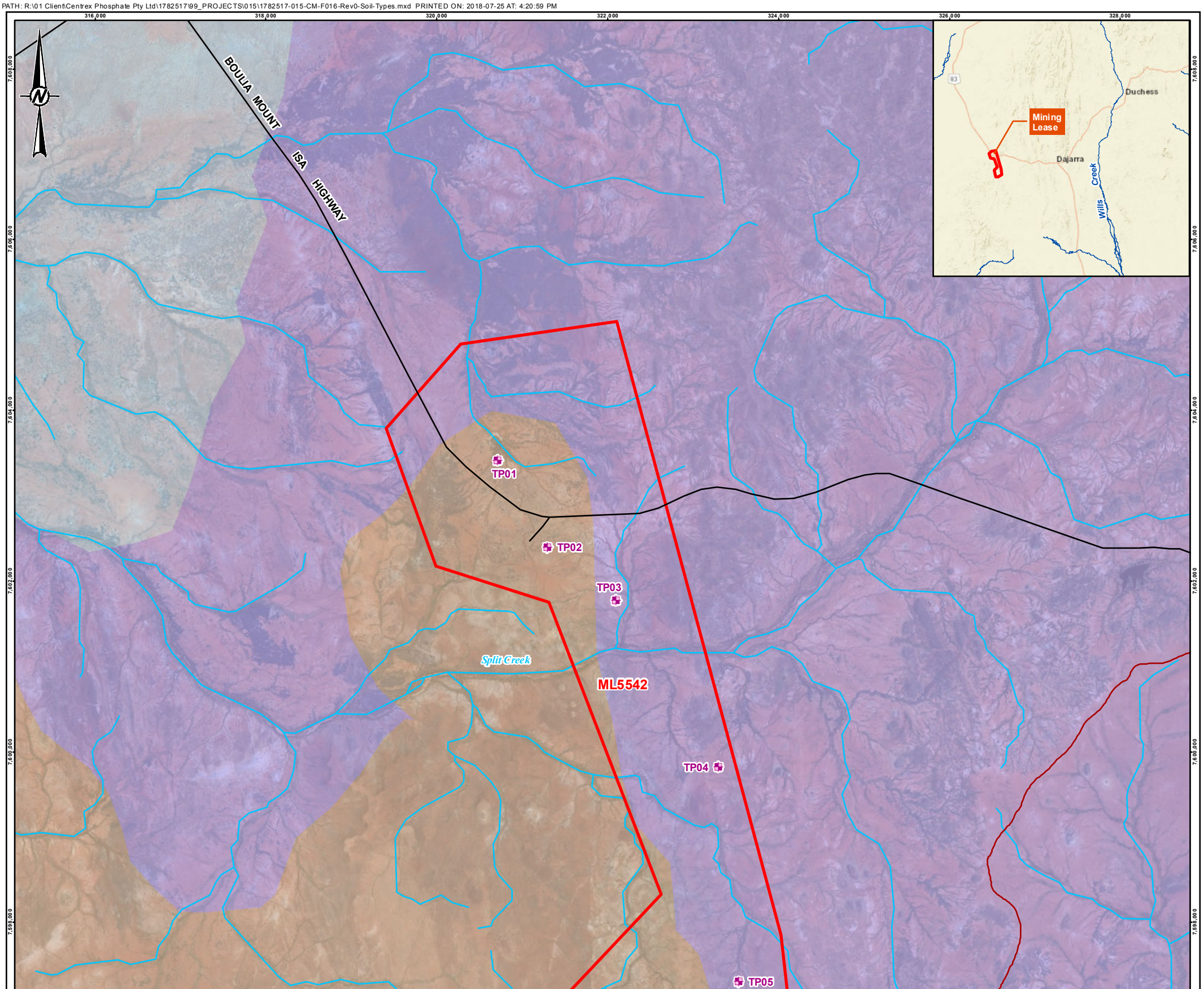
The soil at each site was also logged for the nature and condition of encountered lithology according to the Australian Soil Classification System (ASCS).

Observations of on-site water infiltration noted in previous investigations indicate that the site is very well drained, however some areas are known to pond with water during heavy downpours, likely due to the clay content in near-surface subsoils. A thin topsoil layer (<10 cm) comprising silty sand has been observed, during previous studies, across the majority of the site. Clay/sandy silt/gravelly deposits are red/orange in the southern section of the site with a contrast to a yellow colour in the northern zone. Rock outcrops are observed almost at surface in many areas throughout the ML including some adjacent to the proposed site of the Start-up Operation some areas within the southern portion of the ML (Appendix A).

9.1.2.1 Soil Lithology

The soil lithology was variable across the site with some test pit sites showing similar characteristics. Table 36 groups the similar lithologies, however it is noted that these do not correlate to specific geographic locations across the ML. Locations TP04, TP05, TP09 and TP10 had similar lithology. The Blazen Shale formation was intercepted at shallow depths and refused before 1m depth at TP02, TP03, TP06 and TP07. At locations TP01 and TP08 thicker alluvium was encountered, and the Blazen Shale parent material was not intercepted. At TP01, crystalline inclusions were noted to be possibly gypsum. At TP08 white calcareous segregations were observed below 0.5 m bgl.

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LEGEND

- Soil Test Pit Locations
- Watercourses
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Combined Soils

- Chromosols
- Kandosols
- Vertosols

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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PREPARED	BG
REVIEWED	JR
APPROVED	JR

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Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)
Soils: © CSIRO 2009.
Roads, Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Start-up Operation, Start-up Operation Access Track: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
SOIL TEST PIT LOCATIONS AND MAPPED SURFACE SOILS

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	16

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Table 36: Soil Lithology

Depth	Lithology
TP04, TP05, TP09, TP10	
0.0 - 0.3 m bgl	Sandy Loam to Light Clay, low plasticity, red to dark red, with plenty of silt, fine to medium sand and gravels, granular to blocky structure
0.3 - 0.6 m bgl	Sandy Clay Loam to Light Clay, low plasticity, dark red, with decreasing clay and silt content, plenty of fine to medium sand and gravels, massive structure.
0.6 -1.2 m bgl	Clayey Gravel, fine to coarse sub-rounded to angular gravel, dark red, with low to medium plasticity clay, plenty of sand, massive structure
	Weathered bed rock was intercepted at the bottom of test pits TP04 and TP05
TP02, TP03, TP06, TP07	
0.0 - 0.3 m bgl	Silty Loam to Clayey Gravel, low plasticity, dark red, fine to coarse sub-rounded to angular gravel. with some slit and fine sand.
0.3 - 0.98 m bgl	Sandy Loam to Sandy Clay Loam, low plasticity, dark red to orangish red, with many fine to coarse sub-rounded to angular gravels and cobbles.
TP01, TP08	
0.0 - 1.45 m bgl	Medium Clay, low to medium plasticity, dark red, with some silt and fine sand.

Across the ML area there were areas of observed bedrock exposure. The Beetle Creek and Blazen Shale formations were observed near the northern portion of the ML. Areas of exposed shale were observed in creek beds and erosion channels. There was also an area of granitic bedrock exposed near the middle of the lease area.

The test pit logs and soil profile photographic log are provided in Appendix A. Plate 4 and Plate 5 provide the location of TP08 which is located close to the Project area.



Plate 4: Location of Test Pit TP08



Plate 5: Location of Test Pit TP08

9.1.2.2 Laboratory Results

The details of laboratory analysis results are provided in Appendix A and a summary is provided below:

- **Soil pH and Electrical Conductivity (EC).** The soil pH and EC provide an indication of soil acidity, alkalinity and soil salinity. The pH is consistent across the mining lease, generally neutral to alkaline. Within the Project area the EC values increased with depth and were classified as extreme (>1.12 mS/cm). There is a notable difference between the topsoils EC and the subsoil EC values. The results at locations TP01, TP03 and TP08 (near the Project site) indicate that these soils are saline.
- **Exchangeable Sodium Percentage (ESP).** Sodicity is a measure of the exchangeable sodium (Na) in proportion to the total remaining exchangeable cations. Exchangeable sodium percent (ESP) results are used for classification of sodicity. The ESP values for topsoil and subsoil indicate that the site is highly variable, with both non-sodic to sodic soils.
- **Emerson classification.** The Emerson classification and Ca:Mg ratios are indicators of soil dispersivity or structural stability. Soils which are high in exchangeable sodium and exchangeable magnesium are generally more dispersive than those that are high in exchangeable sodium and exchangeable calcium. The majority of the results of soils across the ML area show low (Class 4) to moderate (Class 3) dispersivity levels, indicating these soils are described as *'low to potential dispersive soils'.* The Ca:Mg ratios for topsoil and subsoil are high in the Project area, meaning the soil is less likely to be dispersive.
- **Atterberg Limit testing and Particle Size Distribution**. The liquid limit results, provided as part of the Atterberg Limit testing, generally support the variable plasticity of the materials which is a mixture of fine and coarse-grained soils observed in the field. Soils which contain higher clay and silt content have higher water holding capacity. However, the increased clay and silt can decrease water infiltration. The soils which contain higher sand and gravel contents are more permeable to water infiltration, and therefore less suitable for dams and other water retaining structures. In the Project area the soils contain greater than 25 percent gravel content, with highly variable sand content. The clay and silt content is also variable and generally considered as low.
- **Organic matter and nutrients.** The nutrients within the soils were measured by assessing the Total Kjeldahl Nitrogen (TKN), which is the sum of organic nitrogen, ammonia (NH3) and ammonium (NH4+). The results indicated that nutrient reserves, including total nitrogen, total potassium, and total sulphur are at low levels, with the exception of concentrations of total sulfur at TP01 and TP08 which were high. Organic matter was generally found to be low, ranging from <0.5% to 1%. In addition to the low total nitrogen concentrations, the carbon (organic matter):nitrogen ratios are moderate to high, which leads to possible slow nutrient mineralisation within the soils.
- **Erosion potential.** The results for ESP and Ca:Mg ratios indicate that three test pit areas (TP01, TP03 and TP08) may have poor soil structure and be prone to erosion. The results for the sample locations surrounding the project area indicate relatively stable soil structure properties. At location TP08 the near surface (0.1 m to 0.3 m) and the subsoil (0.5 m to 0.6 m) indicate sodic soils which are prone to dispersion and erosion.
- **Rehabilitation suitability.** The results give an indication of the suitability and availability of soil for rehabilitation activities. Topsoil is generally thin (0.1 m bgl) and subsoil in the 0.1 m to approximately 2 m range. The natural soil fertility of the area is generally poor. Limited soil will be available for

rehabilitation activities. Some areas with deep alluvial material present (e.g., TP01 and TP08) have subsoils containing high concentrations of sulfates and sodium which could inhibit rehabilitation activities.

From the site observations and test pit sample analysis, the main soil type identified was a Haplic, Eutrophic, Red Chromosol. However, from analytical results, the locations TP01, TP03 and TP08 appear to be more representative of Kandosol soils. This indicates that the site has a slightly different split of Chromosols and Kandosols than what is depicted in Figure 16.

The soils within the ML generally have poor physical and chemical properties and a moderate propensity for dispersion. These soil characteristics are typical of the region's arid environment.

9.1.3 Pre-Existing Land Contamination

A search of the DEHP Environmental Management Register (EMR) and Contaminated Land Register (CLR) was undertaken on 27th March 2018 across the two (2) land tenure parcels in which the ML is contained (Lot 16 CW62 and Lot 4 SP117500). The search results for both tenures showed the Project area is not included on either the EMR or CLR registers.

Both registers do not include details of land which contaminated land or land on which a notifiable activity is being or has been undertaken if DES has not been notified. Therefore, an independent soils sampling program was undertaken (Appendix A) to characterise the soil types within the Project area and no evidence of contamination was recorded during this program.

9.1.4 Land Use

The land systems of the regional area have been mapped by the CSIRO (1954). The land system mapping considers the topography and land forms, soils, vegetation, and climate and categorise the land suitability. The Project area is mapped as 'Pasture land – native pastures', which is in line with what the land is currently used for. The current land use is grazing and native vegetation.

The Queensland Land Use Mapping Program (QLUMP) maps and assesses patterns of land use and land use change across the state at catchment scale, in accordance with the national standard for land use classification. A review of the QLUMP for Lot 4, SP117500 (the parcel of land which the Project is located) indicates that the site is not mapped as a Priority Agricultural Area, Strategic Environmental Area or Strategic Cropping Land under the *Regional Planning and Interests Act 2014*.

9.1.5 Environmental Values

The soil supports ecosystems by providing a suitable growth medium for vegetation (good quality soil which remain stable in-situ). Impairment of either soil availability (quantity) or quality as a result of mining activities may impact terrestrial and aquatic ecosystems, and surface water quality.

The environmental value for soil is therefore the provision of good quality soil of a suitable quantity for vegetation growth. The retention of soils in-situ (non-erosive) is also important to prevent adverse impacts to aquatic ecosystems and surface water quality. The sensitivity of the soils in the area are considered to be moderate.

9.2 Potential Impacts

Clearing and earthworks expose soils, change landforms and alter drainage. Impacts will likely occur primarily with new ground disturbance as a result of excavation and placement of fill from earthworks. An

estimated 11.7 ha of land will be disturbed in some way from Project activities during construction. Clearance of vegetation and excavating the landscape will change natural landscape features. The excavation of the area to develop the mine will result in a temporary change to the landscape. Potential impacts during construction and operation are included below.

9.2.1 Soil Erosion

The key potential impact relating to soils is erosion (loss of soil) and the subsequent effects of erosion (mainly sedimentation of watercourses). The potential for impacts to surface water is discussed in Section 12.2.2.

Soil erosion from the site has the potential to cause:

- Localised erosion during rainfall events which could lead, over time to a permanent loss of substrate for vegetative growth.
- Loss of soils available to support vegetation and available for vegetation growth during rehabilitation.

Erosion management measures will be built into the Project design and will include a combination of managing surface water flows using drainage ditches and clean water diversions

The Surface Water Technical Report (Appendix E) reviewed field sample results of topsoil and subsoil and from values from the Best Practice Erosion and Sediment Control Guideline by IECA (2008) to determine the erodibility parameters for a Revised Universal Soil Loss Equation (RUSLE) analysis. The RUSLE analysis was used to predict the long-term average loss of soil in runoff from land and the subsequent sedimentation of natural watercourses.

The prediction of erosion rates is important to understand the likely runoff and sediment load from disturbed areas.

Soil erosivity is expected to increase significantly compared to the existing site conditions where areas of limited vegetation ground cover exists. The RUSLE analysis indicated that the overburden stockpiles have a potential loss of soil of 15.05 t/ha/yr without the consideration of implementation of erosion and sediment control measures.

9.2.2 Soil Compaction

During mine development disturbed areas such as the carpark, roads and laydown areas will have the soil compacted. Post mining compacted soils may increase water runoff and sheet erosion if not ripped or scarified.

9.2.3 Localised Soil Contamination

It is possible that during the course of mining there could be contamination to soils as a result of minor leaks or accidental spills of liquid hydrocarbons, fuels, lubricants and chemicals, as well as releases caused by accidents (e.g., fuel tank failure, oil spillage).

In the event of contaminant spills or leaks from the operation of the Project, contaminants would be able to be contained through implementation of standard spill management procedures.

9.2.4 Issues with Soils Available for Rehabilitation

As stated previously, the Project area has limited natural vegetation groundcover and topsoil cover for rehabilitation. Therefore, it is likely that following rehabilitation the natural state of limited vegetation cover will be returned.

In normal landforms the use of mine overburden materials for rehabilitation without the topping of sub-soil or topsoil may result in a reduction in revegetation success post mining. If soils are not managed and stored appropriately during construction and operations, there may not be a suitable volume available for rehabilitation and closure.

As the topsoils are naturally thin or non-existent at the site, the proposed rehabilitation and closure plan relates to the realistic achievable outcomes in such environments. The proposed land use post mining is similar to that which exists now; grazing within sparse native pasture or vegetation.

Although the success of vegetation rehabilitation may be limited, the topsoil and sub-soil will be progressively stripped and stockpiled, with a 100 mm strip for topsoil and a 300-500 mm strip and stockpile until the rock overburden is reached.

9.3 Avoidance, Mitigation and Management Measures

This section identifies proposed mitigation and management measures to lower the potential for soil compaction and contamination and erosion of soils.

Measures to reduce impacts (compaction and erosion) will include the following:

- The Project footprint will be limited during the construction and operations phases where possible.
- The workforce will be restricted to only those areas that need to be accessed or trafficked on formed roads, tracks and paths, where possible.
- The overburden dump, indurated storage facility, ROM, TSF and disturbed infrastructure areas will be designed to manage high surface water flows during rainfall events, where possible.
- Erosion and sediment control measures will be implemented and will include:
  - Minimising the extent of vegetation clearance as much as is operationally practicable.
  - Temporarily stockpiling topsoil and subsoil for rehabilitation of disturbed areas.
  - Stabilising topsoil and subsoil stockpiles (using vegetation or other methods).
  - Minimising the duration of soils stockpiled on site will help reduce the risk of soil erosion occurring.
  - Using slope stabilisation techniques on constructed landforms.
  - Immediate reuse of cleared vegetation as revegetation or for stabilisation where possible.
  - Progressively rehabilitating and revegetating (if possible) disturbed areas, as soon as possible after mining or construction activities are completed.

Measures to reduce localised soils contamination from spills or leaks of fuels or chemicals:

- Re-fuelling of light vehicles and trucks will be done offsite.

- Re-fuelling of mining fleet will be onsite within a dedicated re-fuelling area.
- Bunding will be present around chemical storage areas.
- Contaminated soils will be cleaned up as soon as practicable after the event occurs.

Measures to reduce the potential for issues with soils available for rehabilitation or landform erosion:

- Conservation and erosion and sediment control best practises (listed above) should be utilised to reduce the risk of soil erosion.
- During mining operations, collect and store topsoil (i.e., the upper 0.1 m of soil, including organic material) and the subsoil (0.3 m to approximately 2 m deep). Store topsoil in separate stockpiles no greater than 2 m in height, where practicable.
- Retain vegetation material with stripped surface soil material, where practicable, to minimise the risk of erosion when reused as a rehabilitation medium.
- Avoid locating soil stockpiles in low-lying areas that will impede the natural drainage patterns.
- Rip surfaces of reconstructed landforms and rehabilitation areas to a depth of more than 0.50 m following topsoil application, where feasible.

9.4 Residual Impact

Table 37 provides a summary of the predicted residual impacts of the Project on soils following successful implementation of the proposed management measures.

The potential impacts and effect on the soil will be short in duration (at the most 1 year if the Full-scale Operation does not proceed). The volume of fuels and chemicals on site will be minor, therefore if any accidental leaks or spillages occur, the impact will be reversible. Mitigation is adequate and achievable for all potential impacts therefore the intensity ranking is low and overall residual impact is minor.

Table 37: Summary of Land Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
04	Soil erosion (causing sedimentation)	Not sensitive	Low	Minor
05	Soil compaction	Not sensitive	Low	Minor
06	Localised soil contamination from accidental spills and leaks of fuels and chemicals.	Not sensitive	Low	Minor
07	No suitable soils available for rehabilitation / landform erosion control	Negligible	Negligible	Negligible

9.5 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant Environmental Protection Policy.

Section 3.19, Section 9.3 and Section 9.4 demonstrate how the following environmental objective and performance outcomes (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna.
- **Performance Outcomes:**
  - Activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land, and
  - Areas disturbed will be rehabilitated or restored to achieve sites that are:
    i) safe to humans and wildlife
    ii) non-polluting
    iii) stable; and
    iv) able to sustain an appropriate land use after rehabilitation or restoration.
  - The activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants.
  - The application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

10.0 VISUAL AMENTITY

This section describes the existing visual amenity characteristics of the landscape and visual impacts associated with the Project's activities.

Key objectives of management include maintaining consistency with the visual amenity objectives of both the Cloncurry and Boulia Shire Council's Planning Schemes and provides proposed mitigation and management measures to reduce the potential impacts.

Relevant legislation for this section includes:

- *Environmental Protection Act 1994*. This Act aims to protect Queensland's environment and achieve ecologically sustainable development in Queensland, whereby public amenity is defined as an environmental value encompassed under Sections 8 and 9 of the Act.

10.1 Baseline Environment

A desktop study was undertaken to identify the Project area's potential landscape and visual amenity values and likely sensitive receptors by reviewing planning schemes from Cloncurry and Boulia Shire Councils, digital aerial photography, cadastral data, hydrological features, vegetation (including Qld RE mapping and NRC ground-truthed RE mapping), land use and cultural heritage features.

As previously described in Section 6.0 of this report, the Project is situated on the eastern margin of the Barkly Tableland within range country. The landscape is predominately flat and relief throughout the area is low, though rugged outcrops are present being up to 50 m above the valley bases. The area's vegetation is described as sparse with low, very open woodland, with eight (8) RE's having been identified within the Project area. Tree heights range from 3-8 m throughout on gravelly plains and slightly undulating areas primarily around rock outcrops.

Denser vegetation is present along ephemeral watercourses, with canopy trees reaching up to 14 m, however cattle grazing and pest plant species invasion have significantly impacted all areas, particularly riparian areas.

Visual receptors identified with a likelihood of impact by the Project included local residents of the closest township of Dajarra 23 km to the east, residents of nearby rural properties, particularly Ardmore Station located 15 km northwest of the Project, and tourists or neighbouring landowners passing the Project area by vehicle on the highway. Three (3) viewpoints were selected from public vantage points around the Project site (refer Figure 10) to represent the potential visual receptors with a likelihood of impact by the Project:

- Viewpoint 1 - Urandandie South Road to Ardmore Homestead (Latitude: -21.611788, Longitude: 139.226565; Plate 6 - Plate 9)
- Viewpoint 2 - Boulia-Mount Isa Highway in the north of ML (Latitude: -21.669587, Longitude: 139.274055; Plate 10 to Plate 12)
- Viewpoint 3 - Split Creek – location of proposed future dam (Latitude: -21.666208, Longitude: 139.314194; Plate 13 to Plate 16)



Plate 6: Viewpoint 1 at Urandangie South Road facing SE (direction of Project)



Plate 7: Viewpoint 1 at Urandangie South Road facing SW



Plate 8: Viewpoint 1 at Urandangie South Road facing North West



Plate 9: Viewpoint 1 at Urandangie South Road facing North East



Plate 10: Viewpoint 2 at Boulia-Mount Isa Highway facing East (to Dajarra)



Plate 11: Viewpoint 2 at Boulia-Mount Isa Highway facing South



Plate 12: Viewpoint 2 at Boulia-Mount Isa Highway facing North-West



Plate 13: Viewpoint 3 at Split Creek facing North-East (Upstream)



Plate 14: Viewpoint 3 at Split Creek facing South-West (Downstream)



Plate 15: Viewpoint 3 at Split Creek facing North-West (to Mount Isa)



Plate 16: Viewpoint 3 at Split Creek facing South-East (to Dajarra)

10.1.1 Environmental Values

The characteristics of the landscape dictate the overarching value sensitivity. The value includes the visual amenity and landscape characteristics. The environmental value is not sensitive to change or disturbance and is able to fully recover from the short-term mining activities. The sensitivity of the value is therefore considered to be not sensitive.

10.2 Potential Impacts

This section provides a discussion of potential impacts to visual amenity as a result of the construction and operation of the Project.

10.2.1 Reduction in Visual Amenity

Though the closest visual receptor (vehicles along the road) is located approximately 7 km from the proposed Project infrastructure (Boulia-Mount Isa Highway location), all phases of the Project (construction to decommission) have the potential to impact the existing landscape and visual amenity of the region through:

- Nuisance impacts such as:
  - Production of dust from activities (plant operations and transportation).
  - Production of artificial light from night time plant operation.
- Change to context of landscape through vegetation clearing and excavation.
- Addition of built form in the area (industrial structures).

The closest permanent receptor is located 15 km to the northwest of the site and it is most unlikely that any of these potential visual impacts would be recognised.

Dust creation as a by-product of vegetation clearing, construction earthworks and transport of equipment to site is likely to be the biggest potential impact to visual amenity during the construction phase of the Project. Given the remote location, the landscape will be intrinsically dark at night and should construction activities take place after sunset, introduced flood-lighting may be visible from the highway if there are minimal obstructions (vegetation, varied topography, etc.).

As the Project's overburden storage facility will be approximately 4-5 m high and the plant will not exceed one (1) storey high, the overall height of the built infrastructure and the distance from each visual receptor location during the operational phase, it is considered unlikely that Project infrastructure will be visible to the naked eye from any of the identified visual receptors during the operational phase.

Vegetation clearing for the infrastructure and access tracks may have an impact on the context of the landscape. Dust generated by earthmoving works, processing and loading and transport of product by double and/or triple road trains both from the Project site and on public roadways all have the potential to impact visual amenity and given the Project processing plant will run 20 hours a day, artificial light pollution may also be a potential impact during this phase of the Project.

Should full-scale mining not proceed, activities during decommissioning of the Project will be similar to those outlined during construction, where dust and light may be produced while reforming land form and rehabilitation processes are undertaken.

10.3 Avoidance, Mitigation and Management Measures

Given the separation distance between the closest visual receptor (vehicles along the Boulia-Mount Isa Highway) and the operation it is possible dust from the operation may be visible at this location on windy days. However, these receptors are transient and would only see the dust for a short period of time. Similarly, flood-lighting may be visible from the highway but this will only been seen for a short period of time as vehicles pass by.

Measures to reduce impacts will include:

- Communication with the local community regarding activities to reduce perceived nuisance impacts.
- Water spraying on roads and stockpiles to reduce dust emissions when appropriate.

10.4 Residual Impact

Table 38 provides a summary of the potential residual impacts to visual amenity following the successful implementation of the proposed management measures.

The potential impacts and effect on the visual amenity of transient receptors will be very short in duration (as vehicles drive along the highway). The impact will be local, temporary and potentially unlikely to be detectable. The changes to the visual environment will be minimal. The intensity ranking is negligible and overall residual impact is minor.

Table 38: Summary of Visual Amenity Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
08	Reduction in visual amenity due to the Project	Not sensitive	Negligible	Minor

10.5 Environmental Protection Objectives

There are no requirements stipulated in the EP Act, EP Regulation and any relevant Environmental Protection Policy relating specifically to visual amenity. Regardless of this, an environmental protection objective has been developed for visual amenity:

- The activity will avoid or minimise impacts to landscape character within the region.

11.0 ECOLOGY

This section describes the existing terrestrial and aquatic ecology, and potential impacts from the proposed mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

Relevant legislation for this section includes:

- *Environment Protection and Biodiversity Protection Act 1999* (Cth). This act relates to the protection of Matters of National Environmental Significance (MNES), including nationally and internationally important flora, fauna, and ecological communities.
- *Vegetation Management Act 1999*. This act provides a framework for the management of Queensland native vegetation, and its broad-scale clearing. The framework is based on the regional ecosystem (RE) classification scheme.
- *Nature Conservation Act 1992*. This act relates to the conservation of protected areas, protection of wildlife and habitat, and the sustainable use of native wildlife and areas.
- *Environmental Offsets Act 2014*. This act provides the mechanisms by which unavoidable residual impacts on significant environmental matters can be compensated. Significant prescribed environmental matters can include species or ecosystems determined to be valuable. These are referred to as Matters of State Environmental Significance, as defined by the Environmental Protection Regulation 2008.
- *Biosecurity Act 2014.* This act relates to the management of invasive and pest species within Queensland.
- *Environmental Protection Act 1994*. This act aims to protect Queensland's environment while allowing for ecologically sustainable development.

Relevant guidelines include:

- Application requirements for activities with impacts to land (DEHP, 2017c).
- The Matters of National Environmental Significance: Significant Impact Guidelines Version 1.1 (DoE, 2013).
- Queensland Environmental Offsets Policy: Significant Residual Impact Guideline (DEHP, 2014a).

11.1 Baseline Environment

The site is in an area with a low average annual rainfall (464 mm, refer to Section 6.2), which drives the ecosystems that are typical of the North-west Highlands bioregion. These ecosystems are strongly influenced by cattle grazing, which is a driver of the ecological integrity of the area. This is particularly noticeable near the two stock-water dams, which are heavily overgrazed and denuded of vegetation cover to some distance from the water points. Despite this influence from cattle grazing, the site does support ecological values. Centrex commissioned NRC to conduct baseline terrestrial flora, fauna and aquatic ecology assessments to identify biodiversity values within the ML. The investigations undertaken by NRC are summarised in the following sections (see also Appendix D – Ecology Technical Reports).

11.1.1 Methodology

NRC's desktop assessments incorporated searches of State and Commonwealth environmental databases including Queensland Government Wildlife Online and the DEE Protected Matters Search Tool. Environmental mapping produced by DNRME, DEHP and DSITI were consulted, and literature reviews and previous studies of the Project area were undertaken.

The desktop assessment identified one near threatened flora species, eight listed fauna species, and six migratory fauna species with potential relevance to the ML. The desktop assessment identified that no threatened ecological communities (TEC) could potentially be within the ML, or within a 25 km radius of the ML. The Environmentally Sensitive Areas (ESA) map identified multiple areas of Category B ESA's within the ML, being Regional Ecosystem (RE) 1.3.7 with a biodiversity status of endangered in the Regional Ecosystem Description Database. Essential habitat for the Purple-necked Rock-wallaby is mapped within the ML.

NRC undertook two flora and fauna survey events, coinciding with timing for an early dry season survey between 31 May – 6 June 2017 and wet season survey between 19 – 23 March 2018.

To verify the RE extent and remnant status of the site's vegetation communities and perform targeted searches for threatened flora species, vegetation surveys conducted by NRC used the RE assessment techniques described in Neldner et al (2017) "Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland". The random meander technique was also employed to locate and identify protected EVNT flora species as per the DEHP (2014) "Flora Survey Guidelines – Protected Plants". A total of 27 RE and 40 quaternary assessments were conducted within the ML to ground-truth the state published RE mapping based on the floristic structure and composition of the vegetation communities.

Over the two survey periods, six systematic survey sites were selected to provide spatial distribution across different habitat types, using array of survey techniques such as Elliott traps, pitfall and funnel traps, cage traps, bat call detectors, active diurnal searches, diurnal bird surveys and nocturnal surveys. Figure 17 depicts the fauna survey types and locations selected by NRC.

11.1.2 Terrestrial Ecology

Eight REs were identified during vegetation ground-truthing, none of which are threatened ecological communities (TECs) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) (NRC, 2017). Aside from RE 1.3.7b, all other REs recorded and mapped within the ML have a 'least concern' status under the VM Act, and a 'no concern at present' biodiversity status. The RE 1.3.7b has an endangered biodiversity status, and, therefore, is an ESA under the EP Reg. Although no areas of regrowth or non-remnant vegetation are mapped within the mining lease, small areas have been cleared and modified to create stock-water dams for cattle. Similarly, small isolated areas of disturbance, from historical exploration activities, are present within the vicinity of the Project area (Figure 18).

All the REs, except one, have a 'least concern' status, and a 'no concern at present' biodiversity status under the *Vegetation Management Act 1999* (Qld) (VM Act). The RE 1.3.7b (the River Red Gum (*Eucalyptus camaldulensis*) fringing woodland on Split Creek and some other watercourses and margins) has an endangered biodiversity status, and, therefore, is an ESA and MSES under the EP Reg (see Plate 17). The on-the-ground extent of this community is less than that mapped on the certified RE mapping, that is, 29.2 ha as opposed to the mapped 119 ha (Figure 19). That vegetation, and other REs associated with the watercourses crossing ML5542 are also identified as MSESs.

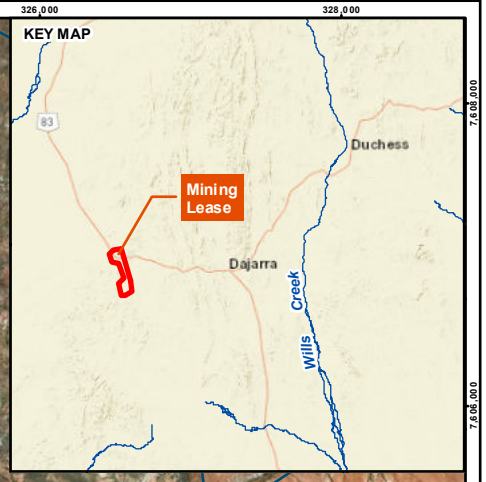
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BOULIA MOUNT ISA HIGHWAY

KEY MAP



Bat detector (night 4)
IR Camera Trap 3
Bat detector (night 1)
Bat detector (night 3)
IR Camera Trap 2
ML5542
Threatened Fauna
IR Camera Trap 1
Bat detector (night 2)

LEGEND

- Anabat Detector
- Infrared Camera
- Threatened Fauna
- Watercourses
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542
- Cadastre
- Purple Necked Rock Wallaby Habitat 200m Buffer

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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NOTE(S)
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)
Roads, Watercourses, Cadastre: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease and Exploration permit: © State of Queensland (DNRM) 2018
Regional Ecosystem Assessment, Purple Necked Rock Wallaby, Fauna Survey Sites, Batcage Survey Points, IR Camera Survey Points, Threatened Fauna: © NRC 2018
All other data: Provided by Centrex 2018

PROJECT
CENTREX ARDMORE PHOSPHATE

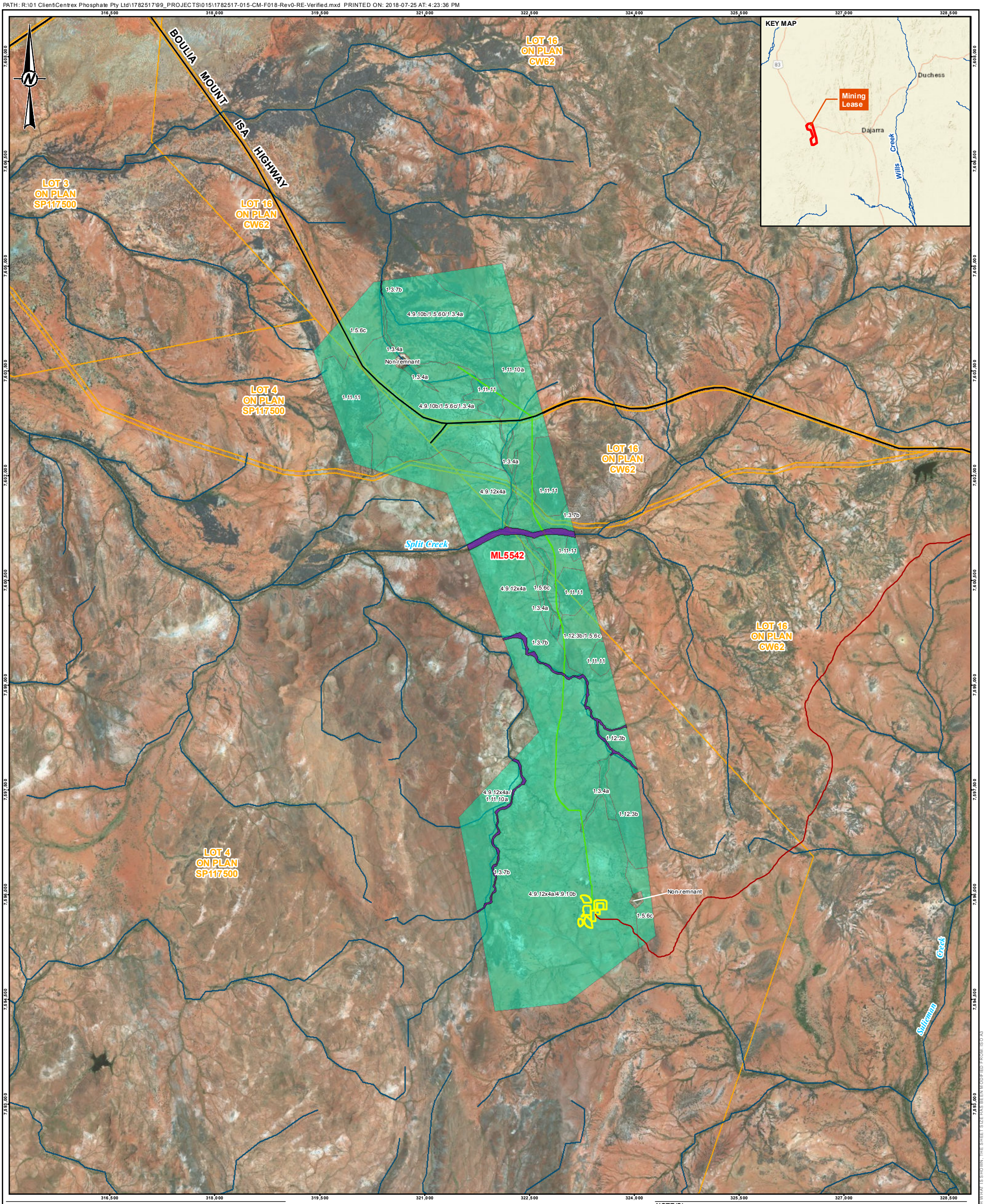
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LEGEND

- Watercourses
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation
- Cadastre

Remnant Regional Ecosystem

- Endangered (Dominant)
- Least Concern

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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APPROVED	JR

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)
Roads, Watercourses, Cadastre: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Remnant Regional Ecosystem: © NRC 2018
All other data: Provided by Centrex 2018

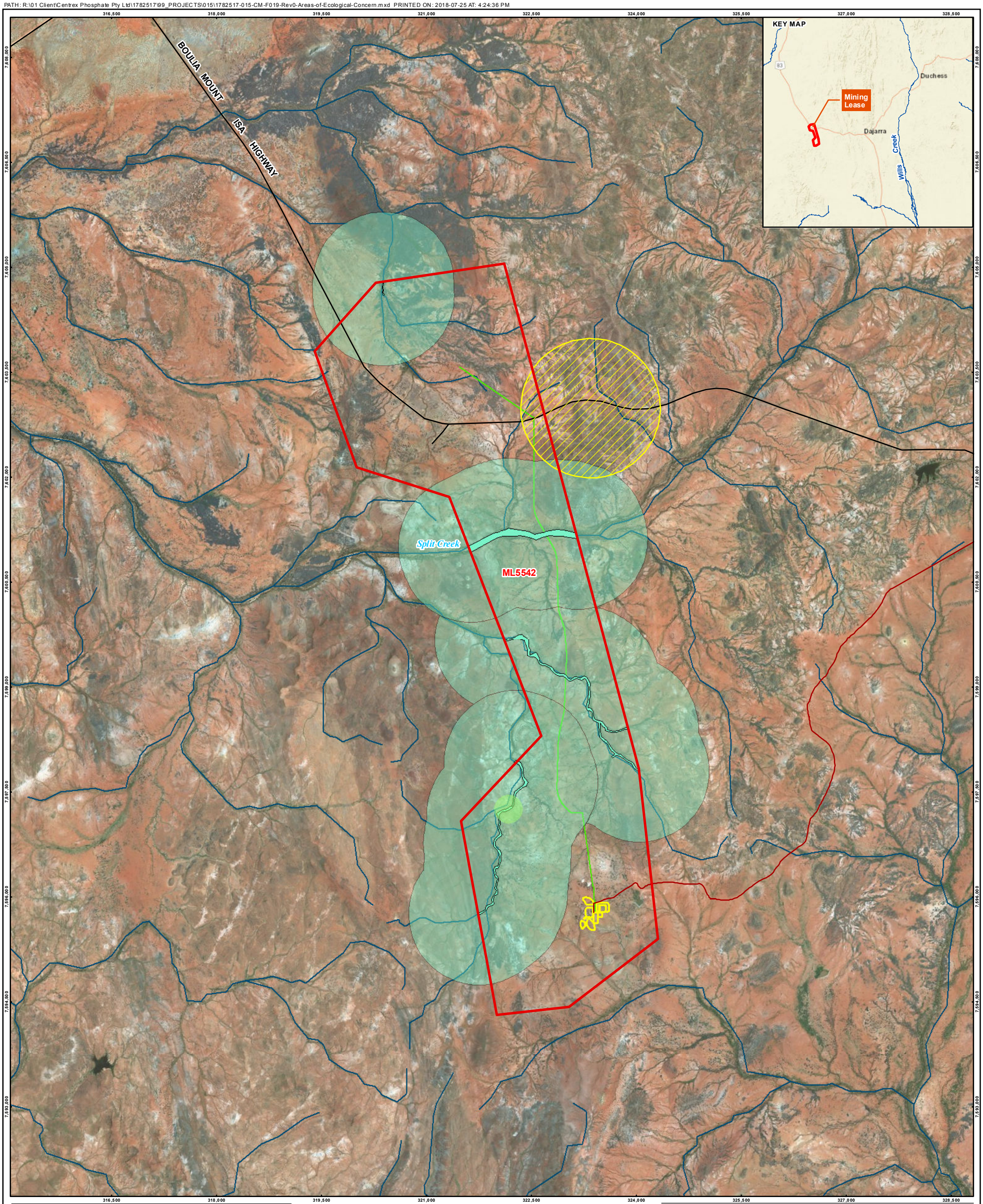
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LEGEND

- Watercourses
- Roads
- Access Track
- Water Pipeline and Access Track
- Start-up Operation Features

Centrex Mining Lease

- ML5542
- Essential Habitat
- Ground Truthed ESAs
- Ground Truthed ESAs 1km Buffer
- Purple Necked Rock Wallaby Observation Buffer (200m)

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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CLIENT
CENTREX PHOSPHATE PTY LTD

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APPROVED	JR

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Ground Truthed ESAs, Purple Neck Rock Wallaby Habitat © NRC 2018.
Roads, Watercourse, Essential Habitat: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018.
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PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
AREAS OF ECOLOGICAL CONCERN

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	19

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0 25mm

No distinct vegetation unit consistent with RE 2.3.18 (which is mapped as occurring in the mining lease), and has an 'of concern' biodiversity status, was confirmed within ML5542.

Cattle grazing has greatly reduced the biodiversity of the ground layer of most of the REs through direct grazing, and the introduction of pest plants. The introduced pasture grass, Buffel Grass (*Cenchrus ciliaris*) has invaded all riparian areas within ML5542, and this competition with native species has greatly reduced the biodiversity values of the riparian communities, particularly RE 1.3.7b (see Plate 17 and Plate 18). The invasive Mimosa Bush (*Vachellia farnesiana**) is commonly present in the shrub layer on the margins of riparian areas. Like Buffel Grass, Mimosa Bush is not a prohibited or restricted invasive plant in Queensland under the *Biosecurity Act 2014*, nor is it a declared weed within the Cloncurry Shire. While the canopy of the riparian community remains relatively intact, the biodiversity values of the understorey layers are severely degraded. Similarly, the REs away from the watercourses exhibit similar, albeit lesser, levels of degradation.

Eighty-one flora species, representing 31 families, are recorded within ML5542, none of which are listed under either the EPBC Act, or the *Nature Conservation Act 1992* (Qld) (NC Act). All the species recorded are common and widespread throughout the region. The vegetation diversity is reflective of the influences of cattle grazing.

Habitat values for most faunal groups were relatively low and sparsely distributed throughout ML5542. Connectivity values are limited given that the vegetation within the mining lease is part of a broader landscape. Limited microhabitat features, except in areas of rock outcrops and riparian communities, occur. Rocky outcrop features primarily occurred on the eastern and western borders of the mining lease where areas of eroded limestone or low outcropping hills were present. Small areas of limestone outcrops (typically less than 0.1 ha) occurred sporadically in the southern portion of the mining lease and provide some refugia for small fauna species in areas that were otherwise sparse and provided very limited fauna habitat. Distinct habitat features are associated with Split Creek, which has a large sandy bed, with mounds of woody debris collected in some areas and mature hollow-bearing River Red Gums. The only permanent water sources were the two stock water dams located in the north and south sections. Indeed, given the distinct seasonality of the rainfall, it can be expected that highly mobile species, in particular birds and bats, could move through the area during favourable times.

That paucity in habitat diversity is reflected in the fauna species recorded. Twenty species of mammals from ten families, 23 species of reptiles from eight families, three species of amphibian from two families, and 64 species of birds were recorded. Appendix D provides more information on the baseline terrestrial environment.

The environmental values present within the direct vicinity of the proposed start-up operation location were predominately very sparse with limited to no habitat values, on RE 14.9.12x4a/4.9.10b. Vegetation comprised a sparse ecotonal mix of *Acacia cambagei* and *Corymbia terminalis* very open woodland on skeletal soils, with large portion of the proposed start-up location containing only a sparse groundcover of *Enneapogon polyphyllus* (Plate 19 and Plate 20).



Plate 17: RE1.3.7b River Red Gum (*E. camaldulensis*) Fringing Open Woodland (NRC, 2017)



Plate 18: Narrow RE1.3.7b Riparian Community with Buffel Grass Invasion (NRC, 2017)



Plate 19: Current Site Condition – TSF Location facing North-West



Plate 20: Current Site Condition – Test Pit Location facing South-West

11.1.3 Aquatic Ecology

No wetland protection areas, wetlands of high ecological significance, or wetlands of international significance were identified during desktop or field-based assessments (NRC, 2017). The two stock water dams, located at the northern and southern ends of the mining lease, are the only permanent water sources within area.

Split Creek is the only aquatic ecological watercourse feature considered large enough to provide corridor connectivity values at the local scale within the ML. It is an ephemeral watercourse with a number of narrow tributaries which transects the centre of the ML in an east-west direction, with a sandy bed of approximately 40 m width and supporting a substantial River Red Gum community (NRC, 2017).

Given the ephemeral nature of the aquatic ecosystems within ML5542, Split Creek was the only site that contained enough water for aquatic macroinvertebrate sampling during the field-based assessment; macroinvertebrate index scores at this site were low, despite the habitat being considered 'good' (NRC, 2018a). The NRC Baseline Aquatic Ecology Report in Appendix D provides more information on the baseline aquatic environment.

11.1.4 Threatened Species and Communities

No threatened or near threatened flora species were confirmed within the ML (NRC, 2017). Although not recorded in the mining lease, potentially, the near threatened, widely distributed Maconochie's Mulla Mulla (*Ptilotus maconochiei*) could occur within suitable rocky habitat.

The RE 1.3.7b, a Category B ESA was confirmed within the ML (Figure 18) (NRC, 2017). The spatial extent of this RE within the ML (that is, 29.2 ha) was less than represented in the Queensland Herbarium RE mapping (which was 119 ha), with some areas mapped as RE 1.3.7b not supporting the River Red Gum (*Eucalyptus camaldulensis*), the defining species for this RE.

Despite intensive searches, no distinct vegetation unit consistent with RE 2.3.18 (identified in Queensland Herbarium RE mapping during desktop assessments), which has an 'of concern' biodiversity status, was recorded during the field surveys (NRC, 2017).

One threatened species of fauna was confirmed on the western edge of the ML - the State listed vulnerable Purple-necked Rock-wallaby. A population was recorded in an area consisting of outcropping limestone, watercourse and spinifex grasslands, a preferred food source of this species (refer to Figure 19 for location). A 34.8 ha area of essential habitat is mapped in the north-east of the ML boundary, with two observation records from 1976 and 1985 are associated with this area, however the ground-truthing of this area undertaken by NRC concluded the mapped essential habitat was considered marginal (NRC, 2018b).

Given their habitat requirements, the environmental values within the ML have a moderate or high likelihood of supporting an additional seven threatened species:

- Night Parrot.
- Red Goshawk.
- Painted Honeyeater.
- Carpentarian Antechinus.

- Plains Death Adder.
- Grey Falcon.
- Northern Leaf-nosed Bat.

The desktop assessment identified a further six migratory fauna which could utilise the environmental values of the ML. None of these species were recorded during field assessments, and all are considered to have a low likelihood of occurrence as it was determined The ML supports very few resources that would be important to the migratory species.

In order to determine if actions of the Project are likely to have a significant impact on any MNES, a self-assessment was undertaken using the EPBC Matters of Environmental Significance – Significant Impact Guidelines 1.1 (DoE, 2013). Refer to Appendix D for more information.

11.1.5 Environmental Values

The key environmental values of the area are summarised below:

- Remnant vegetation associated with a watercourse or drainage feature is classified as a MSES.
- The RE 1.3.7b, a Category B ESA was confirmed within the ML (29.2 ha), has an endangered biodiversity status, therefore is an ESA under the EP Reg.
- Split Creek which supports a substantial River Red Gum community, and more distinct riparian habitat values, including hollow-bearing River Red Gums is the only watercourse feature considered large enough to provide corridor connectivity values at the local scale within the ML.
- Threatened fauna and habitat for the State-listed vulnerable Purple-necked Rock-wallaby. While mapped Essential Habitat is located in one area to the north-east of the ML (34.8 ha within the ML boundary), field-based assessment confirmed a lack of essential shelter habitat factors. Suitable habitat features were identified outside the ML to the east and south that may provide shelter and breeding habitat for the Purple-necked Rock-wallaby (Figure 19).

Further details about the valued ecological components are provided within Appendix D.

11.2 Potential Impacts

This section provides a discussion of the potential impacts to ecological values as a result of construction and operation of the Project, and potential interactions with environmental values.

11.2.1 Project Footprint

During the construction, operations, and decommissioning of the Project, all Project features that have a physical footprint, such as the Project infrastructure, access road and water pipeline infrastructure (as detailed in Section 3.4) have the potential to affect environmental values.

During construction and operations, all Project activities and features can create physical barriers that impede or completely obstruct movement for a range of species. Complete barriers to movement can isolate patches of fauna habitat and can also isolate a subset of a population. This is particularly the case for less mobile and fossorial species.

11.2.2 Traffic

Increased traffic levels in the ML can increase the risk of valued component mortality through direct collisions with vehicles. Additionally, increased traffic into the area could: spread or introduce pests and weeds; and cause increased dust levels in areas adjacent to roads.

11.2.3 Vegetation Clearing and Site Preparation

Vegetation clearing and site preparation has potential direct and indirect impacts to MNES and MSES, including:

- Reduction in extent of Category B ESAs within the ML.
- Reduction in extent of State-mapped essential habitat within the ML.
- Reduction in extent of habitat for threatened fauna species.
- Reduction in habitat quality associated with impacts from dust, erosion, changes to habitat suitability and quality, etc.
- Direct mortality of threatened fauna and flora.
- Fragmentation of habitats, and reduction of connectivity in remnant vegetation patches.
- Creation of edge effects, which open up habitat in areas where it was previously continuous, leading to changes in the abiotic conditions and species composition. Depending on the species, edges can have either a positive or negative effect on habitat quality and quantity.
- Creating exposed soils which can create favourable habitats for weed species. Vegetation clearing and the use of earth-moving equipment can spread exotic and/or invasive plant species if equipment is not properly cleaned prior to procurement and mobilisation to the site. It is noted that the condition of vegetation within the local study area is already impacted by cattle grazing and introduced weeds.

Table 39 outlines area of clearance associated with the Project footprint, the RE and the percentage of RE that will be impacted within the ML.

Table 39: Area of Disturbance Associated with Project Footprint

Regional Ecosystem	Total Area within Mining Lease (ha)	Area to be disturbed (ha)	Area to be disturbed as a % of existing RE
RE 4.9.12x4a / 4.9.10b	663.5*	17	2.5%

*Total area of mixed RE 4.9.12x4a / 4.9.10b. Does not include individual RE 4.9.12x4a or 4.9.10b areas (combined total of 867.5 ha).

The proposed borrow pits for rock material will each be approximately 70 m x 70 m x 3 m depth. When determining the location of each borrow pit, a site selection process will initially assess the potential sites with sufficient quantity of extractive material within close proximity to where the material is required. A review of these sites will then exclude any sites that are within Cat B ESAs, MSES areas or areas of importance to the Purple-necked Rock-wallaby. Therefore, the borrow pit sites will avoid areas of high ecological value and minimise impacts.

The Start-up Operation will require sand prior to processing of the ore to facilitate dewatering. Approximately 500 m^3 of screened sand is proposed to be sourced from Split Creek prior to the commencement of mining. The sand will be sourced from an area that is devoid of vegetation, therefore no clearance will be required. The RE 1.3.7b (the River Red Gum fringing woodland on Split Creek and some other watercourses and margins) has an endangered biodiversity status, and, therefore, is an ESA and MSES under the EP Reg. River Red Gum vegetation will be avoided during extraction of sand and no significant impacts are expected to the ESA.

11.2.4 Dust and Air Emissions

Air emissions and dust created from construction and operation activities can affect habitat quantity and quality. Air emissions and dust sources include site clearing, preparation, and vehicle traffic. Dust deposition on vegetation, or in water, can reduce the quality of habitat, plant photosynthetic capacity, and food source availability and, in some cases, may degrade it to a point where the vegetation is no longer used as habitat by dependent species (Gleeson and Gleeson 2012).

A detailed noise and air quality assessment (Golder, 2018b) identified that, although products of combustion will contribute to the Project air emissions, the dominant emission during the Project will be airborne dust from the movement of vehicles on unpaved roads, windblown dust from exposed areas and emissions from the uplift and deposit of material through bulldozer action, loaders and stockpile creation. As products of combustion emissions are considered minor, and the Project is proposed to be operating for a relatively short time, products of combustion were not considered any further in this assessment.

At baseline, average dust concentrations were between 20 – 30 $mg/m^2/day$, while the inferred 75^{th} percentile concentration of PM_{10} for the area was 19.5 $\mu g/m^3$ (Golder, 2018b).

11.2.5 Sensory Disturbance

Sensory disturbances such as noise, vibration, light, and odour, have the potential to affect various species. Sensory disturbances can result in reduced use, or complete avoidance, of affected areas by some species, or, in the case of artificial lighting at night, may attract and increase use of an area by some species. The reduced use or complete avoidance of affected areas can create movement barriers, or adverse effects to reproductive success, or increase stress, leading to increased predator-prey interactions (for example, see Gleeson and Gleeson 2012).

Inferred baseline noise measurements for the ML are typical of rural areas with low background levels. Background (LA90) values of the day-time, evening, and night-time periods typically falling within a 20 dB range (Golder 2018a). Day-time background noise levels ranged from ~21 dB to 34 dB, evening noise levels ranged from 27 to 49 dB, while night-time background noise levels ranged from ~18 dB to ~38 dB (Golder, 2018a). Noise sources were expected and normal for such a rural setting and would be typically generated by wildlife and livestock. The highest levels of noise predicted to occur during construction, operation and decommissioning will occur within, and immediately adjacent to, the actual footprint of the Project. Predicted ambient noise levels during construction, operation, and decommissioning at the boundary of the footprint will be in the range from 81 to 118 dB (L_{Aeq}) (Golder, 2018b).

No specific vibration baseline data were available for the ML. Nevertheless, based on experience from similar projects, ground-based vibration levels during construction, operation, and decommissioning are predicted to be negligible. Ground vibration from heavy machinery and mining operations is not predicted to travel more than 100 m from the source (Chen *et al*. 2013).

Light disturbances will result from most Project infrastructure because facilities and other infrastructure must be lit at night to ensure minimum health and safety standards. Interactions between nocturnal species, such as terrestrial invertebrates, birds and bats, and light disturbances are predicted to be most important at the perimeter of the footprint, where light placement may be adjacent to habitat. Lighting can decrease habitat use by species, particularly nocturnal species adapted to night-time conditions, or lead to increased mortality of individuals that may be attracted to lights. Artificial night-time light has also been attributed to species disorientation, feeding and foraging changes, and implications for reproductive success and photosynthesis (Gaston *et al.*, 2013). For various reviews and examples, see Jetz *et al*. (2003), Bruce-White and Shardlow (2011), and Gleeson and Gleeson (2012).

Odours (for example, food) can attract certain animals, or they can elicit avoidance behaviours because the odours are associated with human presence. Odours will originate from human presence, petrochemicals and other chemicals, food, and garbage and waste management. Odours are predicted to have low consequences during construction, operation, and decommissioning.

11.2.6 Surface Water Quality

Altering vegetation and surface topography has the potential to impact surface water quality including:

- Soil loss and erosion resulting in increased sediment generation, particularly following rainfall.
- Surface water yield.
- Peak surface water flow values.

These have the potential to directly affect the Category B ESAs, which are located along watercourse and drainage features in the ML.

A detailed surface water impact assessment (Golder, 2018d) concluded that the Project will increase surface water yield and sediment generation, but have negligible impact on peak flows within the ML. The Project has the potential to increase the presence of contaminants (associated with spills, leaks etc.) and therefore contaminant run-off, which could affect aquatic habitats.

Changes to water quality and reduction in surface water flows can result in changes in habitat quantity and quality, particularly for aquatic and semi-aquatic species (for example, frogs). Changes in surface water flows can cause changes to soil, vegetation, riparian ecosystems, and wetlands, thereby affecting habitat quantity and quality. However, any such changes in habitat quantity and quality are expected to be negligible given the very seasonal nature of the water flows in the ML, and the short duration of the Project. Furthermore, the footprint of the Project makes up less than 0.1% of the Regional Study Area (RSA); therefore, the impacts are minimal and manageable with appropriate erosion and sediment control measures.

11.2.7 Invasive and Pest Species

Invasive and pest species can quickly establish in disturbed areas and compete with native species. Two invasive pest plant species and two pest fauna species were observed within the ML (NRC, 2018b).

Vegetation clearing has the potential to introduce or spread species through mobilisation of equipment, which has not been properly cleaned, and by creating soil disturbance. The presence of waste may attract pest fauna species.

Pests and invasive species have the potential to impact MNES and MSES.

It is noted that the condition of vegetation within the ML is already impacted by cattle grazing and introduced weeds (NRC, 2017).

11.2.8 Environmental Offsets

The *Environmental Offsets Act 2014* provides the mechanisms by which unavoidable residual impacts on significant environmental matters can be compensated. Significant prescribed environmental matters can include species or ecosystems determined to be valuable.

Environmental offsets work by securing land elsewhere to replace those significant environmental matters which were lost through unavoidable residual impacts, therefore, counterbalancing the impact of undertaking a prescribed activity.

No significant impacts are expected as a result of the Project. Offsets are not considered to be a mitigation measure required to manage any potential impacts within the scope of the Project.

11.2.9 Major Hazards

Hazards, such as oil and chemical spills and accidents, have the potential to reduce habitat quality and quantity. However, oil and chemical handling, storage, and spill response are expected to be part of standard policies and Environmental Management Plans.

11.3 Avoidance, Mitigation and Management Measures

The following section describes the mitigation measures that Ardmore will use in the design, construction, operation, and decommissioning of the Project.

- Location of the Project infrastructure
  - Away from the south-west area of the ML where Purple-necked Rock-wallaby were observed utilising rock outcrop habitats, including the associated spinifex grasslands (200 m radius), with no development planned to take place within the area where Purple-necked Rock-wallaby were observed or the associated spinifex grasslands.
  - The temporary water pipeline will predominately be laid on top of ground, and only buried at the highway and three creek crossings with placement to avoid vegetation where practicable.
  - An access track will be formed along the water pipeline route to assist maintenance purposes.
  - Minimising the disturbance footprint, including locating infrastructure in already disturbed and affected habitats.
  - Access and road network has been planned to minimise total length and reduce the width of roads where practicable (limited to 5 m). Existing tracks will be utilised for ore haulage and upgraded rather than construction of new roads.
  - Clearly marked proposed clearing boundaries to minimise the potential for over-clearing or unnecessary habitat disturbance.

- Conduct progressive site clearing in a pattern to avoid creating habitat ‘islands’ within the footprint, and to allow any fauna present in the area to move to areas away from construction activities.
- Conduct site clearing so that progression of clearing moves animals towards intact habitat.
- To minimise potential interaction with nocturnal species, vegetation clearing activities will be restricted to daylight hours.

- Reduction of physical hazards
  - Restrict vehicle speeds (40 km/h for heavy vehicles, 60 km/h for light vehicles).
  - Minimise the number of vehicles using roads where practicable (e.g., use of buses).
  - Gaps will be left between stockpiles to reduce potential physical barriers and allow fauna passage.
  - Placement of soil stockpiles and bunds to avoid drainage features.
- Soil management
  - Construction activities, including vegetation clearing and soil movement, will work from areas with fewer weed species/smaller infestations towards areas where there is a greater abundance of weeds, where practicable.
  - Inspection of vehicles and equipment brought onto site to ensure they are free of dirt and other material that may contain weed seeds.
  - Regular monitoring of disturbance sites and stockpiles for establishment of weed species. New weed species will be assessed, and appropriate control measures implemented.
- People management
  - Cleary marking the boundary of ESAs, buffer zones and essential habitat to prohibit entry and prevent unnecessary disturbance.
  - Mandatory environmental training for all workers and contractors that highlights conservation issues and species-specific sensitivities.
- Dust, light and noise
  - Water spraying on crushing plant, stockpiles, and mobile plant on-site, when appropriate, to reduce fugitive dust emissions.
  - Stripping of topsoil limited to the immediate area to be extracted.
  - Soil stockpiles limited to 2 m in height to reduce wind-blown dust.
  - Overburden stockpiled separately for future use.
  - Covered truck loads, and stockpiles where appropriate.
  - Assessing weather forecasts and planning disturbance activities to avoid high wind conditions, where practicable.
  - Selection of equipment with lower sound power levels.

- Mobile equipment is turned off when not in use.
- Equipment maintenance in accordance with manufacturer's specifications.
- Manage light sources including using the minimum number and brightness of lights required for safety, not using bare light bulbs or any lighting pointing upward or outwards, particularly at the periphery of the Project footprint.

- Reclamation and rehabilitation
  - All disturbed areas will be returned to their original levels and stockpiled top soil spread after completion of the Project (limited vegetative groundcover).

11.4 Residual Impact

It is unlikely that a site disturbance caused by the development and operation of the Project will cause any significant residual impacts to the MNES and MSES of the ML. The Project disturbance footprint is minimal and the area is already degraded, with impacts expected to be negligible once the site is rehabilitated. Table 40 provides a summary of residual impacts.

Table 40: Summary of Ecology Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
10	Disturbance to Category B ESA State-listed vulnerable Purple-necked Rock-wallaby essential habitat	Very Sensitive	Negligible	Minor
11	Disturbance to River Red Gum community	Moderate	Negligible	Minor

11.5 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant Environmental Protection Policy.

This section (Section 11.0) demonstrates how the following environmental objective and performance outcomes (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna.
- **Performance Outcomes:**
  - Activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land, and

- Areas disturbed will be rehabilitated or restored to achieve sites that are:

  i) safe to humans and wildlife

  ii) non-polluting

  iii) stable; and

  iv) able to sustain an appropriate land use after rehabilitation or restoration.

- The activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants.
- The application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

12.0 SURFACE WATER

This section describes the existing (baseline) surface water values and potential impacts to surface water from the proposed Project. It also provides proposed mitigation and management measures to reduce the potential impacts. A supporting Surface Water Impact Assessment for the Project has been prepared by Golder to support this EA application (see Appendix E – Surface Water Technical Report).

In Queensland, environmental impacts associated with surface water are regulated under the EP Act, EP Regulation, the *Water Act 2000* and the Environmental Protection (Water) Policy 2009 (EPP Water).

This assessment has been conducted in accordance with the requirements of the DEHP *Guideline, Application requirements for activities with impacts to water* (DEHP, 2017e).

12.1 Baseline Environment

The baseline assessment for surface water includes an assessment of existing environmental values in the Mining Lease area, including surface water quality and quantity, and hydrology assessments including yield assessment modelling and peak runoff assessments of the relevant catchments.

12.1.1 Surface Water and Hydrology

The Project is situated in the Georgina River Basin, which is based around the Georgina, Burke, and Hamilton Rivers. The basin is approximately 325 000 km^2 in area and extends from north-western Queensland and into the Northern Territory. The main surface water resource of the Georgina River Basin is the Georgina River. Split Creek, a tributary of Georgina River, flows east to west through the centre of the ML, and within the ML, a smaller drainage line flows southward from the southern catchment which flows into Sulieman Creek, into the Burke River, and eventually into the Georgina River.

The climate and hydrology in the Project area is characterised as hot, semi-arid with a pronounced wet season from December to March. This coincides with very high temperatures with maximums averaging 36.5°C. Minimal rain falls occur from June to September with daytime maximum temperatures remaining moderate at an average 24.3°C.

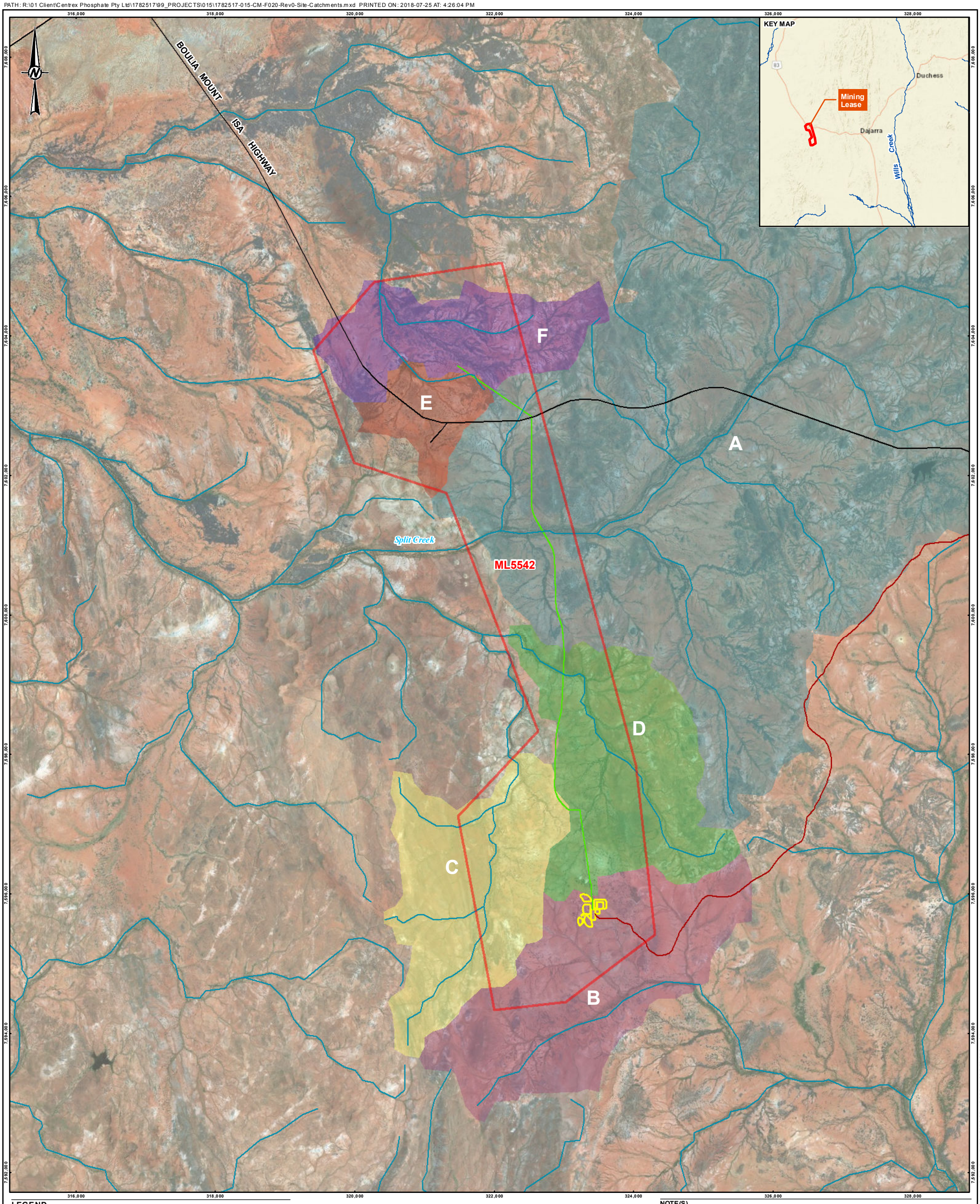
Due to the pronounced wet and dry seasons the majority of streamflow occurs in the summer months often associated with monsoonal activity. For runoff to occur the precipitation needs to be significant or prolonged enough to fill the soil surface stores and generate runoff. A significant amount of this runoff will also then infiltrate to the alluvium of the ephemeral streams.

Appendix E Surface Water Technical Report mapped the sub-catchments within the ML area. The largest site catchment has been labelled as Catchment A and is on Split Creek. The Project is located within a small sub-catchment, termed Catchment B on Figure 20. The area of each defined catchment is provided in Table 41.

Table 41: Site Catchments

Catchment	Area (km^2)
A	78.1
B	8.6
C	7.0
D	7.3
E	1.8
F	4.6

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LEGEND

- Watercourses
- Water Pipeline and Access Track
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Site Catchments

- A
- B
- C
- D
- E
- F

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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1:50,000 at A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Watercourse, Cadastre, Essential Habitat: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018.
All other data: Provided by Centrex 2018

CLIENT
CENTREX PHOSPHATE PTY LTD

PROJECT
CENTREX ARDMORE PHOSPHATE

CONSULTANT
GOLDER

YYYY-MM-DD	25/07/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

TITLE
SITE CATCHMENTS

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	0	20

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0 25mm

12.1.2 Surface Water Quality

A desktop review of publicly available surface water information as well as results from a Baseline Survey has been undertaken to determine the baseline water quality of watercourses on the Project tenure area. The existing land has been historically degraded from land-clearing and stock grazing contributing to erosion and sedimentation.

The Department of Natural Resources and Mines and Energy Water Monitoring Information Portal (DNRM, 2017), provides an online register of water quality data from monitoring locations throughout Queensland. There are two water quality monitoring locations (listed on the DNRM portal) are located within 150 km of the site and provide some indication of potential background water quality at Ardmore. One location is at the Burke River at Boulia and one location is at the Georgina River at Roxborough Downs. Specific details of the monitoring site locations are provided in Appendix E.

Relevant measured water quality parameters are provided in Table 42 including pH, Total Dissolved Solids (TDS), Turbidity, Electrical Conductivity (EC), Total Suspended Solids (SS), Total Hardness as $CaCO_3$ (Total Hardness) and Dissolved Oxygen (DO). Water quality parameters are provided as the 5th percentile, mean and 95th percentile of available records and are compared to the Australian Drinking Water Guidelines (NHMRC, 2016) and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Stock Water (ANZECC, ARMCANZ, 2000).

Of those parameters recorded at Burke River at Boulia, the only exceedances of the Drinking Water Guidelines (NHMRC, NRMMC, 2011) are for Turbidity for the 5th percentile, mean and 95th percentile results. There are no exceedances of the Stock Water Guidelines (ANZECC, ARMCANZ, 2000).

Table 42: Summary Water Quality Parameters Compared to Guideline Values (Burke River at Boulia)

Analyte	Unit	Drinking Water (NHMRC, NRMMC, 2011)	Livestock (ANZECC, ARMCANZ, 2000).	5th Percentile	Mean	95th Percentile
pH	pH Unit	6.5 - 8.5	NA	7.4	7.6	8.0
TDS	mg/L	600	4000	61	125	269
Turbidity	NTU	5	NA	8	149	460
EC	µS/cm	746	NA	88	215	446
TSS	mg/L	NA	NA	3	105	400
Total Hardness	mg/L	200	NA	34	82	147

NA: No value available

Of those parameters recorded at Georgina River at Roxborough Downs, the 95th percentile pH, TDS, EC and Total Hardness as CaCO3 values exceed the Drinking Water Guidelines (NHMRC, NRMMC, 2011).

Turbidity exceeds the Drinking Water Guideline (NHMRC, NRMMC, 2011) for 5th percentile, mean and 95th percentile measured results (refer to Table 43). There are no exceedances of the Stock Water Guidelines (ANZECC, ARMCANZ, 2000).

Table 43: Summary Water Quality Parameters Compared to Guideline Values (Georgina River at Roxborough Downs)

Analyte	Unit	Drinking Water (NHMRC, 2016)	Livestock (ANZECC, 2000)	5th Percentile	Mean	95th Percentile
pH	pH Unit	6.5 - 8.5	NA	7.0	7.6	8.6
TDS	mg/L	600	4000	77	362	1004
Turbidity	NTU	5	NA	8	149	460
EC	µS/cm	746	NA	114	556	1677
TSS	mg/L	NA	NA	7	86	211
Total Hardness	mg/L	200	NA	40	163	418
DO	% saturation	NA	NA	4.9	6.3	7.7

Northern Resource Consultants conducted a 2018 baseline wet season receiving environmental monitoring program (REMP) within the ML (Appendix D). This consisted of surface water quality sampling at three sites, as well as stream sediment quality sampling at 11 sites. Findings of the monitoring program have been summarised below.

Note that due to the intermittent nature of flow on the site, only one round of surface water samples was collected. Only three of the eleven sites had sufficient water for surface water quality sampling. Sites with water were included and there were two on Split Creek (ARD4 and ARD6), and one on its tributaries (ARD5). A summary of surface water quality results is presented below.

- pH was above the ANZECC trigger values for toxicants for the protection of slightly to moderately disturbed systems (pH 6.0 – 7.5) at ARD4 (pH 7.6).
- EC was above the QWQG salinity guideline (200 µS/cm) at ARD4 (398 µS/cm).
- DO was below ANZECC guideline range (90 – 120 %saturation) at all sites sampled (69.1, 6.8, 20.9 %saturation at ARD4, ARD5, ARD6 respectively).
- Filterable reactive phosphorus (FRP) was above the ANZECC guideline (0.005 mg/L) at all of the sites sampled (0.016, 0.049, 0.015 mg/L at ARD4, ARD5, ARD6 respectively).
- Total aluminium concentration was elevated above the guideline value (0.055 mg/L) at ARD5 (0.15 mg/L).
- Total and dissolved uranium concentrations were below the LOR at all sites; however, the LOR (1 µm/L) was higher than the relevant guideline value (0.5 µm/L).

- All other physico-chemical parameters and metal concentrations were below published guideline values.

Stream sediment quality was sampled at eleven sites. A summary of sediment quality has been presented below.

- Most sites consisted of sediment of coarse and large-medium sand (300 µm – 2 mm), which accounted for 67% on average of stream sediment.
- Fine fraction sediment (<63 µm) represented less than 10% of the sediment at each site, with the exception of ARD10 which consisted of over 20% fines.
- Concentrations of metals in stream sediment varied considerably between sites however, there were no exceedances of metals exceeding guideline values.
- Significant variation in stream sediment nitrogen and phosphorus. Total Kjeldahl phosphorous (TKP) ranged from 170 mg/kg at AD4 and 17 000 mg/kg at ARD7.

12.1.3 Environmental Values

The EPP Water defines the environmental values and water quality objectives for the surface water environment in Queensland. The Project tenure is situated in the Georgina River Basin. There are no water quality objectives prescribed in the EPP Water for the Georgina River Basin.

In accordance with the EPP Water, if there are no prescribed specific environmental values or water quality objectives for the waters on, or adjacent to, the site, then the water quality objectives are the set of water quality objectives that will protect all environmental values for the water.

These are, in order of preference: site specific documents for the water, any Queensland water quality guidelines or any Australian water quality guidelines. Local water quality objectives can also be derived using the Queensland water quality guidelines procedures.

12.2 Potential Impacts

The Project infrastructure footprint is a small development relative to the area of the ML, and to the catchment on which the Project is located. The Surface Water Impact Assessment (Appendix E) focused on the following:

- Impact of the Project on water quality of stormwater runoff and consequently the receiving watercourse.
- Impact of land disturbance caused by the development of the Project infrastructure on water quality of stormwater runoff and consequently the receiving watercourse.
- Impact of the Project infrastructure footprint on the volume of runoff (annual yield) produced by stormwater runoff.
- Impact of the Project infrastructure footprint on the peak flows of stormwater runoff.

12.2.1 Water Quality

There are many sources of contaminants on the Project site which can be mobilised by surface runoff and result in pollution to the environment.

The TSF will be designed to allow for the appropriate storage capacities and water management requirements to ensure dam safety as well as environmental safety. The tailings and water stored in the TSF are likely to be of quality exceeding the water quality guidelines discussed in Section 12.2.1. Appropriate storage allowances built into the design will reduce the risk of spill from the dam.

Surface water generated from the Project can be categorised into clean water (i.e., from undisturbed or rehabilitated areas), dirty water (i.e., from disturbed areas that have not come into contact with contaminants) or contaminated water (i.e., runoff that has come into contact with contaminants).

The Southern Zone, which includes the Project area contains footwall material which is completely oxidised and the potential for PAF material in this area is negligible.

The environmental risks associated with management of water from surface material during mining, temporary stockpiling and ultimate placement of overburden during rehabilitation is relatively low.

The likely sources of contaminated water at the Project site are chemical and hydrocarbon spills from the site.

A summary from Appendix B is provided below:

- **Ore and tailings streams –** Sampling has found ore and tailings streams are non-acid forming (NAF) and geochemically benign, with low risk of generating acidic or saline drainage.
- **Overburden –** Sampling suggests overburden materials taken from the south of the ML are NAF. Some samples showed elevated EC measurements.
- **Basement/Footwall units –** Sampling has identified basement/footwall units in the Southern Zone as being completely oxidised and the potential for PAF material in this area is negligible.
- **Vehicles, mine plant and equipment, storage areas, and washdown areas** – Leaks and spills of chemicals and hydrocarbons are possible from these areas.

The contaminants have potential impacts to receiving environments including:

- Reduction of soil productivity due to excess salts.
- Affect the growth of aquatic plants.

These impacts are expected to be contained to waterways and soils downstream of the contaminant within the ML. The duration of these impacts is predicted to be short-term due to the ephemeral nature of the drainage lines in this area – watercourses often dry out within a few weeks after rainfall events. The impacts are expected at a low frequency associated with rainfall events.

Contamination to water could occur as a result of minor leaks or accidental spills of liquid hydrocarbons, fuels, lubricants and chemicals, as well as releases caused by accidents (e.g., fuel tank failure, oil spillage).

It is likely that in the event of contaminant spills or leaks from the operation of the Project, contaminants are unlikely to enter watercourses and would be able to be contained through implementation of standard spill management procedures. The topography across the site is quite flat, minimising the reach of any spills or leaks and the likelihood of contaminants reaches watercourses. Furthermore, due to the ephemeral nature of the watercourses on the ML, even if the contaminant reaches a drainage line, it is likely that there will be low or no flows in the watercourse to receive and propagate the contaminant downstream.

In the event that a spill or a leak occurs concurrently to a rain event it is likely that the volume of runoff will dilute the concentration of contaminant in the stream.

The mining of sand within Split Creek to aid in the processing of phosphate could potentially alter the flow of the watercourse and disturb the stream bank if not undertaken appropriately.

12.2.2 Sediment and Soil Loss

Sedimentation due to land disturbance is likely to be the most relevant water quality issue for the development of the Project. Soil losses expected from existing and expected site conditions have been calculated to give indication of the magnitude of potential water quality issues.

The assessment of soil loss rates has been provided in Section 9.2.1 (Soil Erosion).

Impacts to water quality from sedimentation are expected to be contained to waterways downstream of the Project. The duration of impacts to aquatic environments are predicted to be short term due to the ephemeral nature of the drainage lines in this area – watercourses often dry out within a few weeks after rainfall events. The impacts are expected at a low frequency associated with rainfall events.

12.2.3 Surface Water Yields

The volume of surface water available on the Project site is likely to increase slightly from the development of the Project. Natural land cover generally infiltrates more water than cleared or developed surfaces. As the natural land cover of the existing site is cleared and turned into hardstand areas with diminished infiltration properties, more runoff will be available on the surface. This will result in increased annual surface water yield (Appendix E provides the calculations).

The Project development increases the volume of runoff off. However, the increase is minimal considering the spread of this yield across a year.

12.2.4 Peak Flows

Peak flows are expected to increase marginally due to the development of the Project. Natural land cover generally has higher surface roughness properties. Rough surfaces increase the time taken for runoff to flow, and thus reduces the magnitude of peak flow. As the area of natural land cover is reduced by the Project development, it is expected that peak flow off the catchment will increase.

Increases in peak flows can result in increased erosion through channels, and increased flood extents. However, the small increase in peak flows through the catchment is likely to have negligible impact on the receiving environment.

12.3 Avoidance, Mitigation and Management Measures

This section identifies proposed mitigation and management measures to lower the potential for impacts to water quality and downstream impacts from predicted increases to surface water yields and peak flows.

Potential impacts to downstream from changes in stream flow are considered to be negligible and no mitigation or management measures are proposed.

Measures to reduce impacts water quality include the following:

- Spill control procedures:
  - Ensure that all plant and equipment used in the construction and operation of the Project is maintained appropriately to minimise spills and leaks of contaminants.
  - Any activities that may carry a high risk of spills or leaks should be managed to minimise the risk.
  - Management of ore loading, transport, and unloading should be undertaken by trained personnel.
  - Implement spill emergency response procedures.
  - Dust suppression measures over the ore stockpile, when appropriate.
  - Drainage and water management systems for stockpile areas.
- Erosion and sediment control measures:
  - Minimise disturbance and retain natural vegetation.
  - Schedule works to minimise soil exposure during rainy season.
  - Vegetate and mulch areas disturbed areas where possible.
  - Minimise slope steepness and slope length by using benches, terraces, contour furrows or diversion ditches.
  - Stockpiles to be located outside limits of drainage lines.
  - Keep sediment on-site by using sediment traps, bunding, or sediment barriers.
  - Monitor and inspect sites frequently and correct problems promptly.

The extraction of sand from Split Creek will involve:

- Minimising the extent of the area required to carry out the activity to be limited to the minimum area necessary to reasonably carry out the works.
- Disturbed banks will be returned to a profile similar to the pre-disturbance condition.
- Natural stream bed controls or features that create natural waterholes (e.g., riffles, logs, sediment or rock bars) will not be lowered or removed.

12.4 Residual Impact

Table 44 provides a summary of the residual impacts of the Project on surface water following successful implementation of the proposed management measures.

The potential impacts and effect on the water quality will be short in duration (at the most 6 months if the Full-scale Operation does not proceed). The volume of fuels and chemicals on site will be minor, therefore if any accidental leaks or spillages occur, the impact will be reversible. Mitigation is adequate and achievable for all potential impacts therefore the intensity ranking is low and overall residual impact is minor.

Table 44: Summary of Surface Water Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
12	Reduction in water quality due to accidental spills and leaks of fuels and chemicals.	Not sensitive	Low	Minor
13	Reduction in water quality due to sedimentation from erosion.	Not sensitive	Low	Minor

12.5 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant Environmental Protection Policy, such as the EPP (Water).

This section (Section 12.0) demonstrates how the following environmental objective and performance outcomes (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity will be operated in a way that protects the environmental values of waters.
- **Performance Outcomes:**
  - The storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks.
  - Contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water.
  - The activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment.
  - Any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland.
  - The activity will be managed so that adverse effects on environmental values are prevented or minimised.

13.0 GROUNDWATER

This section describes the existing (baseline) groundwater values and potential impacts to groundwater from the proposed Project. It also provides proposed mitigation and management measures to reduce the potential impacts. A supporting Groundwater Impact Assessment has been prepared by Golder to support this EA amendment application (see Appendix F - Groundwater Technical Report).

In Queensland, environmental impacts associated with groundwater are regulated under the EP Act, EP Regulation, the *Water Act 2000* (Water Act) and the Environmental Protection (Water) Policy 2009 (EPP Water).

This assessment has been conducted in accordance with the requirements of the DEHP Guideline, Application requirements for activities with impacts to water (DEHP, 2017e). The EP Act (Exercising water rights section 227AA and S126A) and the DEHP Guideline, Requirements for site-specific and amendment applications – underground water rights (DEHP, 2016c) has also been used to guide this section.

Resource operators have the right to take associated water under the *Minerals Resource Act 1989*. Associated water (e.g., from dewatering) is considered to be a by-product from the mining process. The Start-up Operation will not require dewatering during mining operations and therefore no associated water extraction is required.

Resource operators also have an obligation to comply with the underground water management framework under the Water Act. The underground water management framework requires that resource operators undertake a number of assessments and plans that relate to groundwater. The 'Baseline Assessment Plan' guideline (ESR/2016/2004) provides guidance for resource tenure holders in preparing and complying with a Baseline Assessment Plan (BAP) in accordance with sections 397 to 401 of the Water Act. A BAP identifies water bores located on a holder's tenure and sets out a timetable for undertaking baseline assessments of those bores.

Chapter 3 of the 'Baseline Assessment Plan' guideline requires that the ML holder must identify whether any water bores, registered or unregistered, exist on the tenure. Where it can be verified that there are no water bores located in the area of a resource tenure, a BAP is not required.

A review of the registered groundwater bores has been undertaken (Section 13.1.1). There are no landholder water bores within the ML and therefore a BAP is not required. Centrex will advise the Chief Executive of the department as early as possible that this is the case.

13.1 Baseline Environment

In a regional context, the ML is located within an outlier of the Georgina Basin which extends across the Queensland - Northern Territory border. This basin is described as a large northwest-southeast trending extensional sedimentary basin, containing mainly Cambrian-Ordovician dolomite and limestone aquifers, with some sandstone aquifers around the southern margin. Tertiary aquifers occur in small overlying basins. Groundwater flow is partly northwest to an internal drainage basin and partly southeast down the Georgina Valley and ultimately beneath the Great Artesian Basin.

13.1.1 Registered Groundwater Bores

The Queensland Globe database shows 510 registered bores within 75 km of the Project, including 266 yielding bores. The majority of the high yielding bores are located in close proximity to the Phosphate Hill Mine Site (Operated by Incitec Pivot Limited), approximately 75 km from the ML.

Four bores were identified within 10 km of the Project area. A summary of the registered bores is presented in Table 45. The locations of the 510 registered bores are shown in the Groundwater Impact Assessment Report (Appendix F).

There is no extraction rate information available for all the registered bores except Bore ID 118041A that has a reported yield of 0.5 L/s.

The search identified a registered bore (bore ID 5495A) which was mapped as being located on the ML (Figure 21). The database indicated that the bore was drilled in 1950 and it has been abandoned. On ground surveys have not located the bore and the landowner advised that there are no bores (registered or unregistered used by the landowner) within the ML area.

The nearest third-party production bore (Ardmore bore, RN5496) is located outside of the search area, about 11 km northwest to the project area. The drilling and installation of the bore was conducted early 1919 and the bore depth is 186.5 m below ground level. Bore cards of these four registered bores are attached in Appendix F.

Table 45: Summary of Registered Bores within 10 km from the Project Area

Bore ID	Distance from proposed groundwater extraction (km)	Bore Depth (m)	Drilled Date	Easting (m)	Northing (m)	Purpose	Status
5189	10	Unknown	Unknown	327677	7593150	Unknown	Decommissioned
5188	10	Unknown	30/09/1943	331373	7600251	Unknown	Decommissioned
5495A	1.5	29	10/07/1950	320024	7602481	Unknown	Abandoned. Bore does not exist / not located on the ground
118041A (Frank's bore)	5	30	10/09/2002	315702	7603000	Unknown	Functional

Bore ID	Distance from proposed groundwater extraction (km)	Bore Depth (m)	Drilled Date	Easting (m)	Northing (m)	Purpose	Status
RN5496	8	186.5	1919	312280	7603476	Production bore (Ardmore Bore)	Unknown

13.1.2 Groundwater Dependent Ecosystems

A Groundwater Dependent Ecosystem (GDE) is defined as an ecosystem which requires access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Wetland info, 2014). Ecosystem dependency on groundwater may vary over time and depending on location. GDEs include aquifer, caves, lakes, palustrine wetlands, lacustrine wetlands, rivers and vegetation.

Appendix F (Groundwater Technical Report) used two sources to identify potential GDE settings:

- The Queensland GDE mapping layer.
- The Australian GDE Atlas.

The Queensland GDE mapping layer includes coverage for the Project for Subterranean GDE identical to the coverage provided by the Australian GDE Atlas.

The GDEs identified with the Australian GDE Atlas are shown to potentially be in the western and southern parts of the ML and are mapped as being of Aquatic, Subterranean and Terrestrial type. Potential GDE locations and the identified local registered groundwater bores are presented together in Figure 21.

PATH: R:\01 Client\Centrex Phosphate Pty Ltd\1782517\99_PROJECTS\015\1782517-015-CM-F021-RevA-Potential_GDE-Drawdown_contour.mxd PRINTED ON: 2018-07-25 AT: 4:03:15 PM

316,000 318,000 320,000 322,000 324,000 326,000 328,000

7,608,000 7,606,000 7,604,000 7,602,000 7,600,000 7,598,000 7,596,000 7,594,000 7,592,000

BOULIA MOUNT ISA HIGHWAY

1 m

1.5 m

0.5 m

118041A

5495A

Split Creek

ML5542

5189

Sellheim Creek

KEY MAP

Mining Lease

Duchess

Dajarra

Wills Creek

83

LEGEND

- Registered Bores
- Watercourses
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542
- Inferred Groundwater Drawdown (m) - Most Conservative Scenario
- Inferred Groundwater Drawdown (m) - Least Conservative Scenario
- Subterranean GDEs
- Terrestrial GDEs

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 500 1,000 1,500 2,000
1:50,000 at A3 METRES

CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	25/07/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	JR
APPROVED	JR

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Major Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.
GDE Data: © State of Queensland (Department of Science, Information Technology and Innovation) 2017.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
POTENTIAL GDES AND DRAWDOWN CONTOURS

PROJECT NO.	CONTROL	REV.	FIGURE
1782517	015	A	21

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

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A full review of the identified GDEs can be found in the Groundwater Impact Assessment (Appendix F). There are no GDEs mapped in the area of the Project. The findings are summarised below:

- **Subterranean GDEs.** The Australian GDE Atlas indicates an area of "Derived GDE – Unknown Confidence" along the western border the northern half of the ML. The presence of potential GDEs in this area has not been investigated.
- **Terrestrial GDEs.** The potential terrestrial GDEs nominated in the area relate to the "*Eucalyptus spp* low open woodlands often with Triodia dominated ground layer". The Queensland GDE Atlas defines it as a moderate potential GDE. The groundwater table in the area containing this potential terrestrial GDE occurs between 8 and 19 m below ground level and as such is not sustaining these plants.
- **Aquatic GDEs.** The desktop search from Atlas GDE identified Split Creek as being having potential for an aquatic GDE. The aquatic GDE dataset expresses the potential for groundwater interaction for rivers, springs, and wetland ecosystems across Australia. It shows the ecosystems that potentially rely on groundwater that has been discharged to the surface, for example, as baseflow or spring flow. The field activities carried out onsite included a walkover of the entire site and the drilling of a monitoring bore close to Split Creek (MB002). Split Creek has been identified as an ephemeral creek and a recharge area for the aquifer, with the water table within the BCF in the vicinity of Split Creek being 8 m below ground level. Split Creek is sustained by rainfall and not groundwater, therefore it is not an aquatic GDE.

13.1.3 Groundwater Quantity

A series of desktop studies and field investigations have been undertaken to better understand the existing hydrogeological conditions and to investigate groundwater as a potential source of water supply for future mining activities

The field investigations carried out by Golder included the installation of four new monitoring bores, two pilot bores and one test pumping bore, groundwater sampling and level monitoring rounds of these wells and existing wells in the northern area of the ML, as well as a series of pumping tests. Centrex installed an additional monitoring bore for the most recent pumping test conducted in March 2018.

The hydrogeological field investigations focused primarily on the northern part of the ML as it has been identified as comprising a water bearing unit with most extraction potential. The 2017 field investigations included the drilling of a monitoring bore in the Southern part of the ML within the Beetle Creek formation to a depth of 9.1 mbgl which was dry. Exploration drilling by Centrex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 mbgl, which is much deeper than the proposed depth of the pit (10 m).

13.1.4 Groundwater Quality

Groundwater quality was assessed based on the results of two sampling rounds carried out in the monitoring bores installed in 2017 as well as in the landowner bore (Frank's bore).

The first sampling round was carried out immediately after the bores were completed and includes samples collected from MB01, MB021, MB03, PH1, PH2 and Frank's bore. The second sampling round was collected during the second series of pumping tests carried out in March 2018 and includes samples

collected from the same bores. The locations and further details of the sampling is provided in Appendix F.

These samples were analysed for major elements as well as for some contaminants. Field and laboratory analysis suggest that groundwater in the fractured rock aquifer of the Beetle Creek Formation in the northern portion of ML 5542 is generally brackish to saline, with laboratory Electrical Conductivity measurements ranging between 5 800 µS/cm to 22 500 µS/cm. The groundwater in this formation is generally neutral to slightly basic and is typically sodium-chloride dominant. Small concentrations of some metals, including As, Cd, Cu, Ni, Pb, and V, as well as TRH were found.

Field analysis collected during the development of monitoring bore MB03 indicate that groundwater in the Thorntonia Limestone formation in the vicinity of this monitoring bore is neutral with a pH value of 7.47 to 7.64 and highly saline with laboratory Electrical Conductivity measurements ranging between 16 500 to 16 800 µS/cm. The groundwater in this formation is generally neutral to slightly basic and is typically sodium-chloride dominant.

The concentration in major ions recorded suggest that the water contained in both the Beetle Creek Formation and the Thorntonia Limestone are from a same origin and could possibly be hydraulically connected.

13.1.5 Environmental Values

The Environmental Protection (Water) Policy 2009 (EPP Water) lists the environmental values and water quality objectives of groundwater for some waterway basins and areas of Queensland. The ML is in a waterway basin for which values have not been defined in the EPP Water. Regardless of this, the following environmental values have been identified to be relevant to the site:

- Users of groundwater indicated by registered groundwater bores.
- Groundwater Dependent Ecosystems (GDEs).

13.2 Potential Impacts

Potential impacts to groundwater users and GDEs from the extraction of groundwater from bores in the northern area of the ML (Figure 21) are discussed below.

13.2.1 Reduced Quantity of Water due to Excavation of the Pit

The pit will not exceed 10 m depth and any groundwater within the aquifer that may be present in the southern part of the ML would be at depths greater than 50 m. Therefore, there is no potential for a reduction in groundwater quantity available for users or GDEs from excavating the pit.

13.2.2 Reduced Quantity of Water due to Groundwater Extraction

Two pumping wells are proposed for the purposes of the Project, with pumping rates of 7.5 L/s per well for the short-term duration (approximately 12 weeks) of the operation.

Preliminary drawdowns for various distances to the extractions wells after 90 days of pumping were calculated using Theis equation for non-leaky confined aquifers. These estimates provide an initial understanding of the potential impact that the extraction of groundwater may have on surrounding groundwater levels in the Beetle Creek Formation.

Table 46 presents the drawdown for a selection of radius surrounding the pumping well after 90 days of pumping at 15 l/s (i.e., life span of Project). The first estimated drawdowns (column 2) considers the most conservative values of Transmissivity and Storativity while the second estimated drawdowns (column 3) considers the most conservative values. The extent of the drawdown is presented in Figure 21.

Table 46: Calculated Drawdowns after 90 Days of Pumping (15 L/s)

Radius (m)	Drawdown (m) for S= 2.82×10^{-5} and T=950.5 m^2/day	Drawdown (m) for S= 9.79×10^{-3} and T=1761.0 m^2/day
50	1.61	1.02
100	1.46	0.48
200	1.31	0.40
300	1.22	0.35
500	1.11	0.29
1000	0.96	0.21

Drawdowns in groundwater levels in the aquifer in the area of Split Creek will not impact any potentially present aquatic GDEs in Split Creek as it is sustained by rainfall and not groundwater.

Drawdowns in the groundwater levels in the aquifer in the area of the potential terrestrial GDEs will not impact the terrestrial GDEs as they are not sustained by groundwater.

Predicted groundwater level drawdowns were calculated after 90 days of pumping at 15 L/s using the Theis radial flow equation for non-leaky confined aquifers and hydraulic properties determined from onsite testing. The drawdown were calculated for two cases considering the most and least conservative values of transmissivity and storativity. In all cases, the 2 m drawdown cone is within 50 m of the pumping wells, due to the high formation transmissivity and short pumping duration. For the most conservative case, a 1 m drawdown contour extends approximately 820 m from the pumping wells at the end of the 90-day pumping period. Figure 21 shows the estimated drawdown in the BCF.

Any potential subterranean GDEs that may be present would be associated with the Thorntonia Limestone below the BCF. It is assumed that drawdown in this formation will be smaller and potential GDEs will not be impacted by groundwater extraction.

13.3 Avoidance, Mitigation and Management Measures

It is unlikely that the Project will affect other groundwater users or potential GDEs as a result of water extraction or from mining.

13.4 Residual Impact

Table 47 provides a summary of the residual impacts of the Project on groundwater values.

The potential impacts and effect on the water quantity due to groundwater extraction will be short in duration (approximately 12 weeks). There are no third-party groundwater users or known GDEs within the

predicted draw down area. The water level changes in the aquifer are expected to recover from the water extraction. Therefore, the intensity ranking is negligible and overall residual impact is minor.

Table 47: Summary of Groundwater Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
14	Reduced quantity of water available due to groundwater extraction	Not sensitive	Negligible	Minor

13.5 Environmental Protection Objectives

When deciding an application DES is required to assess the application against requirements stipulated in the EP Act, including considerations stated in the EP Regulation and any relevant Environmental Protection Policy, such as the EPP (Water).

This section (Section 13.0) demonstrates how the following environmental objective and performance outcomes (prescribed under Schedule 5, part 3, table 1 of the EP Regulation) will be achieved:

- **Environmental Objective:**
  - The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.
- **Performance Outcomes:**
  - There will be no direct or indirect release of contaminants to groundwater from the operation of the activity.
  - There will be no actual or potential adverse effect on groundwater from the operation of the activity.

14.0 CULTURAL HERITAGE

This section describes the known and potential historical cultural heritage values of the Project area and potential impacts to these values resulting from the proposed mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

Relevant legislation for this section includes:

- *Environmental Protection and Biodiversity Conservation Act 1999 (*Cth*)* (EPBC). This Act is the key national heritage legislation, enhancing the management and protection of Australia's natural, historic and Indigenous heritage places of outstanding national heritage value.
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) (ATSIHP). This Act assists in the preservation and protection of places, areas and objects of particular significance to Indigenous Australians from injury or desecration.
- *Queensland Heritage Act 1992* (QHA). This Act aims to provide for the conservation of Queensland's cultural heritage for the benefit of the community and future generations. It is the principal legislative instrument through which areas of non-aboriginal cultural heritage significance are identified and managed in Queensland.
- *Aboriginal Cultural Heritage Act 2003* (ACHA). This Act aims to provide recognition, protection and conservation of significant Aboriginal cultural heritage in Queensland based on respect for Aboriginal knowledge, culture and traditional practices.

14.1 Baseline Environment

An aboriginal cultural and historic heritage assessment of the lease area was undertaken by RBC Environmental together with traditional owner representatives on behalf of Centrex in June 2017, in accordance with the QHA and ACHA Duty of Care guidelines. Due to the cultural sensitivity of some of the content, the report has not been included as an appendix. Prior to the assessment by RBC Environmental, there had been no previous cultural heritage studies undertaken specific to ML5542.

14.1.1 Desktop Assessment

14.1.1.1 Indigenous Cultural Heritage

RBC undertook a search of the Department of Aboriginal and Torres Strait Island Partnerships (DATSIP) Aboriginal Cultural Heritage Database and Register to discern the Native Title or Aboriginal Party(s) and/or Cultural Heritage Bodies and the recorded Aboriginal cultural heritage places identified within the Project area. Any previous cultural heritage reports for the Project area were also reviewed to identify any Aboriginal heritage sites not registered on the DATSIP Aboriginal Cultural Heritage Database and Register and assess for the potential of previously unidentified Aboriginal cultural heritage sites.

A search of the DATSIP Cultural Heritage Register of the ML area did not identify any Aboriginal cultural heritage sites. As ML5542 is "pre-1996 grant", the lease area is not subject to matters related to the *Native Title (Queensland) Act 1993*. The determination recognised the rights and interests of the holders of ML5542 as falling predominantly within the 2014 determined Bularnu Waluwarra and Wangkayujuru People (BWW) Native Title area (Figure 22).

Approximately 99 ha of the lower southern portion of the ML extends into an area not covered by currently registered or determined native title claims. Consultation with QSNTS legal officers identified the last registered claim on this area being from the Kalkadoon people (RBC Environmental, 2017).

14.1.1.2 Non-Indigenous Cultural Heritage

The non-indigenous cultural heritage desktop assessment was undertaken based around the broad policy assessment criteria outlined in the Environmental Protection Agency 'Using the Criteria: A Methodology' (2006), which aim to provide a framework for the identification of historical significance and a common values analysis methodology. This was achieved by briefly reviewing historical studies, documents and previous historical cultural heritage assessments of the Project area and surrounds and also comprised searches of relevant Commonwealth and State registers including the World Heritage List, National Heritage List, Commonwealth Heritage List, Register of the National Estate List, Queensland Heritage Register and local or regional heritage registers/planning schemes.

No non-indigenous recorded/protected historical sites or places were identified within the ML. The Moonah Creek 'Hanging Tree', a tree with historical significance for encounters between indigenous and non-indigenous peoples in the 1870s-1890s, is identified on the Queensland Heritage Register as being located within the Ardmore Station property, however does not fall within the ML boundary (DES, 2016b).

14.1.2 Field Assessment

Surveys to identify Aboriginal and historical archaeological sites and places within the ML were undertaken by an archaeologist from RBC Environmental and four BWW traditional owner representatives from 9th to 15th June 2017, using a pedestrian search and rapid site recording method. Further field surveys have since been conducted within specific areas of the ML including the Project area.

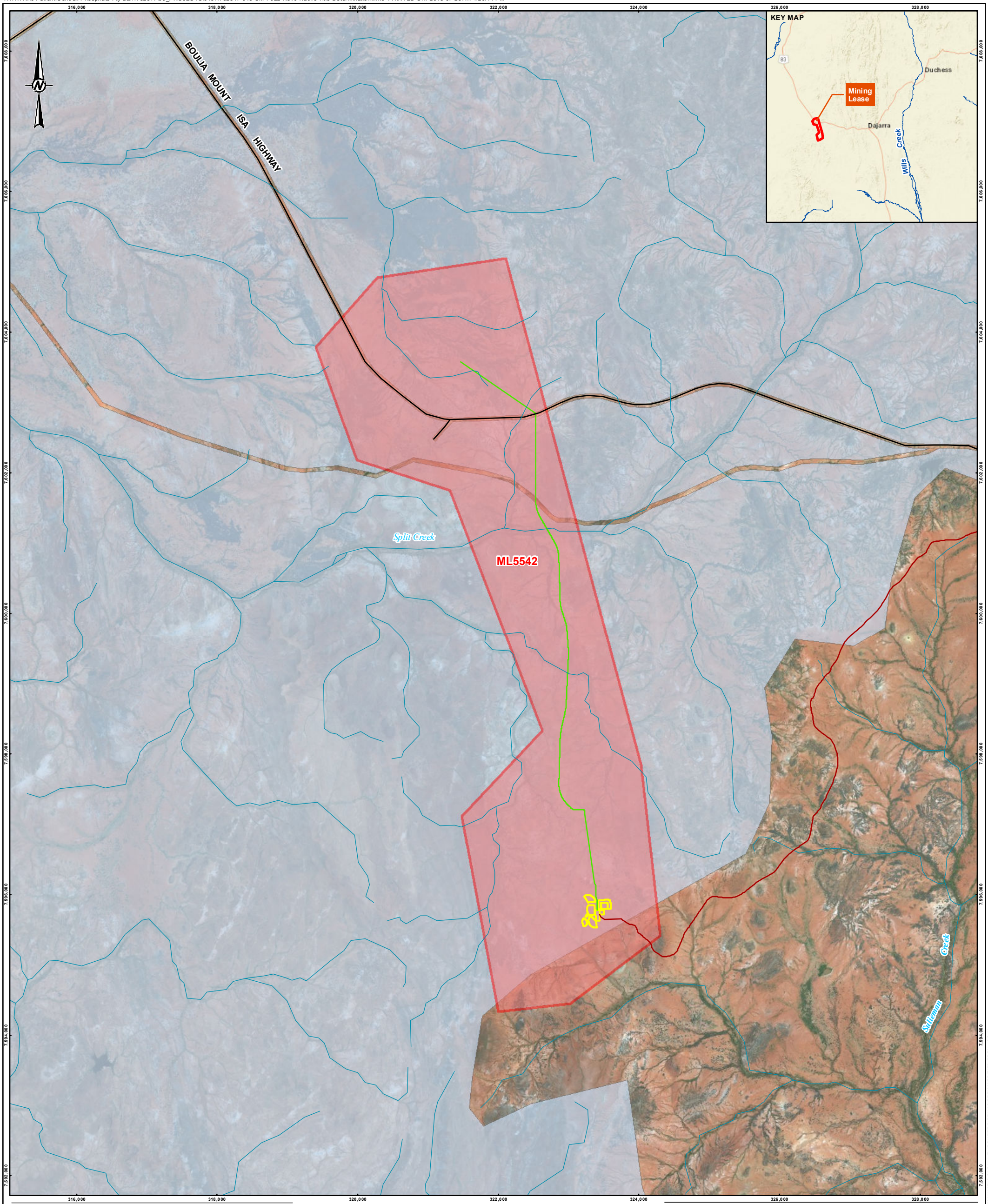
The ground surveys have identified Aboriginal archaeological sites consisting of a series of knapping and 'assaying' sites associated with outcropping chert and/or exposed nodules. The sites have varying amounts of knapping debris and primary flakes. In these cases, all artefacts are located within, or in close proximity of the outcropping stone material (generally within 5 m). Several smaller outcrops of weathered quartz also showed signs of working to a lesser degree. A major water course dissects the mining lease (Split Creek) with low to medium density artefacts associated with distinct campsites and seasonal habitation identified in close proximity to it or at junctions of smaller ephemeral creeks. In most cases material has been spread and transported at peak flood levels associated with intense rainfall events.

14.1.3 Environmental Values

While some areas of the site were found to be highly disturbed, the entire ML contained a large number of artefacts having cultural significance to the BWW people, particularly in areas of minimal disturbance, though many of these artefacts are largely considered to be of low significance given the type and abundance of isolated artefacts throughout the area. There was one high significance artefact site location within the wider area, however this is outside of the area of disturbance for the Start-up Operation.

Two artefact sites were found to be within proximity to the Project's area of disturbance – a chert knapping and worked silcrete outcrop. No areas or sites of historical significance were identified during field assessments.

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LEGEND

- Watercourses
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation
- ML5542

Certified Indigenous Land Use Agreement

- Bulamu Waluwarra Wangkayujuru Aboriginal Corporation RNTBC

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease and Exploration permit: © State of Queensland (DNRM) 2018
ILUA Native Title: National Native Title Tribunal
All other data: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
NATIVE TITLE DETERMINATION BOUNDARY

PROJECT NO.	CONTROL	REV.	FIGURE
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14.2 Potential Impacts

Construction and operation of the Project will involve the excavation and movement of soil within the proposed footprint area, including removal and storage of topsoil, excavation for the pit and for the widening to the existing access track. These activities have the potential to affect any potential sites of archaeological significance that have not yet been identified by either disturbing or destroying them.

14.2.1 Disturbance of Identified Archaeological Sites or Objects

A targeted archaeological survey identified archaeological sites or objects adjacent to the Project area of largely low significance. No archaeological sites or objects identified and entered on the DATSIP Cultural Heritage Register lie within the Project area and as such will not be impacted by mining activities.

14.2.2 Disturbance or Destruction of Unidentified Archaeological Sites of Significance

There is potential for the Project to disturb cultural places that are as yet unidentified and their significance unassessed ('unexpected finds'), in particular areas where surveys may have impeded by ground cover. Mitigation measures are outlined in Section 14.3.

14.3 Avoidance, Mitigation and Management Measures

Duty of Care guidelines (DATSIP, 2004) identify any ground breaking activity to be assessed as Category 5 areas, where development should not proceed without further cultural heritage consultation with the area's Aboriginal Party(s). Targeted surveys of the area of disturbance have been conducted to comply with the Duty of Care for the Project.

Ongoing baseline assessment of cultural heritage should be undertaken to further assess areas identified for future activities involving significant ground impacts. In areas where cultural heritage sites have been identified, the following recommendations are provided:

- A Work Program Notice identifying activity type and areas to be disturbed should be arranged or BWW representative present for ground breaking activities associated with the Project.
- Avoid all identified cultural heritage sites wherever practical, maintaining a minimum 5 m buffer.
- Flag or otherwise mark identified cultural heritage sites within close proximity to the Project disturbance areas to ensure no unintended impacts from construction or associated access.
- Ensure all site procedures and contractor inductions include cultural heritage awareness and avoidance measures.
- Prior to any ground disturbance activities at the Project site, a procedure should be in place detailing the appropriate steps if an unexpected find is encountered. This procedure should encompass the following steps:
  - Cease work in the immediate area and secure the find.
  - Do not remove or further disturb the find, erecting a temporary buffering fence if required.
  - Report the find directly to the site supervisor/manager.
  - Consult the Aboriginal Party(s) for further assessment and recommendations for management.

14.4 Residual Impact

Physical disturbance of the land as a result of Project related activities is inevitable. However, active management measures will be adopted to identify and avoid areas of Indigenous cultural heritage or archaeological significance. If disturbance is unavoidable, Centrex will seek to mitigate the disturbance by recording or removing the material to a secure place in accordance, as per Section 14.3 above.

Given the relative abundance and type of cultural heritage material located within the ML both on a local and regional scale, the proposed management and mitigation methods Centrex will employ will reduce the intensity of potential impacts on the cultural heritage areas of significance, and residual impacts are considered to be minor. Table 48 provides a summary of the potential residual impacts.

Table 48: Summary of Cultural Heritage Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
15	Disturbance to identified archaeological sites of significance	Not sensitive	Low	Minor
16	Disturbance to unidentified archaeological sites of significance	Moderately sensitive	Moderate	Moderate

14.5 Environmental Protection Objectives

The primary cultural heritage objectives are:

- To protect all identified and potential heritage values within the ML from adverse impacts caused by project related activities by avoiding disturbance to known cultural heritage values, and where this is not possible, managing disturbances in accordance with agreed procedures.
- To ensure procedures for identifying and managing identified and potential cultural heritage values are successfully implemented.

15.0 WASTE

Waste management in Queensland is controlled using a number of Acts and policies including:

- The *Environmental Protection Act* (EP Act) that provides for the protection of Queensland's environmental values.
- The *Environmental Protection Regulation 2008* (EP Regulation); *Environmental Protection (Waste Management) Policy 2000* (EPP Waste), and *Environmental Protection (Waste Management) Regulation 2000* (EPWMR) under the EP Act. The EP Regulation defines 'general waste' as waste other than regulated waste. Regulated wastes are wastes that contain hazardous contaminants or may cause environmental harm if improperly managed.
- The *Waste Reduction and Recycling Act 2011* (WRR Act) provides a strategic framework for managing waste and establishes management principles. *Waste Reduction and Recycling Regulation 2011* provides a mechanism to enforce the WRR Act including waste management planning and reporting requirements.
- The *Draft Queensland Waste Avoidance and Resource Productivity Strategy (2014-2024)* (DEHP, 2014c) provides strategic objectives in dealing with waste in Queensland.
- Application requirements for activities with waste impacts, ESR/2015/1836, version 4 (DEHP, 2017d).

15.1 Waste Management Strategy

The waste management hierarchy is an internationally and nationally accepted guide for waste management practices with the objective of achieving optimal waste management outcomes. This hierarchy promotes waste avoidance and reduction and to encourage resource recovery and efficiency and specifies the preferred order of practices, ranked from most to least preferred (DEHP, 2014c). This hierarchy is reflected in the EPP Waste and is outlined below:

- REDUCE unnecessary resource consumption and waste generation.
- REUSE waste resources without further manufacturing.
- RECYCLE waste resources to make the same or different products.
- RECOVER waste resources, including the recovery of energy.
- TREAT waste before disposal, including reducing the hazardous nature of waste.
- DISPOSE of waste only if no viable alternative.

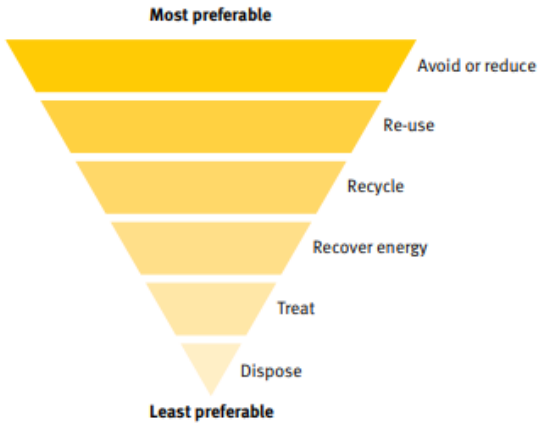


Figure 23: Waste Management Hierarchy

The following activities will be undertaken as part of the Project:

- Ensure systems and procedures relating to waste management are being fully implemented and complied with during construction, operations and decommissioning.
- Inspect the mine site and surrounding environment for general waste containment.

15.2 Waste Types

The waste types likely to be generated by the proposed activities, excluding waste rock and tailings, would mostly be defined as ‘general waste’ and include construction materials waste, green waste, putrescible and domestic waste. These wastes will be removed from the site to the Dajarra waste disposal site that is lawfully able to accept the waste under the EP Act. There is some capacity to dispose of waste on site as the current EA permits limited a limit of no more than 50 tonnes of general waste to be disposed of within ML5542 per annum.

Limited ‘regulated waste’ generated on site such as oils and tyres will be removed and transported from site by a person who holds a current authority to transport such wastes to the waste handling facility at Mount Isa. This facility is lawfully able to accept the regulated waste under the EP Act.

The mining activity does not plan to collect water generated for beneficial reuse or using treated effluent for irrigation.

Waste tracking for the Project will be undertaken in accordance with the EP Regulations.

15.3 Environmental Protection Objectives

Centrex has established the following waste management objectives for the Project:

- Any waste generated, transported, or received as part of carrying out the activity is managed in a way that protects all environmental values.
- Design the mine layout and operations to minimise the generation of waste;
- Minimise the generation of waste through applying the avoidance, minimisation and mitigation principles to reduce, reuse, recycle, recover, treat and dispose of waste; and
- Ensure safe management and disposal of waste that cannot be reused or recycled.

16.0 TRAFFIC

This section describes the existing traffic of the Project area and potential impacts to traffic, road users and the community resulting from the proposed Project mining activities. It also provides proposed mitigation and management measures to reduce the potential impacts.

This section follows the intent of the Department of Transport and Main Roads (DTMR) Guide to Traffic Impact Assessment (September 2017), for conducting a Traffic Impact Assessment (TIA).

The objectives of this traffic section include:

- Desktop review and description of the existing road transport environment and the development impact assessment area.
- Review of existing vehicle traffic volumes of count data from Boulia and Cloncurry Shire Councils, and DTMR.
- Review of the planned Project mine construction and operation vehicle traffic volumes, including vehicle type, tonnage, routes and expected schedule.
- Traffic impact assessment of the Project, including proposed mitigation measures to reduce the impacts to an acceptable level to the community and sensitive receptors.

This impact assessment does not determine the health and safety risks associated with the increased traffic to road users but is limited in scope to the environmental impacts to the community and sensitive receptors as a result in the changes to traffic volume and occurrence from the Project. In addition, the Traffic Impact Assessment included in Appendix G considers the impacts of the full production mining Project and not just the Start-up Operation.

16.1 Baseline Environment

The Project ML is approximately 11 km from Dajarra by road from via the Diamantina Developmental Road (also known at Mount Boulia Highway), that is a state-controlled road under the authority of DTMR. The Project ML can be accessed from Mt Isa along a single-lane bitumen sealed road for two-way traffic, Diamantina Development Road which joins Boulia and Mt Isa and passes through the northern end of the lease (Figure 1). An unused section of the original gazetted, unsealed Urandangi South Road also traverses a section of the ML in the north. Several private station tracks pass through parts of the ML. The local road network provides access to surrounding properties.

Following mining and ore processing, concentrate produced by the Project will be transported via the Boulia Mount Isa Highway (also known as the Diamantina Developmental Road) and then via the Duchess Dajarra Road (also known as the Cloncurry Dajarra Road) a road state-controlled by DTMR, through to an existing rail siding at Cloncurry. It is proposed that for the Full-scale Operation, should they proceed, a new rail siding will be established at Duchess. The intersection of the Boulia Mount Isa Highway and the Duchess Dajarra Road is a priority T-intersection on the state-controlled road network (Figure 24). The Cloncurry Dajarra Road is a graded natural material road which narrows at creek crossings and cattle grids with a minimum width of 3 m.

The DTMR supplied 2017 Traffic Analysis and Reporting System (TARS) data, with the Annual Average Daily Traffic (AADT) and heavy vehicle percentage for the road segments proposed for the haulage route (Table 49). TARS data also indicates that the Diamantina Development Road has declining traffic

volumes over the last year (-13.24%) and 10 years (-2.55%), with the Cloncurry Dajarra Road with increasing traffic volumes over the last year (18.52%) and 10 years (7.6%).

Table 49: TARS Base Traffic Volume

Road	Annual average daily traffic (AADT)	Heavy Vehicle %
Diamantina Development Road (north)	59 vpd	25%
Cloncurry Dajarra Road	64 vpd	22%
Diamantina Development Road (south)	79 vpd	19%

Note. 'North' and 'South' refer to section of Diamantina Development Road relative to the intersection with the Cloncurry Dajarra Road

16.2 Potential Impacts

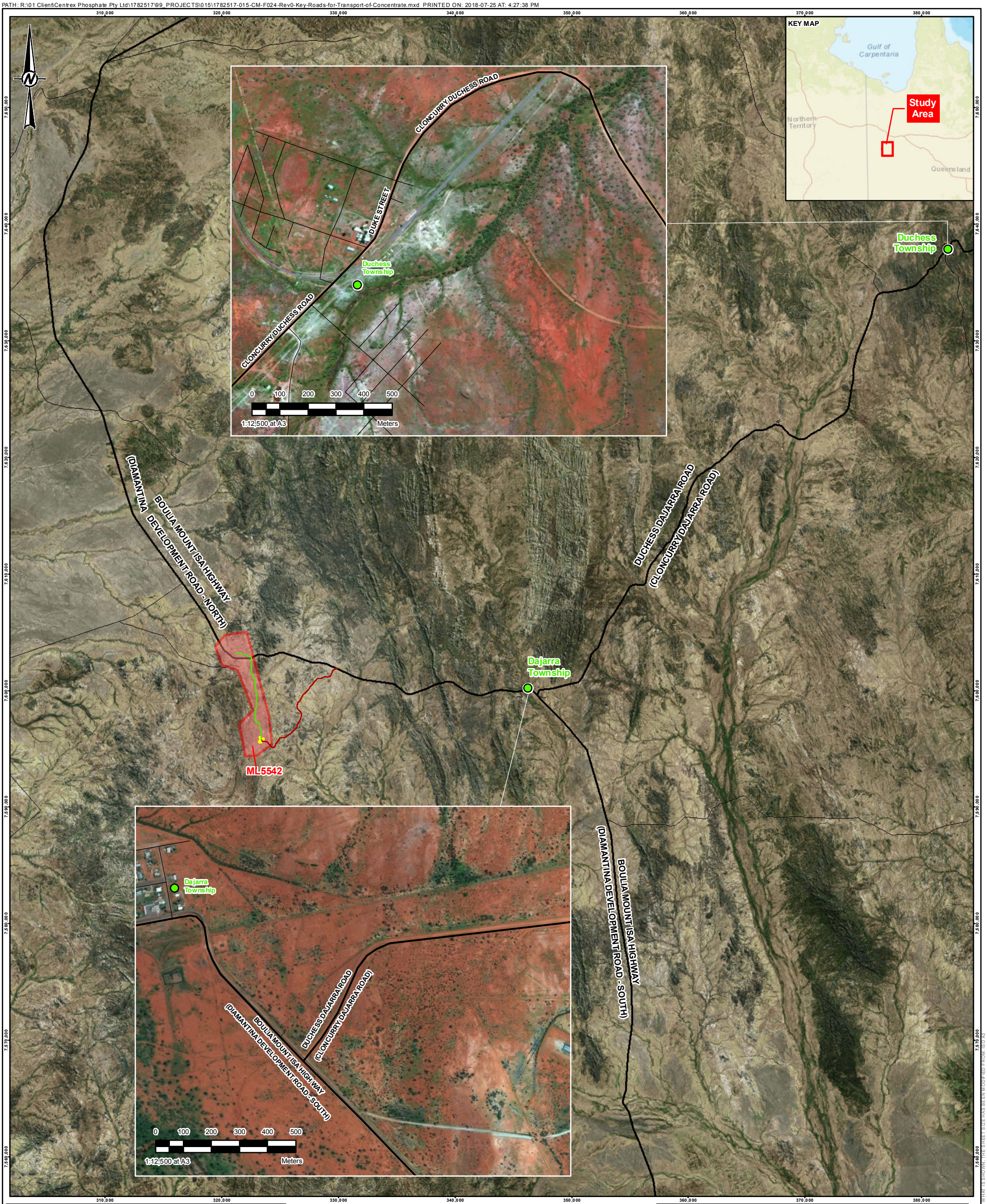
The potential impacts of the additional traffic of the Project relate to a range of vehicle traffic including:

- **Truck Product haulage (Triple Road Trains)** – phosphate concentrate will be transported in containers from the Project site through to Dajarra (27 km), from Dajarra along the Diamantina Development Road (north) and the Cloncurry Dajarra Road to Duchess (74 km) and then to Cloncurry (134 km) rail siding, with unloaded trucks returning to the Project site.
- **Truck (B-Doubles)** – several per day during construction mobilisation and demobilisation, and several per week during mining for supplies such as equipment and fuel.
- **Light Vehicles or Buses for Commuting workers** – commuting workers are to be transported by LV's and/or a bus from Dajarra to the site (expected six (6) vehicle movements per day).
- **Deliveries of stores and food supplies** – expected to occur to the site on a weekly basis.
- **Other vehicle movements** – including other light vehicle trips between the Project and nearby towns. These vehicles will be mobilised from Dajarra to site / return, with other movements as required.

The product haulage route is 235 km, using triple road train trucks with a capacity of 94.3 tonnes per load. The number of triple road trains expected during the Project include:

- Product Ore concentrate transport – 32,000 tonnes (over 10 weeks of transport)
- Trucks (over 10 weeks) – 339 (loaded), 678 (loaded and unloaded)
- Trucks (per week) – 34 (loaded), 68 (loaded and unloaded)
- Trucks (vehicles per day) – 5 (loaded), 10 (loaded and unloaded).

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LEGEND

- Townships
- Water Pipeline and Access Track
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

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REFERENCE(S)
Townships: © State of Queensland (Department of Natural Resources, Mines and Energy) 2018
Roads: © State of Queensland (DNRM) 2017.
Mining Lease: © State of Queensland (DNRM) 2018 .
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
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Table 50 describes the Project AADT of triple road trains against the baseline data of the current AADT along the proposed haulage route. The heavy vehicle percentage as a result of the Project will account for a 10% increase on the Diamantina Development Road north and Cloncurry Dajarra Road. This increase is for a 10-week period during the Project schedule.

Table 50: Project Traffic Volume

Road	Project Annual average daily traffic (AADT) – total triple road train trucks	AADT – Project plus baseline	Project Heavy Vehicle % - Project plus baseline
Diamantina Development Road (north) – ML site to Dajarra	10 vpd	69 vpd	35% (25%)
Cloncurry Dajarra Road – Dajarra to Cloncurry	10 vpd	74 vpd	32% (22%)
Diamantina Development Road (south) – Dajarra south	N/A	79 vpd	19% (no change)

The impact assessment was based on the total forecast traffic load (i.e., the additional traffic generated by the project during the construction and operational stages, plus the existing traffic load). The Project will generate increased heavy traffic along the proposed haulage route by up to 10 vpd. As this additional traffic is all triple-road trains there will be a 10% increase in the heavy vehicle use, compared to the current traffic recorded.

During the construction and operational phase of the Project the volume of vehicle traffic will increase between the site and Cloncurry. Traffic volumes will also increase on the Diamantina Development Road from light vehicles accessing the site from Mt Isa and from Dajarra to the site access track. Potential impacts relating to project-related traffic include:

- Increased traffic volume and change in traffic composition.
- Members of the community being exposed to traffic hazards or traffic accidents.
- Potential noise and air impacts from increased heavy vehicle traffic to sensitive receptors at Dajarra and Duchess from increased heavy vehicle traffic to Cloncurry.

The primary issue relating to traffic is the greater volume of project-related traffic and change in the traffic composition (i.e., minor increase in the proportion of heavy vehicles associated with haulage activities to Cloncurry).

The increase in traffic will be short term for the Project, but it may result in a decrease in road safety, particularly at the intersection from the site access track to the Diamantina Development Road turning to and from the Dajarra to Duchess Road. The limited increase in heavy vehicle traffic during the start-up operation is unlikely to degrade the road surfaces and cause delay to other users of the road from slow haulage vehicles.

16.2.1 Traffic Hazards or Traffic Accidents

The minor increased traffic volume and change in traffic heavy vehicle composition could result in an increased risk of traffic hazards or traffic accidents to the community for this Project. For the production phase of the Project there are proposed mitigation measures included in Appendix G. For the Start-up Operation the mitigation measures are explained in Section 16.3 and are relevant for the minor increase in risk.

16.2.2 Air and Noise Impacts from Traffic

There will be potential noise and air (dust) impacts to sensitive receptors at Dajarra (through traffic), Duchess and Cloncurry (entry to and from rail siding), from increased heavy vehicle traffic through Dajarra. The sensitive receptors include the community at Dajarra, Duchess and Cloncurry and several residences along the Dajarra to Cloncurry Road (Figure 24).

The noise impacts will be similar to existing levels of trucks travelling along existing roads with the difference being the increased traffic volume through the construction and operational phases of the Project.

The air (dust) impacts will be caused by increased traffic volumes leading to potentially larger levels of dust produced that may linger in the air environment longer.

16.3 Avoidance, Mitigation and Management Measures

The proposed management measures are designed to avoid or minimise the potential impacts associated with a greater volume of traffic and changes to traffic composition, including on road intersections are:

- Health and safety and environmental controls with trucking contractor / drivers through community areas such as Dajarra and Duchess e.g., speed limits to conditions, driver behaviour, school drop-off and pick-up times, noise minimisation of exhaust breaking.
- Community (Dajarra and Duchess) communication prior to starting construction equipment and product haulage to inform of increased levels of heavy vehicle traffic along the Diamantina Development Road and Cloncurry Dajarra Road, Dajarra and Duchess towns.

16.4 Residual Impact

Table 51 provides a summary of the potential residual impacts.

Table 51: Summary of Traffic Residual Impacts

ID	Impact	Sensitivity	Intensity	Residual impact
17	Increase in community health and safety risk from heavy vehicle use of haul route	Moderate	Low	Moderate
18	Increase in dust and noise from heavy vehicle use of haul route	Moderate	Negligible	Minor

16.5 Environmental Protection Objectives

The primary traffic objectives are:

- To ensure the health and safety risk to the community from increased traffic is minimised to acceptable levels.
- To minimise the nuisance and disturbance to the community and residence sensitive receptors from air (dust) and noise impacts is minimised to acceptable levels and ensure that any complaints are responded to in a timely manner.

17.0 SOCIO-ECONOMIC ENVIRONMENT

The Social Impact Assessment (SIA) Guideline (DSDMIP, 2018) prepared by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) is a statutory instrument for resource projects and has been made by the Coordinator-General in accordance with section 9(4) of the *Strong and Sustainable Resource Communities Act 2017* (SSRC Act). As the Project does not trigger the requirements for an EIS, there is no requirement to follow specific socio-economic impact assessment guidelines. Although not required, the SIA guidelines will be used as a general guide for this section.

This socio-economic assessment identifies predicted Project related changes to employment, local businesses and industry. The Baseline Socio-economic Report is provided in Appendix H.

17.1 Baseline Environment

The socio-economic characterisation for the Project is based on a desktop review of available information sources and feedback from stakeholder engagement activities (see Section 4.0). Outcomes from public consultation and community engagement are a fundamental part of the approvals process and the assessment of potential impacts to the social-economic environment and the ongoing management and monitoring of potential social impacts during the construction and operational phases of the Project.

This section provides information on the key aspects of the socio-economic environment:

- History, community values and infrastructure.
- Population and demography.
- Economy and industry.

17.1.1 History, Community Values and Infrastructure

Established in the early 20th century, Dajarra began as a railway construction camp for the Great Western Railway, extending the train line from Cloncurry in the 1920s. Being the most western-point of the Queensland rail system, it rapidly became strategically significant as one of the world's largest cattle-trucking depots, as it provided access to the east coast markets and ports for international export (RBC Environmental, 2017; O'Rourke, 2011).

The area is rich in Aboriginal heritage and lies within the Georgina River region, an area which provided food, shelter, social and spiritual significance to the Bularnu Waluwarra and Wangkayujuru people (BWW) (RBC Environmental, 2017).

While the introduction of road-trains for cattle transport in the late 1950s-early 1960s lead to a decline in opportunities in Dajarra township, beef cattle farming remains the dominant industry of employment within Dajarra, and the local school continues to teach the traditional Aboriginal language as part of the curriculum, through the Waluwarra language program (ABS, 2016; Dajarra State School, 2017). By Australian demographic standards, Dajarra has an unusually high proportion of Aboriginal residents and it is considered to be an important social and service town for Aboriginal people from the local area as it is located an equal distance between Boulia and Mt Isa (Long, 2007).

The provision of services to local residents of the region is difficult due to the isolated nature of its geographic location, particularly potable water supply, which has been a problem for Dajarra with the bore water and rainwater both lacking in quantity and quality (O'Rourke, 2011).

The reticulated town supply is hard, saline bore water pumped from bores located outside of the town which fails to meet the Australian Drinking Water Guideline standards, and the poor quality adversely impacting the town's housing and infrastructure. As the bore water quality has significant high mineral and salt content, it leads to an unsatisfactory/unpleasant taste for residents and affects the maintenance and longevity of houses and household supply items through the excessive scaling and corrosion of any metal fittings which are frequently exposed to the water supply (O'Rourke, 2011).

The community services are typical of a small town and include the Dajarra Roadhouse (including fuel, food, accommodation and mail centre), Jimberella Housing Cooperative (the Aboriginal Community's corporate body), Dajarra State School, Parent and Community organisation, Dajarra Sports committee, Cloncurry Shire Council, Centerelink, Legal Aid, Queensland Police, Queensland Health clinic, Allied Health, Aboriginal Health, Royal Flying Doctor Service, Home and Community Care, Catholic Church, Protestant Church, Aboriginal and Islander Catholic Council, Church of the Latter-Day Saints, State Emergency Service (SES), employment agency and Dajarra Hotel (O'Rourke, 2011). Plate 21 to Plate 24 depict the style and context of Dajarra township.

17.1.2 Population and Demography

There were 191 people living in Dajarra at the time of the 2016 Australian census (ABS, 2016a). ABS census information indicated the median age of the population of both Dajarra and Mount Isa (27 and 31 years respectively) was comparatively young given the Queensland median age of 37.

Approximately 19.4% of Queensland's total population are aged 0–14 years, however this age group comprise a larger proportion of the population in both Dajarra (30.4%) and Mount Isa (24.1%).

The population structure within both Dajarra and Mount Isa of people aged 65 years and over is considerably lower than the 15.3% which comprises Queensland's total population, where only 5.8% of Dajarra's population and 7.0% of Mount Isa's population are within this demographic.

Dajarra has a higher ratio of males to females, with males comprising 53.7% of the population (3.1% higher than the Queensland average), while Mount Isa has a more balanced gender ratio.

A large indigenous community is present within Dajarra, with 60.3% of the population identifying as an Aboriginal or Torres Strait Islander, considerably higher than the total proportional indigenous populations of both Mount Isa (16.6%) and Queensland (4%).

Census data (2016) indicates approximately 23.5% of Dajarra's population had completed schooling to Year 9 or below, and the overall proportion of secondary education levels were significantly lower than the state average. Dajarra State School (Plate 23) is a government coeducational primary school which serves years P-7. The closest high school facilities to the town are state school boarding facilities provided in Mount Isa.



Plate 21: Dajarra Hotel



Plate 22: Dajarra Roadhouse



Plate 23: Dajarra State School



Plate 24: Jimberella Community Hall

17.1.3 Economy and Industry

Of Dajarra's total population, the 2016 census data reports 68.1% of residents are aged over 15 years and over, with 56.9% of these persons reportedly active in the labour force and being employed either full-time (66.2%), part-time (12.2%), away from work (4.1%) or unemployed (9.0%). 32.3% of the population identified themselves as persons not in the labour force, which is defined by the Australian Bureau of Statistics (2014) as people who are neither employed or unemployed, and either:

- Want to work and are actively looking for work but are not available to start work in the census reference week.
- Want to work and are not actively looking for work but are available to start work within four weeks.
- Did not want to work.
- Want to work, but were not actively looking for work and were not available to start within four weeks.
- Permanently unable to work.

ABS census data from 2016 reports 9.0% unemployment rates in Dajarra, however community consultation undertaken by Centrex indicated high levels of unemployment is an issue for the town, therefore it is unknown if the ABS census employment statistics are reflective of the town's true unemployment figures.

The 2016 census data reports the dominant industry of employment within Dajarra is Beef Cattle Farming (Specialised), employing 25.5% of the area's population. Primary education (23.4%), fertiliser manufacturing (12.8%), local government administration (10.6%) and hospitals (8.5%) are the other major employment industries for the town.

Mining is well-known to be the predominant industry of employment in Mount Isa. Copper ore mining employed 18.6% of the population in 2016, with other major industries of employment comprising silver-lead-zinc ore mining (9.0%) hospitals (4.6%), primary education (3.9%) and supermarket and grocery stores (2.5%).

The median individual ($565), family ($1,031) and household ($900) weekly incomes recorded in Dajarra are considerably lower than the Queensland averages (ranging from $660 for individuals to $1,661 for family incomes).

17.2 Potential Impacts

During the construction and operational phase of the Project potential (positive and negative) impacts relating to the socio-economic environment include:

- **Additional workers affecting population and demographics.** The workforce will be very small for construction and operation (12 people). This minor increase in people over a short period of time will not affect the local population and demographics.
- **Intermittent decreased availability of accommodation at Dajarra**. It is likely that the workforce will be accommodated at Dajarra for the duration of mining.

- **Pressure placed on existing industries and services.** There is potential for a migration of workers from local councils and businesses. However due to the short period of Project construction and operation, this will not result in major pressures to existing industries and services.
- **Direct and indirect employment opportunities for the local community.** Centrex will aim to use local community (Mt Isa – Dajarra – Cloncurry) where possible for direct Project employment should appropriately skilled workers be available, where possible. Use of local businesses for accommodation and other services may result in small increases of local community in-direct employment opportunities.
- **Local economy injection.** It is likely that the Project workforce will use local businesses at Dajarra for accommodation and for services at the roadhouse, petrol station and hotel/pub.

The Project will have a positive influence on elements of the socio-economic environment. There will be a minor injection into local and regional economy as a result of the Project expenditure and a possible increase in employment. Potential negative impacts were determined to be negligible.

17.3 Management Measures

The potential socio-economic impacts from the Project are positive. Therefore, Centrex will aim to maximise the positive effects from the Project by:

- Maximising employment opportunities for the local community where possible, however this is dependent upon the type of skills and experience available.
- Reducing the proportion of workers engaged in fly in fly out arrangements, where operationally feasible.
- Sourcing goods and services locally wherever practicable, based on local capacity, ability to supply, quality and cost competitiveness.
- Continuing stakeholder engagement activities with the local community to ensure that if any negative impacts on the socio-economic environment arise as a result of the Project that they are monitored and, if required, managed.

The Project will not require a large workforce, however opportunities for future training and development initiatives to improve local and regional skills and capacity will be considered as part of the Full-scale Operation if possible.

17.4 Residual Impact

An impact assessment involving quantitative and qualitative assessment of stakeholder perceptions and values has not been undertaken. However, an assessment has been made on the potential issues that may arise from the Project's impact, based on a desktop assessment and findings of stakeholder engagement. Table 52 provides a summary of the potential residual impacts, both positive (*in italics*) and negative.

Table 52: Summary of Socio-Economic Residual Impacts

ID	Impact / *Positive effect*	Sensitivity	Intensity	Residual impact
19	Additional workers affecting population and demographics	Moderately sensitive	Negligible	Minor
20	Pressure placed on existing industries and services	Moderately sensitive	Negligible	Minor
21	Intermittent decreased availability of accommodation at Dajarra	Negligible	Negligible	Negligible
22	*Direct and indirect employment opportunities for the local community*	-	-	*Positive*
23	*Local economy injection*	-	-	*Positive*

17.5 Socio-Economic Environment Objectives

The socio-economic environment objectives have been taken from DSDMIP (2018) where relevant and relate to the identified potential residual impacts and positive effects. The objectives are:

To ensure Project workforce management practices:

- Prioritise recruitment of workers from local and regional communities and workers who will live in regional communities, however this is dependent upon the type of skills and experience available.
- Reduce the proportion of workers engaged in fly in fly out arrangements, where operationally feasible.

To ensure Project housing and accommodation arrangements:

- Do not contribute to significant affordability and availability impacts on housing and accommodation in local and regional communities.
- Are well planned, enhance worker well-being, and do not place an excessive burden on existing infrastructure, facilities and services used by local and regional communities.

To ensure Project procurement practices:

- Maximise opportunities for competitive and capable local businesses to provide goods and services to the Project.
- Reduce barriers to entry for local businesses where feasible.

18.0 MANAGEMENT SYSTEMS

Centrex will use an existing health, safety and environmental management framework throughout the Project's construction, operations and decommissioning. The key elements of the framework are:

- Health, Safety and Environment (HSE) Management Systems which provide the structure to manage social, environmental, health, safety and security aspects of the Project.
- Policies and codes which describe the management processes and procedures to manage health, safety and security on site.
- An EMP required under the EP Act relating to a prescribed ERA. The EMP provides the proposed mitigation and management measures that are applicable to the protection of environmental values during construction, operation and decommissioning of the Project. The EMP will be updated prior to construction of the Project with the management system bridging between Centrex and the mining contractor's HSE Management Systems.
- Centrex will ensure that a contractual obligation of the mining contractor is to comply with the Project EMP and ensure their HSE Management Systems bridge to comply with Centrex's systems.
- Standard operating procedures (SOPs) will be developed to provide more specific mitigation and management measures for the Project under the EMP. These SOPs will include aspects such as vegetation and soils clearance, spillage management and emergency plans, overburden and tailings management, erosion and sediment control, flora and fauna management and cultural heritage management.

Environmental management of the construction, operation and decommissioning of the Project will be in accordance with the conditions of approval determined through the EA assessment process at a minimum. These conditions along with commitments made in this EA supporting report, will be incorporated into the project-specific EMP and standard operating procedures.

18.1 Environmental Polices

Centrex has corporate policies which directly address the areas of occupational health, safety and environment, social responsibilities and rehabilitation (e.g., OHS_POL Occupational Health and Safety, OHS_POL Social Responsibility and OHS_POL Rehabilitation) which are relevant to the Project. Additional policies will be developed as the project evolves.

18.1.1 Occupational Health and Safety Policy

Centrex aim to have an injury free workplace with 'No Harm' and no unplanned environmental impacts. The OHS Policy manages Occupational Health, Safety & Environmental ('OHS&E') aspects of mining activities through:

- Committing adequate resources and funding for the effective implementation and maintenance of the OHS Management System.
- Identifying and complying with health, safety and environmental laws and regulations and adopt industry best practice.
- Establishing effective systems and consistent methodology for identifying hazards, evaluating and controlling risks.

- Ensuring all employees are appropriately trained to accomplish their job tasks in a safe and environmentally responsible manner.
- Defining improvement objectives and assigning responsibility and accountability for OHS performance and regular public reporting of our performance.
- Establishing procedures and management systems, fully integrating them into operating and contracting activities.
- Leading constructive consultation & communication with all stakeholders, encourage full participation in the prevention of accidents and incidents, and endeavour to achieve mutually acceptable outcomes from all activities.
- Investigate accidents, incidents and near misses, taking preventative and corrective action to prevent reoccurrence, identify areas to improve performance.
- Recognise that activities may have a localised and shot-term impact on the environment and will work to reduce this impact wherever practicable.
- Conduct activities in a manner that ensures that rehabilitation to the agreed end land use can be achieved at the earliest practical time.

18.1.2 Social Responsibility Policy

The Social Responsibility Policy outlines Centrex's commitments:

- Respect the social, economic and cultural rights of indigenous people.
- Develop a Social Management Plan, where applicable, which identifies key objectives and targets and specifies time-based actions to meet the objectives.
- Communicate our performance in an accurate, transparent and timely manner.
- Adopt policies such as Employ Locally and Buy Locally where this makes business sense to do so.
- Consult stakeholders in matters that affect them.
- Seek to share our success by partnering with stakeholders to support appropriate community development programs.
- Centrex understand the actions and conduct of every Centrex Metals employee and contractor are the basis on which our stakeholders will evaluate our commitment to achieving the highest standards of social responsibility.
- Since environment, health and safety issues can affect the communities where we operate, Centrex will carry out the Social Responsibility Policy in conjunction with Centrex's Occupational Health Safety and Environment Policy.

19.0 CONCLUSION

This EA supporting report accompanies the EA amendment application, which is the principal documentation used to seek approval to conduct the proposed Start-up Operation on ML5542 from DES.

This report provides details of the Project to the regulatory authorities, the general public and other stakeholders. It details information on the existing environment of the proposed Start-up Operation site, assesses the environmental and social impacts and describes how the impacts can be managed and mitigated.

The report meets the requirements of the EP Act (section 224, Chapter 5 and section 226) by assessing the potential environmental and social impacts associated with the development of the project and identifies the residual impact once management and mitigation measures have been implemented. Technical studies contained within the appendices and material referenced in the body of the report have been used to support this impact assessment.

This supporting report therefore provides the required information for DES to assess the proposed project.

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21.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - “Important Information Relating to this Report”, which is presented in Appendix J. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

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APPENDIX A

Soils Technical Report

APPENDIX B

Geochemical Technical Report

TECHNICAL REPORT

Geochemical investigation of overburden, footwall units, ore and tailings

Ardmore Phosphate Mine

Prepared for: **Centrex Metals**

RGS

LEADERS IN MINING GEOCHEMISTRY

TECHNICAL REPORT

Geochemical investigation of overburden, footwall units, ore and tailings

Ardmore Phosphate Mine

Prepared for: **Centrex Metals**

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Executive summary

The purpose of the geochemical investigation was to evaluate the potential of the material that will be mined and processed, or utilised for progressive rehabilitation to produce acid, neutral or alkaline drainage with associated saline or metalliferous drainage potential.

Fresh samples of overburden (n=36) and footwall (n=5) samples were collected from drill core and reverse circulation chips drilled from August 2017. Representative samples, ore (n=1) and tailings (n=1) from bulk metallurgical were also provided by Centrex.

The overburden samples were found to be acid consuming (AC (n=6)), non-acid forming – barren (NAF-Barren (n=20) or non-acid forming (NAF (n=10)). The footwall samples were found to be non-acid forming – barren (NAF-Barren (n=1), potentially non-acid forming (PAF (n=3)) or acid forming (AF (n=1). The ore and tailings samples were both NAF.

Based on the total elemental concentrations and soluble leachate analyses the potential for acid and metalliferous is considered to be low. However, the overburden does have elevated salinity. The ore may also be processed using a combination of fresh water and saline groundwater with a total dissolved solids concentration of 17,000 mg/L. Because of this the tailings produced at the site are likely to have a higher salinity than the samples analysed in this study.

The development and implementation of a sampling and static and kinetic analytical program should be developed as part of a site management plan to enable the geochemical properties of the overburden, ore, tailings and footwall samples to be tracked over subsequent stages of the project to verify the findings of this study.

When there is sufficient kinetic leach cell data the outputs from these tests can be used as geochemical source terms with the site water balance model to evaluate if water quality objectives for the project will be met to minimise the potential for environmental harm.

Contents

1 Introduction 1
1.1 Purpose of the investigation 1
2 Geology 2
2.1 Regional geology 2
2.2 Local geology 2
3 Geochemical assessment 5
3.1 Maximum potential acidity 5
3.2 Actual acidity 5
3.3 Potential acidity 5
3.4 Total acid neutralising capacity 6
3.5 Reactive acid neutralising capacity 6
3.6 Net acid producing potential and neutralisation potential ratio 7
3.7 Net acid generation 7
3.8 Metalliferous drainage potential 7
3.9 Saline drainage potential 8
3.10 AMD classification 8
4 Sampling and analytical program 10
5 Interpretation 14
5.1 Ore and tailings samples 14
5.1.1 Net acid producing potential 14
5.1.2 Saline drainage potential 14
5.1.3 Metalliferous drainage potential 15
5.2 Organic geochemistry 17
5.3 Radioactivity 17
5.4 Overburden and footwall samples 17
5.4.1 Net acid producing potential 17
5.4.2 Saline drainage potential 20
5.4.3 Metalliferous drainage potential 20
6 Conclusion and recommendations 23
7 References 25

Figures

Figure 2-1: Mining lease area and geology of Ardmore Phosphate Mine 3
Figure 2-2: Ardmore local geology 4
Figure 4-1: Sampled drill hole locations 12
Figure 5-1: Drill hole samples ANC vs MPA plot 19
Figure 5-2: A comparison of total sulfur vs. chromium reducible sulfur in the drill hole samples 19

Tables

Table 3-1: Relative Mineral Reactivity 6
Table 3-2 Geochemical Abundance Index (GAI) values and Enrichment Factor 7
Table 4-1: Drill hole samples 10
Table 4-2: Analytical Program 13
Table 5-1: Static geochemical properties of the Ardmore tailings samples 14
Table 5-2: Soluble and exchangeable saline properties of the Ardmore tailings samples 15
Table 5-3: Total major cation and phosphorous concentrations in tailings samples 15
Table 5-3: Geochemical Abundance Index of metals and metalloids in the ore and tailings samples 16
Table 5-5: Drill hole samples potential acid mine drainage classification 18
Table 5-6: Drill hole sample acid/base accounting and potential acid formation classification 21
Table 5-7: Geochemical abundance index of total metals and metalloids 22

Glossary of terms and acronyms

AC	Acid consuming mine waste that has the potential to consume substantial acidity.
AF	Acid forming mine waste typified as having an existing pH < 5.
bgl	Below ground level.
Acid Base Account	Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity. See also "NMD".
ANC	Acid Neutralising Capacity, expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC: MPA Ratio	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
CRS	Chromium reducible sulfur. Analytical procedure to determine the sulfide sulfur concentration in a sample.
EA	Environmental authority.
EC	Electrical Conductivity, expressed as µS/cm.
eCEC	Effective cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample.
eH	A measure of the redox (oxidation-reduction) state of a solute. eH is a measurement of electrical potential and thus commonly expressed in volts.
DES	Department of Environment and Science (Queensland).
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
LoM	Life of Mine.
IOR	Intrinsic oxidation rate.
Kinetic Test	Procedure used to measure the geochemical/weathering behaviour of a sample of mine material over time.
KLC	Kinetic leach column.
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material over time.
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (CRS) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.

NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.
NMD	Neutral and metalliferous drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate and metals.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
pH	A measure of hydrogen ion (H^+) concentration; generally expressed as pH.
pH_{Ox}	Hydrogen ion concentration of the oxidised NAG solution.
ROM	Run-of-Mine. Ore as it comes from the mine prior to screening or processing.
S	Sulfur.
SS	Sulfide sulfur.
S_{PYR}	Sulfur as Pyrite.
S_{SO4}	Sulfur as Sulfate.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
Tailings	Fine-grained mineral waste materials produced from the processing of coal or ore.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
TDS	Total dissolved solids is a measurement of the dissolved solids (major ions or salts) concentration in a water sample.
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.

1 Introduction

RGS Environmental Pty Ltd (RGS) was engaged by Golder Associates Pty Ltd (Golder) to undertake a geochemical assessment of overburden, tailings and ore associated with the Ardmore Phosphate Project.

The Ardmore deposit was discovered in the 1960s with comprehensive exploration conducted through the 1970s. The deposit was acquired by Centrex Metals Ltd (Centrex) from Southern Cross Fertilisers Pty Ltd, a subsidiary of Incitec Pivot Limited in 2017. The Ardmore Phosphate Project (Ardmore) is a high-grade phosphate rock deposit located 128 km south of the City of Mount Isa and 25 km west of Dajarra. It is understood that the deposit outcrops and is very shallow with the target phosphorate unit hanging wall and footwall average contact depths being 8.3 m and 12.0 m respectively. It is proposed that the phosphate ore will be mined from a shallow 25 m deep pit and will have a waste:ore stripping ratio of 3:1. The life of mine is approximately 10 years.

Ardmore's deposits are covered by Mining Lease ML5542, held by Centrex. As part of the Feasibility Study, reverse circulation and diamond drilling was undertaken. Samples from 10 diamond drill and 4 reverse circulation holes were submitted to ALS Environmental Pty Ltd (ALS) for testing. The results of this analysis are presented and discussed in this report.

1.1 Purpose of the investigation

The purpose of the geochemical investigation discussed in this report was to evaluate the potential of the material that will be mined and processed, or utilised for progressive rehabilitation to produce:

- acid, neutral or alkaline drainage;
- saline drainage; and,
- metalliferous drainage.

The data from this work will lead to mined material from the soil to the footwall units being classified into deleterious and beneficial material classes. The geochemical data can be combined with the geological model and mine plan to produce a life of mine material balance and material placement schedule to ensure that all practicable measures are considered during development of the project to minimise the potential for environmental harm.

The approach to geochemical characterisation in this report is consistent with Australian and International guidelines (AMIRA, 2002 and COA, 2016, INAP, 2017) to confirm that the sampling and analytical process was appropriate, risk based and focused on obtaining representative samples of regolith units in the overburden above the ore, footwall units below the ore and representative samples of ore and tailings. RGS adopted a phased approach to geochemical characterisation, allowing for the baseline program to develop at a level and pace that complements the development of the Project.

The Stage 1 testing discussed in this report includes static geochemical characterisation of 43 samples to ensure appropriate spatial and compositional assessment of the deposit. Stage 2 would be commenced when the next stage of the project development is approved and is likely to require long-term kinetic leach tests conducted on a limited sample set to quantify sulfide oxidation rates and the rate that major, minor and trace elements may be released from the samples over time under the influence of chemical and physical weathering processes. Stage 2 testing may also include supplemental static test work on fresh rock samples to validate the results of Stage 1 testing.

The results of Stage 1 and Stage 2 are likely to be required to be incorporated into robust conceptual site models and then into numerical models to quantify potential site water quality during mining and through the progressive phase of site rehabilitation through to site closure and relinquishment.

2 Geology

2.1 Regional geology

The Georgina Basin, which stretches across Queensland and the Northern Territory is host to Australia's significant phosphate rock deposits. The basin is a northwest-southeast trending extensional basin which covers an area of 325,000 km^2 across the Northern Territory and western Queensland. Middle Cambrian marine sediments (505 - 515 million years ago) around the edge of the basin are the host to sedimentary phosphorite deposits such as Ardmore (Centrex Metals Limited, 2018).

The Ardmore deposit is located approximately 120 km SSW of Mt Isa within the Ardmore Outlier. It is block bounded to the east by the large regional north-south orientated Rufus fault zone. A lessor fault bounds the deposit to the west (**Figure 2-1**).

2.2 Local geology

The geological setting of the project area is a well-defined stratigraphic sequence that includes a Pre-Cambrian Footwall. The Eastern Creek Volcanics and the Sybella Granite form a basement of crystalline Pre-Cambrian rocks around the Ardmore Outlier. The stratigraphy from youngest to oldest is as follows (Golder Associates, 2017):

- Alluvium (Quaternary): clay, silt, sand gravel; flood-plain alluvium
- Blazan Shale (middle Cambrian): siliceous shale, chert, siltstone, fine arenite, conglomerate, dolomitic and bituminous limestone, phosphorate
- Beetle Creek Formation (middle Cambrian): chert, siliceous shale with trilobite fossils, basal conglomerate
- Thorntonia Limestone (middle Cambrian): Grey crystalline limestone
- Riversdale Formation (early Cambrian): Conglomerate, arenite sandstone, arkose sandstone, shale, mudstone, dolomite
- Sulieman Gneiss (Palaeo Proterozoic): Felsic gneiss, augen gneiss, hornblende schist, amphibolite, quartzite

Phosphate mineralisation is located within the Beetle Creek Formation, as succession of cherts, phosphatic siltstones, phosphate rock and minor shales that outcrops in some areas within the project area (**Figure 2-1**). Within the Beetle Creek Formation, the upper Simpson Creek Phosphorite Member hosts high-grade mineralisation while the underlying Lower Siltsone or Chert Member sub-units have lower grade phosphatic siltstones and shales. The Thorntonia Limestone underlies the Beetle Creek Formation, while the Blazan Shale overlies it (Centrex Metals Limited, 2018).

The Simpson Creek Phosphorite Member is an average of 4.3 m thick across the project. The unit dips shallowly across most of the deposit, although the dip becomes steeper along the eastern bounding fault (Centrex Metals Limited, 2018).

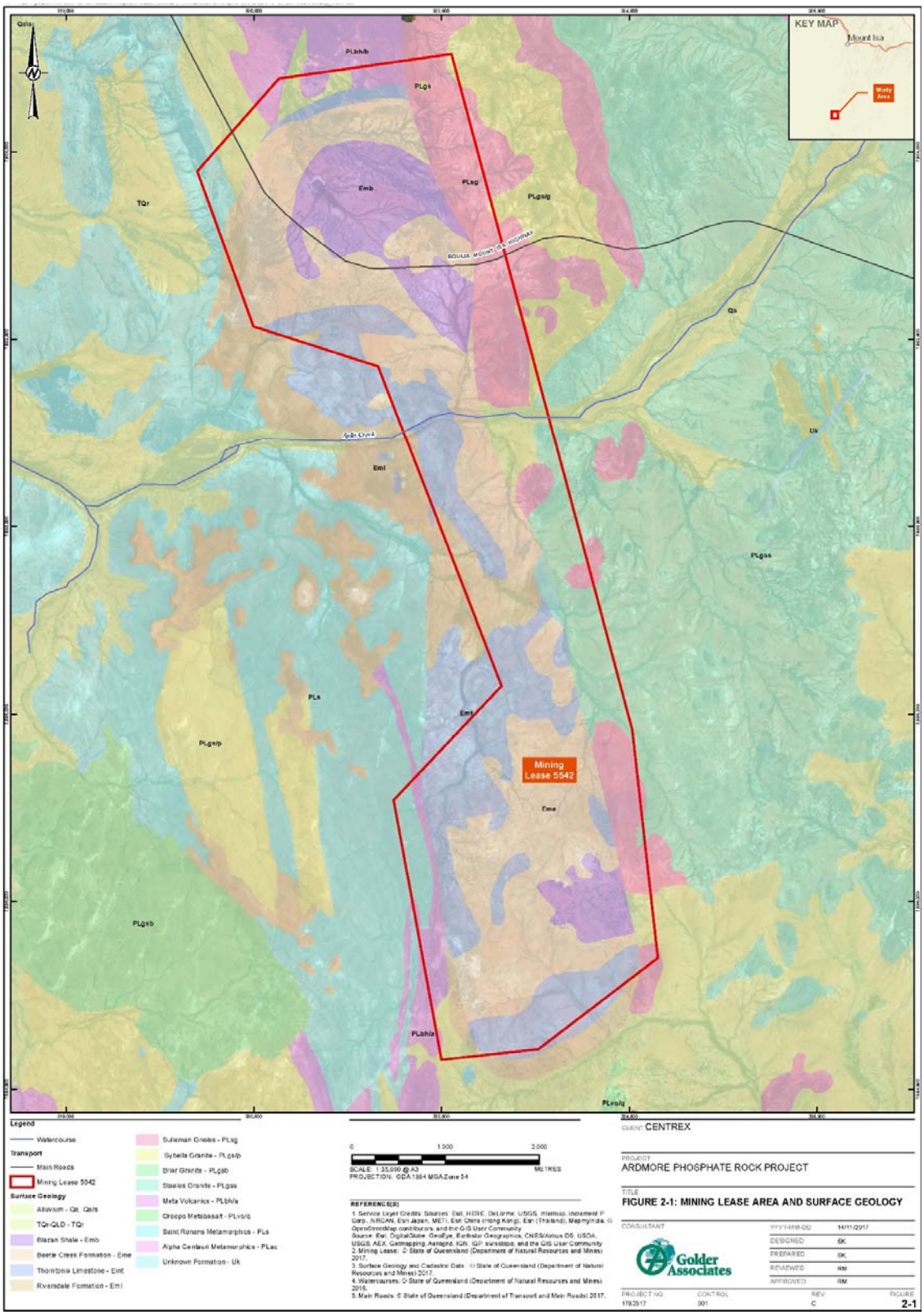


Figure 2-1: Mining lease area and geology of Ardmore Phosphate Mine

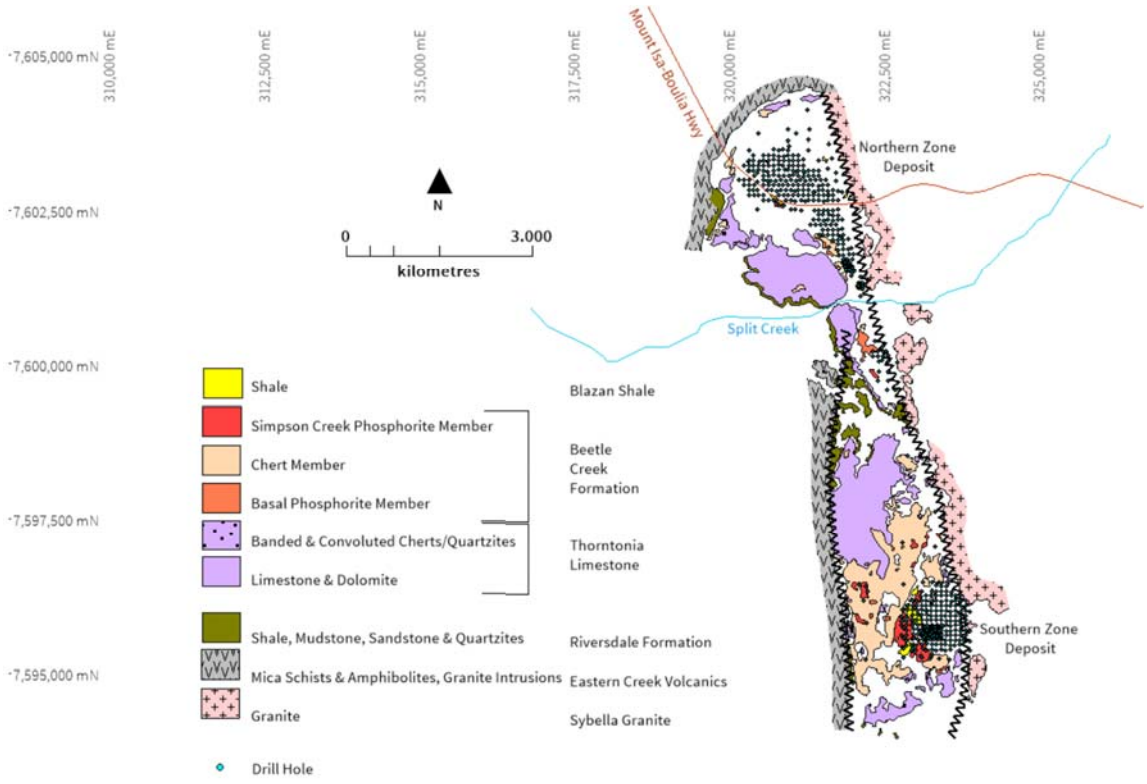


Figure 2-2: Ardmore local geology

3 Geochemical assessment

The most reliable method to characterise the acid producing potential of a sample would be to undertake a range of analyses that include total sulfur (TS), sulfide sulfur (SS) measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), total acid neutralising capacity (ANC_T), reactive ANC using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertake pH, EC, TS and ANC_T on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an appropriate strategy for a project at this level.

3.1 Maximum potential acidity (MPA)

3.2 Actual acidity

Actual acidity can be divided into soluble acidity and retained acidity. Soluble acidity is defined here as acidity measured using a 1:5 (soil:water) extract whereas retained acidity is defined as the acidity that is not recorded in such an extraction . However, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water. Soluble acidity can be subdivided into active soluble acidity and buffered acidity. Active soluble acidity accounts for the activity of hydrogen ion (H^+) whereas buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+}, $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ion when they hydrolyse (Lin et al, 2002). Retained acidity can be sub-divided into (a) exchangeable acidity, (b) acidity carried by protonated variably charged particles, such as clays, and (c) acidity carried by basic sulfate minerals. These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, such as occur in liming or re-flooding with brackish tidal water. Exchangeable acidity is acidity that is retained through cation exchange reactions (Lin et al, 2002). Jarosite is the most common basic sulfate mineral in ASS. One mole of jarosite carries three moles of acidity that can be released by hydrolysis: $KFe_3(OH)_6(SO_4)_2 + 3OH^- \rightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$. Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g. $[Al(OH)]^{2+}\text{-}SO_4^{2-} + 2OH^- \rightarrow Al(OH)_3 + SO_4^{2-}$.

3.3 Potential acidity

TS is measured by combustion of the sample in a furnace at 1,350ºC in the presence of strong oxidants/catalysts. This method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate maximum potential acidity (MPA) is to assume that all sulfur in a sample is potentially reactive sulfide and therefore capable of generating acid. By convention in acid base accounting studies, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g. sulfate sulfur in gypsum and barite). As a result, the TS concentration may overestimate the acid generation potential of a sample which is expressed in kg H_2SO_4 / tonne.

Sulfur can be present within acid producing primary minerals such as Pyrite (FeS_2), Chalcopyrite ($CuFeS_2$) and Bornite (Cu_5FeS_4) and non-acid producing primary minerals such as Galena (PbS) and Sphalerite (ZnS). TS can also be also present as a large number of non-acid producing secondary minerals such as Alunite ($KAl_3(SO_4)2(OH)_6$), Gypsum ($CaSO_4 \bullet 2H_2O$) through to minerals such as Jarosite ($KFe^{3+}3(OH)_6(SO4)_2$) that can store and release acid and trace, minor and major elements.

To differentiate between total sulfur and sulfide sulfur the CRS method was used to measure the sulfide sulfur. The CRS method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the CRS test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic

sulfur it does not differentiate between acid producing (e.g. Pyrite) and non-acid producing (e.g. Sphalerite) minerals.

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction: $4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8H_2SO_4$.

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1% S as pyrite would be 30.6 kg H_2SO_4/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and, to a lesser extent, silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

3.4 Total acid neutralising capacity

The total acid neutralising capacity (ANC_T) can be measured by the peroxide siderite correction for the Sobek method that utilises digestion of a pulp sample with 0.5 M HCl, boiling and addition of 5mL of 30% H_2O_2. The sample is then back titrated with NaOH to measure the amount of acid consumed by reaction with the sample and provides the ANC_T in kg H_2SO_4/t. Acid neutralising capacity is expressed in kg H_2SO_4/t of material representing the capacity of the solids to neutralise acid but not necessarily implying that calcite ($CaCO_3$) is present. This is the method used for this work.

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates. Secondary neutralising minerals accounted for in the measurement of total acid neutralising capacity include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be small under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese do not report to the ANC measurement. The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 3-1**.

Table 3-1: Relative Mineral Reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite,	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm)

3.5 Reactive acid neutralising capacity

The reactive (available) ANC is determined using the ABCC (AMIRA, 2002) method that was derived from the British Columbia Research Incorporated Initial Neutralisation Potential method (Duncan and Bruynesteyn, 1979). The measurements of reactive (available) acid neutralising capacity ($ABCC_{ANC}$) involves slow titration of a sample with the addition of hydrochloric or sulfuric acid over set time intervals

while continuously measuring the pH. The method is used to estimate the ANC of the material and the buffering capacity available at a pre-determined pH value. When acid is added to finely ground particles or aggregates the material will react with the acid neutralising components and reduce the pH of the solution. The amount of acid required to reach each pH interval is dependent on the amount of neutralisation present. 'Buffering' occurs where a significant amount of acid is added before the pH drops, thereby producing a 'step-like' curve in a plot of pH versus volume of acid added. RGS has not included reactive ANC testing in this assessment.

3.6 Net acid producing potential and neutralisation potential ratio

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from acid base accounting (ABA) procedures (DITR, 2007). The NAPP value is derived as the difference between the maximum potential acidity (MPA) and total acid neutralising capacity (ANC_T) of a sample.

The ANC_T/MPA ratio (or Neutralising Potential Ratio (NPR)) is also used as a means of assessing the risk of acid generation from mine waste materials. The purpose of the ANC_T/MPA ratio is to provide an indication of the relative margin of safety within a material. As a general rule, an ANC_T/MPA ratio of 2 or more signifies that there is a high probability that the material will remain circum-neutral in pH (AMIRA, 2002; INAP, 2009).

3.7 Net acid generation

The single addition NAG test involves a single addition of 250 ml of 15% H_2O_2 to a 2.5 g of pulverised (less than 75 µm) sample. The sample is then allowed to react overnight. The entire sample is heated until gently bubbling for approximately 1-2 h to remove excess H_2O_2 and encourage release of inherent neutralising capacity. Once the sample has cooled to room temperature, the pH and titrated acidity to pH 4.5 and 7.0 (in kg H_2SO_4/t of sample) of the solution are measured. A NAG_{pHOx} less than 4.5 generally indicates the sample is acid producing.

A NAG_{pHOx} value can be used in combination with NAPP values to classify the geochemical nature of samples. The Australian Government Leading Practice Handbook on Acid and Metalliferous Drainage COA, 2016 now states that, "the risks of misclassifying Non-Acid Forming (NAF) material as Potentially Acid Forming (PAF) and PAF material as NAF, are substantially reduced by conducting both NAPP and NAG tests."

The NAG method is also known to have a number of limitations that should be considered in the interpretation of data (MEND, 2009). RGS has not included NAG testing in this assessment.

3.8 Metalliferous drainage potential

The potential of a geological material to leach trace, minor or major elements (salts, metals and metalloids) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed. The static methods used in this assessment have measured the "total" and "water soluble" fractions of these elements.

The geochemical abundance index (GAI) quantifies a "total" assay result for a particular element in terms of the average crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in **Table 3-2**.

Table 3-2 Geochemical Abundance Index (GAI) values and Enrichment Factor

GAI	Enrichment factor	GAI	Enrichment factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 2009). This is the case with some environmentally important 'trace' elements, such as As, Cd, Cu and Zn, rather than with major rock-forming elements, such as Ca, Mg, K and Na. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g. low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

A 1:3 (solid:solute) leach can be used to measure the pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts. It should be recognised that direct comparison of geochemical data from 1:3 water extracts with guideline values can be misleading.

RGS has a preference to evaluate the solubility of metals and major ions from mine waste and tailings using kinetic leach cell testing that provides the rate of weathering and associated concentration of elements in the leachate.

3.9 Saline drainage potential

Saline drainage is of concern to regulators in Queensland and other states and territories. Saline drainage can come from the release of major cations and anions from geological units due to weathering of the host rock, or from the accumulation of elements over time e.g. accumulation of NaCl in soil from rain.

Saline drainage can also be attributed to sulfide oxidation process that release sulfate and or the weathering of sulfate minerals such as gypsum. Sulfate and other major ions such as NaCl can be present under both acid and neutral pH conditions.

3.10 AMD classification

Terms used to **classify mined materials** can include the following.

- **AF** (Acid Forming) – sample is producing acidity (< pH 5), contains no ANC and has additional sulfide content that will oxidise and produce additional acid
- **PAF** (Potentially Acid Forming) – has a pH > 5 and has the potential to produce acid when all ANC is consumed
- **PAF-LC** (Low Capacity – Potentially Acid Forming) - has the potential to produce minor acidity
- **NAF-Barren** (Non-Acid Forming - Barren) - is geochemically inert in respect to total sulfur and will produce circum-neutral drainage in the range of 7 to 9 with low sulfate concentrations
- **NAF** (Non-Acid Forming) - will not produce acid but may leach salts and some metals/metalloids due to the presence of low sulfide bearing material
- **AC** (Acid Consuming) - has some ANC that will contribute to ongoing acid neutralisation e.g. calcite

Other terminology used to classify geological materials include the following.

- Saline - material may leach salts dominated by NaCl and or sulfate
- Sodic – this material has a proportionally high concentration of exchangeable Na and has the potential to disperse and tunnel

General industry terms that can be used to **describe water quality** at mines include the following.

- Acid Mine Drainage
- Acid Rock Drainage
- Acid and Metalliferous Drainage
- Neutral Drainage
- Saline Drainage
- Mine Impacted Water

In this report we use the term mine impacted water (MIW) as a general term to describe water that comes into contact with disturbed ground. Mine impacted water (MIW) can be classified as having:

- acid, neutral or alkaline pH
- variable concentrations of major ions (salts e.g. calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride, or in the instance of this project - phosphate)
- variable concentrations of metals (e.g. Al, Fe, Mn and Zn) or metalloids (e.g. Be, Mo, Se and V) with the concentrations often linked to pH.

Potential sources of acid in MIW at mine sites can include:

- oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009)
- oxidation of coal that can produce humic acid like materials and organic acid
- rainfall and leaching of cations such as Ca, Mg, K and Na that reduce soil acidification by atmospheric carbonic, nitric or sulfuric acid
- organic matter decay
- use of ammonium-based nitrogen fertilisers.

Potential sources of salts in MIW at mine sites can include:

- oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium (Ca^{2+})
- chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}) and chloride (Cl^-)
- the mobilisation of sodium chloride (NaCl) or sodium bi-carbonate ($NaHCO_3$) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms

Potential sources of metals (e.g. Al, Fe, Mn and Zn) and oxyanions (e.g. Mo, Se and V) in water at mine sites that can include elements present:

- as ancillary minerals within primary sulfide minerals like pyrite or marcasite that weather very slowly;
- in the solid phase of geological units in a range of minerals with increasing environmental mobility that include immobile oxide <<< carbonate << exchangeable < water soluble.
- in pore water.

4 Sampling and analytical program

Representative samples of ore and tailings samples were provided by Centrex. In addition, RGS reviewed the geological database and identified 41 samples of overburden from 10 diamond drill cores and 4 samples of footwall material from reverse circulation drill holes that were drilled in 2017. The diamond drill hole locations are shown in **Figure 4-1** and drill holes sampled and sampled intervals are detailed in **Table 4-1**. The analytical program was designed to identify the potential for acidic, saline, and metalliferous drainage (herein referred to as AMD) from the overburden and footwall material below the ore deposit (**Table 4-2**).

Table 4-1: Drill hole samples

Client ID	Area Hole ID	GDA94z54 X Coordinate	GDA94z54 Y Coordinate	Depth From	Depth To	Area Hole Interval	Lithology
RDS001	AMDD023	321684	7602514	1	1.9	Northern	CL
RGS002	AMDD023	321684	7602514	2	2.6	Northern	SH
				2.6	2.95	Northern	SH
				2.95	3.35	Northern	SH
				3.35	4.15	Northern	SH
RGS003	AMDD023	321684	7602514	4.15	4.7	Northern	ST
				4.7	4.75	Northern	CH
				4.75	5.1	Northern	SH
				5.1	5.2	Northern	SH
RGS004	AMDD024	320922	7603153	0.9	1.1	Northern	SH
				1.1	1.9	Northern	SH
				1.9	3	Northern	SH
RGS005	AMDD024	320922	7603153	3	3.1	Northern	EV
				3.1	5.05	Northern	SH
RGS006	AMDD024	320922	7603153	7.9	10.85	Northern	SH
RGS007	AMDD024	320922	7603153	14	14.35	Northern	CH
				14.35	14.45	Northern	ST
				14.45	14.75	Northern	ST
				14.75	14.85	Northern	MS
RGS008	AMDD026	322064	7601844	1.8	4.1	Northern	SH
RGS009	AMDD026	322064	7601844	4.2	5	Northern	SH
				5	5.4	Northern	SH
				5.4	5.9	Northern	SH
RGS010	AMDD026	322064	7601844	6.5	7.25	Northern	SH
				7.25	7.3	Northern	CH
				7.3	7.4	Northern	SH
				7.4	7.5	Northern	FC
				7.5	7.65	Northern	SH
RGS011	AMDD026	322064	7601844	12.5	12.6	Northern	CH
				12.6	12.7	Northern	FP
				12.7	13.1	Northern	CH
				13.1	13.2	Northern	CH
				13.2	13.5	Northern	FP
				13.5	14.9	Northern	ST
RGS012	AMDD005	322064	7601844	1.65	1.9	Southern	SH
				1.9	2.7	Southern	SH
RGS013	AMDD005	323431	7595556	8.04	8.06	Southern	CH
				8.06	8.2	Southern	ST
				8.2	8.35	Southern	IP
				8.35	8.65	Southern	ST
				8.65	8.75	Southern	CH
RGS014	AMDD006	323733	7595704	1.4	2.7	Southern	SH
RGS015	AMDD006	323733	7595704	2.73	4.4	Southern	SH
RGS016	AMDD006	323733	7595704	4.4	8.6	Southern	SH
RGS017	AMDD006	323733	7595704	8.6	12.7	Southern	SH

Client ID	Area Hole ID	GDA94z54 X Coordinate	GDA94z54 Y Coordinate	Depth From	Depth To	Area Hole Interval	Lithology
RGS018	AMDD006	323733	7595704	17.53	17.55	Southern	CH
				17.55	17.7	Southern	FP
				17.7	17.72	Southern	CH
				17.72	17.88	Southern	FP
				17.88	17.9	Southern	CH
RGS019	AMDD006	323733	7595704	17.9	19.23	Southern	ST
RGS020	AMDD008	323131	7595728	1.5	3.1	Southern	SH
RGS021	AMDD008	323131	7595728	3.1	3.13	Southern	SH
				3.13	3.15	Southern	CH
				3.15	3.27	Southern	SH
				3.27	3.32	Southern	CH
				3.32	3.71	Southern	SH
RGS022	AMDD008	323131	7595728	7.9	9.1	Southern	ST
RGS023	AMDD010	323475	7595790	1	2.4	Southern	SU
RGS024	AMDD010	323475	7595790	2.4	3.2	Southern	CL
				3.2	3.8	Southern	SC
				3.8	4.94	Southern	SH
RGS025	AMDD010	323475	7595790	4.94	4.96	Southern	CH
				4.96	5.45	Southern	SH
				5.45	5.55	Southern	SH
RGS026	AMDD010	323475	7595790	9.9	10.05	Southern	SH
				10.05	10.1	Southern	CH
				10.1	10.3	Southern	SH
				10.3	10.9	Southern	ST
				10.9	12	Southern	CH
RGS027	AMDD017	323118	7596031	2	3.2	Southern	SH
RGS028	AMDD017	323118	7596031	9	9.02	Southern	CH
				9.02	10	Southern	ST
RGS029	AMDD018	323574	7596175	0.6	2	Southern	SH
RGS030	AMDD018	323574	7596175	2	3	Southern	SH
				3	3.4	Southern	SH
				3.4	3.65	Southern	SH
RGS031	AMDD018	323574	7596175	6.25	6.35	Southern	FP
				6.35	6.55	Southern	ST
				6.55	6.65	Southern	SH
				6.65	6.75	Southern	FP
				6.75	8.5	Southern	CH
RGS032	AMDD021	323742	7596321	1.7	2	Southern	SH
RGS033	AMDD021	323742	7596321	2	4.3	Southern	SH
RGS034	AMDD021	323742	7596321	4.3	5.9	Southern	SH
RGS035	AMDD021	323742	7596321	5.9	7.2	Southern	SH
RGSO36	AMDD021	323742	7596321	10.7	11	Southern	ST
				11	12.7	Southern	CH
				12.7	12.8	Southern	FP
RGS037	AMRC718	321761	7603238	51	52	Northern	ST
RGS038	AMRC728	321683	7603402	51	52	Northern	ST
RGS039	AMRC808	320756	7603619	21	22	Northern	SH
RGS040	AMRC815	321804	7603166	47	48	Northern	ST
RGS041	AMDD024	320922	7603153	17.35	18.35	Northern	ST

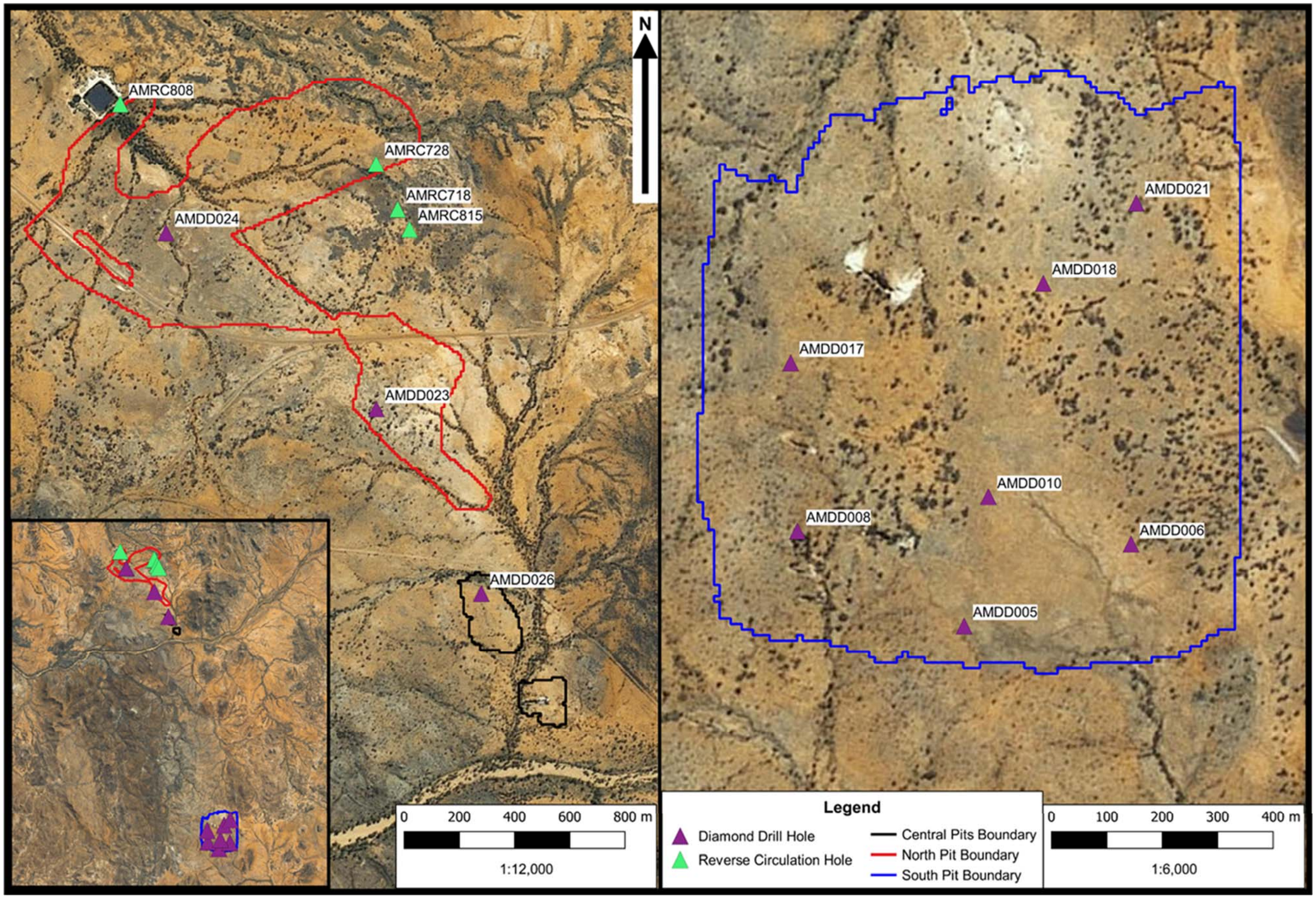


Figure 4-1: Sampled drill hole locations

Table 4-2: Analytical Program

Sample ID	Area Hole ID	Depth From	Depth To	Lithology	EA002: pH (Soils)	EA010: Conductivity (Soils)	EA009: Nett Acid Production Potential	EA013: Acid Neutralising Capacity	EA026: Chromium Reducible Sulfur	ED042T: Total Sulfur by LECO	MPA	NPR	ED006/ED008: Exchangeable Cations	EK067G: Total Phosphorus as P by Discrete Analyser	EK074: Fluoride Extractable Phosphorus (Bray)	EP003: Total Organic Carbon (TOC) in Soil	EP080/071: Total Petroleum Hydrocarbons	EP080/071: Total Recoverable Hydrocarbons -	EP080: Benzene, Toluene, Ethylbenzene, Xylene and Naphthalene	ME-MS41: Total Metals by ICP-MS
					pH Unit	µS/cm	kg H2SO4/t	kg H2SO4 equiv./t	%	%	kg H2SO4 equiv./t		meq/100g	mg/L	mg/kg	%	mg/kg	mg/kg	mg/kg	ppm
Balmore				Final Attrition Test work (Balmore)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tailings - 38µm fraction				Tailings - 38µm fraction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S012	AMDD005	1.65	2.7	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S013	AMDD005	8.04	8.75	CH	✓	✓	✓	✓		✓	✓	✓								
S014	AMDD006	1.4	2.7	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S015	AMDD006	2.73	4.4	SH	✓	✓	✓	✓		✓	✓	✓								
S016	AMDD006	4.4	8.6	SH	✓	✓	✓	✓		✓	✓	✓								
S017	AMDD006	8.6	12.7	SH	✓	✓	✓	✓		✓	✓	✓								
S018	AMDD006	17.53	17.9	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S019	AMDD006	17.9	19.23	ST	✓	✓	✓	✓		✓	✓	✓								
S020	AMDD008	1.5	3.1	SH	✓	✓	✓	✓		✓	✓	✓								
S021	AMDD008	3.1	3.71	SH	✓	✓	✓	✓		✓	✓	✓								
S022	AMDD008	7.9	9.1	ST	✓	✓	✓	✓		✓	✓	✓								
S023	AMDD010	1	2.4	SU	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S024	AMDD010	2.4	4.94	CL	✓	✓	✓	✓		✓	✓	✓								
S025	AMDD010	4.94	5.55	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S026	AMDD010	9.9	12	SH	✓	✓	✓	✓		✓	✓	✓								
S027	AMDD017	2	3.2	SH	✓	✓	✓	✓		✓	✓	✓								
S028	AMDD017	9	10	CH	✓	✓	✓	✓		✓	✓	✓								
S029	AMDD018	0.6	2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S030	AMDD018	2	3.65	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S031	AMDD018	6.25	8.5	FP	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S032	AMDD021	1.7	2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S033	AMDD021	2	4.3	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S034	AMDD021	4.3	5.9	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S035	AMDD021	5.9	7.2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S036	AMDD021	10.7	12.8	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S001	AMDD023	1	1.9	CL	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S002	AMDD023	2	4.15	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S003	AMDD023	4.15	5.2	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S004	AMDD024	0.9	3	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S005	AMDD024	3	5.05	EV	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S006	AMDD024	7.9	10.85	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S007	AMDD024	14	14.85	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S041	AMDD024	17.35	18.35	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S008	AMDD026	1.8	4.1	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S009	AMDD026	4.2	5.9	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S010	AMDD026	6.5	7.65	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S011	AMDD026	12.5	14.9	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S037	AMRC718	51	52	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S038	AMRC728	51	52	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S039	AMRC808	21	22	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S040	AMRC815	47	48	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓

5 Interpretation

5.1 Ore and tailings samples

5.1.1 Net acid producing potential

The ore (Ardmore Ore) and tailings (Pilot plant test work) samples provided by Centrex have mildly alkaline pH measured using a 1:5 solid:water ratio 1 hour leach test. The percentage of the total sulfur (TS%) of 0.29% to 0.5% indicated there is some potential for the presence of sulfide minerals. Supplementary analysis undertaken using the chromium reducible sulfur (CRS) method verified that the actual sulfide concentration is < 0.02%. Based on these results the acid producing potential is therefore very low. Coupled with the presence of minor acid neutralising capacity (ANC) in the range of 36 to 66 kg H_2SO_4/t, the maximum potential acidity (MPA) of the samples using the CRS method was < 1 kg H_2SO_4/t.

The net acid producing potential (NAPP) and neutralisation potential ratio (NPR) of the samples using CRS was:

- -66 kg H_2SO_4/t (NAPP) with an NPR of 148 for the -38 µm geotechnical tailings sample; and,
- -36 kg H_2SO_4/t (NAPP) with an NPR of 63 for the Balmore ore sample.

This analysis verifies that both the ore tailings samples are non-acid forming (NAF) and therefore, there is negligible potential for the samples to produce acidic drainage (**Table 5-1)**.

Table 5-1: Static geochemical properties of the Ardmore tailings and ore samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
$pH_{1:5}$ (EA002)	pH Unit	8.1	7.9
TS	%	0.29	0.5
MPA_{TS}	kg H_2SO_4/t	8.87	15.29
CRS	%	0.015	0.019
MPA_{CRS}	kg H_2SO_4/t	0.45	0.58
ANC	kg H2SO4 equiv./t	66.9	36.8
$NAPP_{TS}$	kg H_2SO_4/t	-58.03	-21.51
NPR_{TS}		7.5	2.4
$NAPP_{CRS}$	kg H_2SO_4/t	-66.45	-36.22
NPR_{CRS}		148	63
Moisture Content	%	60.4	1.1

5.1.2 Saline drainage potential

The NAPP data coupled with (1) the EC measured using a 1:5 solid:water ratio 1 hour leach test (2) soluble major ion concentrations measured using a 1:3 solid:water 16 hour leach test and (3) the CEC of the samples suggests there is a low potential for saline drainage from the ore and tailings samples.

However, the exchangeable sodium percentage (ESP) of the Balmore sample verifies some potential for sodic conditions (slaking) to occur in this sample. The low saline drainage potential of the samples does not exclude the potential for saline drainage to become a management issue in an ore stockpile or tailings impoundment as the effects of evapoconcentration in the project environment will increase the salinity in surface water and seepage within the impoundments.

It is noted that the ore may be processed with saline groundwater, dam water or a combination of both for processing i.e. Centrex will not be processing only with non-saline (dam or reverse osmosis) water and will also be processing with saline water (17,000mg/L TDS) and rinsing with non-saline water (from site water dam or reverse osmosis plant). Either way, the TSF will end up holding a substantial salt load through water use.

Table 5-2: Soluble and exchangeable saline properties of the Ardmore ore and tailings samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
$EC_{1:5}$ (EA010)	µS/cm	167	1030
1:3 soluble Calcium	mg/L	14	71
1:3 soluble Magnesium	mg/L	6	24
1:3 soluble Sodium	mg/L	23	228
1:3 soluble Potassium	mg/L	2	3
1:3 soluble Chloride	mg/L	25	417
1:3 soluble Sulfate	mg/L	38	167
Exchangeable Calcium	meq/100g	6.4	2.3
Exchangeable Magnesium	meq/100g	2.9	0.8
Exchangeable Potassium	meq/100g	0.2	0.1
Exchangeable Sodium	meq/100g	0.4	0.8
Cation Exchange Capacity	meq/100g	10	3.8
Exchangeable Sodium Percent	%	4.5	20.5

The total concentration of major cations and phosphorous is in **Table 5-3**. The elevated concentration of the Ca and P in the tailings could present issues with these elements in seepage from stockpiles and impounded tailings.

Table 5-3: Total major cation and phosphorous concentrations in tailings samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
Sodium	mg/kg	1960	3210
Potassium	mg/kg	3540	1820
Calcium	mg/kg	198000	374000
Magnesium	mg/kg	3610	1630
Total Phosphorus as P	mg/kg	97100	111000
Fluoride Extractable P (Bray)	mg/kg	152	388

5.1.3 Metalliferous drainage potential

The geochemical abundance index (GAI) provides a comparison of total metal/metalloid concentrations compared to median soil values (Bowen, 1979). This can be useful in identifying samples with the potential to elevate metal/metalloid concentrations in the surrounding regolith. GAI values alone are not diagnostic but can be used to highlight metals/metalloids that require further investigation. The solubility of these elements over time is typically assessed using kinetic leach column tests. Total metal/metalloid analysis has been undertaken for the ore and tailings samples and the GAI values are presented in **Table 5-3**.

Nearly all metals and metalloids analysed were within median soil concentrations. While silver, beryllium and tellurium are elevated in comparison to soil concentrations in non-mineralised areas, they are still within the range of background concentrations found in soils. Elevated calcium is likely to be due to the presence of calcium orthophosphate ($Ca_3(PO4)_2$) and apatite ($Ca_5(PO_4)_3(F,Cl,OH)$).

Uranium was present in the ore and tailings samples at 99 and 93 mg/kg and is often elevated in association with phosphatic sediments in sedimentary rocks and may also be present as an accessory

element in detrital grains (Salminen, et al., 2005) possibly derived from the granites surrounding the outlier. Detrital minerals may contain yttrium (Salminen, et al., 2005) and the formation of xenotime (YPO_4) through diagenesis in phosphatic sediments has been observed (Vallini, Rasmussen, Krapež, Fletcher, & McNaughton, 2002).

Table 5-4: Geochemical Abundance Index of metals and metalloids in the ore and tailings samples

	EB1807385-001	EB1807385-002		EB1807385-001	EB1807385-002
Ag	3	3	Mo	3	2
Al	0	0	Na	0	0
As	3	2	Nb	0	0
Ba	0	0	Ni	0	0
Be	5	5	P	4	4
Bi	1	1	Pb	0	0
Ca	3	0	Rb	0	0
Cd	2	2	S	1	2
Ce	2	2	Sb	2	1
Co	1	1	Sc	2	1
Cr	0	0	Se	0	0
Cs	0	0	Sn	0	0
Cu	2	1	Sr	2	2
Fe	0	0	Ta	0	0
Ga	0	0	Te	5	3
Ge	0	0	Th	0	0
Hf	0	0	Ti	0	0
Hg	0	0	Tl	2	2
In	0	0	U	5	5
K	0	0	V	2	1
La	2	2	W	0	0
Li	0	0	Y	3	3
Mg	0	0	Zn	1	1
Mn	0	0	Zr	0	0

Values of 3 not highlighted are due to rounding.

Because of the GAI values and the fine-grained nature of the samples, the potential for metalliferous drainage was evaluated on these materials by subjecting the two samples to a 1:3 solid:water 16 hour leach test. The pH of the samples using this method was 7.7 and 7.46 and the EC was 263 and 1,650 µS/cm. The water-soluble analyses obtained minor concentrations of the metals/metalloids below:

- < 1.0 > 0.1 mg/L for B, Ba, Sr and Zn
- < 0.1 > 0.01 mg/L for Al, Mo and V
- < 0.01 > 0.001 mg/L for Cr, Li, Mn, Rb
- < 0.0001 mg/L for Cd

All other water soluble leachable elements were less than the laboratory limit of reporting (LoR): this included uranium. The low TS and CRS concentrations coupled with the NAPP and NPR values; and the soluble metal/metalloid concentrations measured on 48 major, minor, trace and rare earth elements using a 1:3 solid:water 16 hour leach test; verify there is a low potential for metalliferous drainage from the samples. However, as discussed above, this does not exclude the potential for metalliferous drainage issues to occur in a tailings impoundment due to evapoconcentration.

5.2 Organic geochemistry

The two tailings samples were analysed for total petroleum hydrocarbons, total recoverable hydrocarbons, BTEXN. All concentrations were less than the laboratory LoR. RGS included these analyses as they were requested by Centrex in the initial scope of work developed with Golder.

5.3 Radioactivity

Radioactive materials, like uranium and radium, are normal constituents of the earth's crust. The radioactivity of phosphate rock is enhanced by geological processes. Phosphate rocks of sedimentary origin contain Uranium (238), Thorium (232) and its decay products in addition to phosphate minerals.

Considerable variations are found in the chemical composition of rock phosphate from different mining areas (Roesseler, 1990 in Sahu *et al*., 2014). In general, sedimentary phosphate rocks, or phosphorites, that originated in a marine environment, are characterised by activity concentrations of uranium much higher than those of volcanic and biological rocks. These phosphates are largely used for the production of phosphoric acid, fertilizers and hence phosphate fertilizer industries are considered to be a potential source of natural radionuclide contamination.

This investigation has not evaluated the potential for radioactive emissions and this should be addressed in a subsequent stage of work, on the overburden, footwall units, ore, and tailings streams.

Radioactive emissions are considered unlikely but should be addressed to verify this assumption.

5.4 Overburden and footwall samples

5.4.1 Net acid producing potential

The majority of the 41 samples (n = 37) are circum-neutral or basic with a pH between 6 and 9. The pH of the deionised water used in the analysis of samples was 5.6. Only three samples have pH values below this, 2 at a pH of 5 and 1 with a pH of 3.7, and these are all within the footwall units below the overburden and ore.

Total sulfur concentrations range from 0.02% to 3.15% with a median of 0.12%. Of the 41 samples 16 have total sulfur concentrations below 0.1%. A further 22 samples with a total sulfur concentration of greater than 0.1% were subsequently determined to have sulfide sulfur concentrations measured using CRS of less than 0.1%. The median CRS concentration is notably lower at 0.007%. Only 4 samples had CRS results greater than 0.1%, these were all samples taken from below the maximum proposed pit depth in reverse circulation drill holes (AMRC718, AMRC728, AMRC808 and AMRC815).

In some cases where the samples utilised in the static acid base accounting analyses are older weathered samples there is a need to determine if the measured CRS results accurately reflect in-situ sulfide sulfur content. RGS consider it is probable that the CRS results reflect in-situ conditions. This is because if the samples did initially contain sulfide minerals and they oxidised they would have produced acid that would have resulted in acidic pH measured in the pH analysis, and this was not observed. The samples from this study were drilled in August 2017.

Verification of sulfide content in overburden can be undertaken with the collection and analysis of fresh samples from ongoing drilling that would be collected directly after drilling to ensure that any effects of sulfide oxidation can be accounted for.

Drill hole sample ANC ranges from below the laboratory LoR to the equivalent of 173 kg H_2SO_4/t. The median value is 19 kg H_2SO_4/t. There is no clear correlation between lithology or depth and ANC (at this stage), although this may become apparent with additional analyses over the life of the project.

When the CRS analyses were combined with the ANC results the NAPP and NPR results verified all overburden samples are NAF or AC (**Table 5-6**). These results indicate that the potential environmental risk associated with the mining, temporary stockpiling and ultimate placement of the overburden that would occur during progressive rehabilitation at the site is relatively low. These NAPP results (do not on their own) discount the potential for environmental issues associated with salinity (refer to **Section 5.3.2**).

Conversely the geochemical analyses of the footwall samples verify that the footwall material below the deposit may be PAF (**Table 5-6**). This suggests that the exposure of PAF waste rock below the ore may result in sulfide oxidation, and care must be taken to prevent acid production in the underlying strata exposed by mining. As all the deeper samples have been obtained from the area around the northern pit, further sampling is recommended in the area of the proposed southern and central pits to determine if potentially acid generating sulfide underlie these pits also. RGS note that the overburden / ore and footwall sequence in the southern deposit which will be exposed through mining is totally oxidised and the potential for PAF material in the footwall in this area is much lower (negligible).

The presence of PAF footwall units below the ore may have the following adverse impacts on water and mine waste management and rehabilitation.

- The removal of ore from the pits will result in (relatively) shallow pits that may nevertheless have exposed PAF material on the pit floor.
- Progressive backfilling of NAF overburden into the mined pits to pre-mine topography will enable parts of the pits to be rehabilitated through replacement of the NAF overburden and soil, reinstating the initial regolith profile. Under this style of progressive rehabilitation management, the potential for PAF footwall material to produce AMD may be substantially reduced.
- However, there will inevitably be residual shallow voids (pits) in the landscape and if these areas contain PAF footwall material the seasonal inundation of the pits with water during the wet season will produce acidic drainage. If the AMD in the pits is not contained in the voids it could seep laterally into the adjoining backfilled rehabilitated areas of the pits and this could have an adverse effect on these areas by introducing acid, salts and metals into backfilled NAF overburden.
- The presence of AMD in the residual pits may also affect surface or groundwater resources in the receiving environment.
- It would be advantageous during development of the project to drill, sample and analyse the footwall materials to ascertain if there are NAF footwall units. If there are, the NAF footwall units would be ideal as the residual voids.

Drill hole sample Acid Base Accounting analysis results are shown in **Table 5-6**. Total sulfur is typically used to calculate the MPA and used with ANC results to calculate the NAPP and the NPR. In this study the CRS% (and TS% in the absence of measured CRS) were used with the NAPP. NPR and pH were used to classify the samples for their acid producing or consuming potential (**Table 5-5)**. The bulk of the samples contain insufficient sulfide sulfur to have acid forming potential. The samples classified as PAF are hosted within siltstones and shales at a minimum depth of 21 m below ground level.

Table 5-5: AMD classification

Classification	1:5 pH	Total Sulfur %	Total Sulfide %	NAPP (kg H_2SO_4/t)	NPR	No. of Samples (n=41)
Acid Consuming (AC)	> 5	< 1.0		> -100	> 10	6
Non-Acid Forming - Barren	> 5	< 0.2	< 0.05	-ve		21
Non-Acid Forming	> 5		< 0.1	-ve	≥ 3	10
Potentially Acid Forming – Low Capacity (PAF-LC)	> 5	> 0.2			< 3 > 2	
Potentially Acid Forming (PAF)	> 5	> 0.2			< 2	3
Acid Forming (AF)	< 5	> 0.2	> 0.2	+ve	< 1	1

Figure 5-1 categorises the risk of acidic drainage and sulfate / saline from the drill hole samples. The data points have been coloured to match the classification colouring in **Table 5-5**. The ratio of ANC to MPA for the samples is used to help assess the level of risk of acidic drainage.

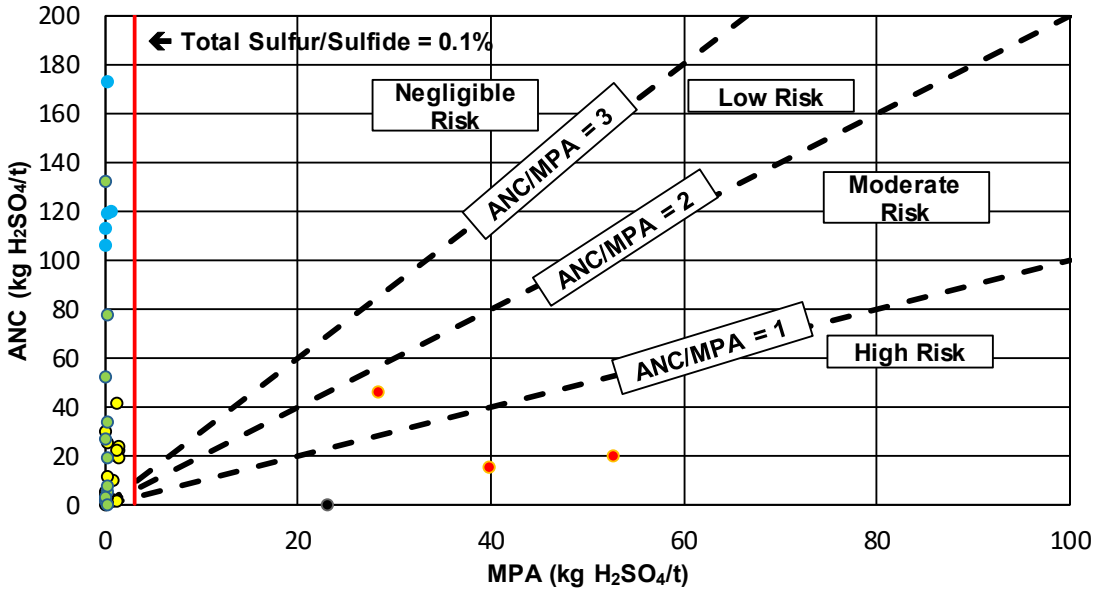


Figure 5-1: Drill hole samples ANC vs MPA plot

Figure 5-2 demonstrates the relationship between TS and CRS in the drill hole samples. All samples contain more sulfur than is present as sulfide sulfur. Lithology logging describes the presence of evaporite minerals thought to be gypsum ($CaSO_4 \bullet 2H_2O$) suggesting sulfur is potentially present as sulfate, and or other secondary sulfate minerals.

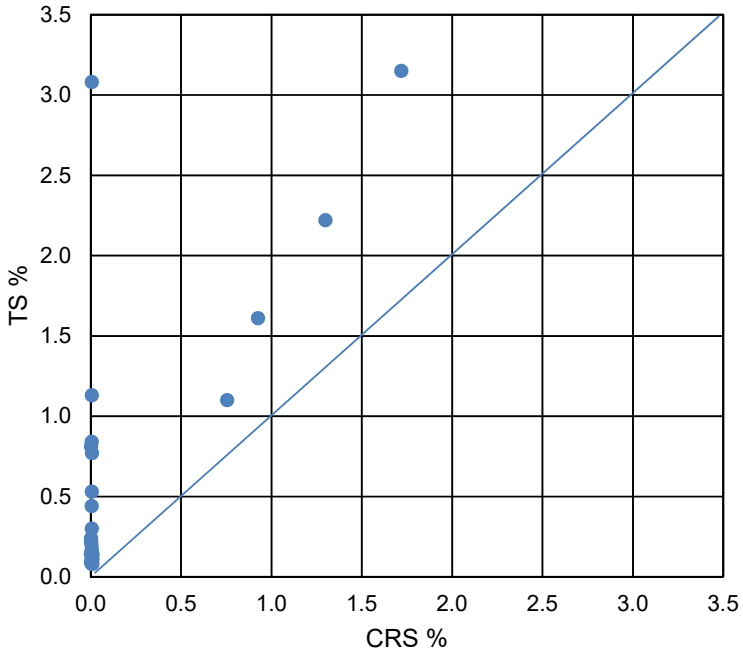


Figure 5-2: A comparison of TS vs. CRS in the drill hole samples

5.4.2 Saline drainage potential

Soil salinity refers to the presence of water soluble salts in a sample that are mainly of sodium, but also of potassium, calcium and magnesium chloride, sulfate or carbonate minerals (Hazelton & Murphy, 2007).

The electrical conductivity was measured using a 1:5 solid to water ratio ($EC_{1:5}$) that determines the salinity level in the samples at the time they were sampled. The $EC_{1:5}$ results are converted to ECe values based on the estimated water holding capacity of the soils that is based on textural classification. For determining EC it was assumed that the predominant texture of the finer graded mined material would be a silty clay.

Of the 41 samples the ECe results determined there are:

- (n=0) < 2,000 µS/cm are non-saline
- (n=5) 2,000 to 4,000 µS/cm are slightly-saline
- (n=6) 4,000 to 8,000 µS/cm are moderately saline
- (n=13) 8,000 to 16,000 µS/cm are highly saline
- (n=17) >16,000 µS/cm are extremely saline

Most samples (n = 30) have an EC result that is categorised as highly saline, i.e. greater than 8,000 µS/cm (Hazelton & Murphy, 2007).

The presence of elevated concentrations of salts in the overburden samples indicates that saline drainage could be a significant aspect for site water management. As there is no obvious correlation between major exchangeable cations and salinity it is hypothesised that salinity is predominately present in the form of sodium chloride and sulfate bearing minerals. The concentrations of total phosphorus suggest phosphate may also contribute to the elevated EC measured on the overburden and footwall samples.

The mining process applied to the soil and overburden will increase the particle size distribution of the samples and lead to an increased potential for elevated EC and saline drainage. If the overburden is not mined, stored and used effectively there could be adverse effects on vegetation from salts (and or excessive phosphorous) and compounding adverse effects on the ability of rehabilitated surfaces to develop resilient vegetative cover and resist erosion.

The risk associated with saline drainage and rehabilitation will be largely overcome through adoption of a strip mining and progressive rehabilitation mine plan that is being proposed by Centrix.

5.4.3 Metalliferous drainage potential

Total elemental analyses were undertaken on selected overburden and footwall samples to evaluate the level of mineralisation in these materials. The total elemental concentrations were compared with average soil concentrations to develop an understanding of potential metalliferous issues. The GAI results (**Table 5-7**) coupled with the elevated sulfide concentrations in footwall geological units verify that there may be some metalliferous issues associated with operational water management. However, the issues are likely to be driven by the presence of elements that are prone to be present at circum-neutral pH in the overburden such as Be, Mo and P. In the footwall materials the oxidation of sulfide minerals may produce acidic drainage that could be elevated in a broader range of elements including Al, Fe, Co, Cu, Fe, Mn and Zn.

The GAI values on their own do not infer these elements will be environmentally mobile. As discussed previously the potential for saline and metalliferous drainage should be evaluated using fresh drill core samples and kinetic leach cell testing.

Table 5-6: Drill hole sample Acid/Base Accounting and material classification

Area Hole ID	Depth From	Depth To	Lithology	pH	EC	ECe	Sulfur - Total as S (LECO)	MPA_{TS}	CRS	MPA_{CRS}	ANC as H_2SO_4	$NAPP_{TS}$	$NAPP_{CRS\ or\ TS}$	NPR_{CRS}	
	m bgl	m bgl		pH Unit	µS/cm	µS/cm	%	kg H_2SO_4/t	%	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t		**Classification**
AMDD005	1.7	2.7	SH	8.4	1270	10922	0.17	5.2	0.0070	0.2	119.0	-113.80	-118.79	555.7	Acid Consuming
AMDD005	8.0	8.8	CH	7.8	492	4231	0.04	1.2	0.0400	1.2	20.0	-18.78	-18.78	16.3	Non-Acid Forming (Barren)
AMDD006	1.4	2.7	SH	7.2	3950	33970	0.81	24.8	0.0025	0.1	1.7	23.08	-1.62	22.2	Non-Acid Forming
AMDD006	2.7	4.4	SH	6.2	1670	14362	0.03	0.9	0.0300	0.9	1.7	-0.78	-0.78	1.9	Non-Acid Forming (Barren)
AMDD006	4.4	8.6	SH	7.3	1420	12212	0.02	0.6	0.0200	0.6	2.6	-1.99	-1.99	4.2	Non-Acid Forming (Barren)
AMDD006	8.6	12.7	SH	7.7	1570	13502	0.02	0.6	0.0200	0.6	1.5	-0.89	-0.89	2.5	Non-Acid Forming (Barren)
AMDD006	17.5	17.9	CH	8.5	513	4412	0.08	2.4	0.0060	0.2	30.2	-27.75	-30.02	164.5	Non-Acid Forming (Barren)
AMDD006	17.9	19.2	ST	8.1	314	2700	0.05	1.5	0.0500	1.5	22.6	-21.07	-21.07	14.8	Non-Acid Forming (Barren)
AMDD008	1.5	3.1	SH	8.6	1000	8600	0.02	0.6	0.0200	0.6	120.0	-119.39	-119.39	196.1	Acid Consuming
AMDD008	3.1	3.7	SH	8.6	1050	9030	0.04	1.2	0.0400	1.2	41.2	-39.98	-39.98	33.7	Non-Acid Forming (Barren)
AMDD008	7.9	9.1	ST	8.6	627	5392	0.05	1.5	0.0500	1.5	19.3	-17.77	-17.77	12.6	Non-Acid Forming (Barren)
AMDD010	1.0	2.4	SU	6.3	3640	31304	0.77	23.6	0.0080	0.2	0.3	23.30	-0.01	1.0	Non-Acid Forming
AMDD010	2.4	4.9	CL	5.8	1880	16168	0.04	1.2	0.0400	1.2	1.6	-0.38	-0.38	1.3	Non-Acid Forming (Barren)
AMDD010	4.9	5.6	CH	6.1	2030	17458	0.1	3.1	0.0070	0.2	0.9	2.16	-0.69	4.2	Non-Acid Forming (Barren)
AMDD010	9.9	12.0	SH	7.9	379	3259	0.05	1.5	0.0500	1.5	23.6	-22.07	-22.07	15.4	Non-Acid Forming (Barren)
AMDD017	2.0	3.2	SH	8.4	768	6605	0.03	0.9	0.0300	0.9	10.1	-9.18	-9.18	11.0	Non-Acid Forming (Barren)
AMDD017	9.0	10.0	CH	8.6	638	5487	0.04	1.2	0.0400	1.2	22.5	-21.28	-21.28	18.4	Non-Acid Forming (Barren)
AMDD018	0.6	2.0	SH	8.1	3310	28466	0.44	13.5	0.0060	0.2	52.3	-38.84	-52.12	285.0	Non-Acid Forming
AMDD018	2.0	3.7	SH	7.6	1680	14448	0.14	4.3	0.0090	0.3	3.4	0.88	-3.12	12.4	Non-Acid Forming (Barren)
AMDD018	6.3	8.5	FP	8.1	1170	10062	0.11	3.4	0.0090	0.3	11.8	-8.44	-11.52	42.9	Non-Acid Forming (Barren)
AMDD021	1.7	2.0	SH	8.3	2540	21844	0.08	2.4	0.0100	0.3	34.1	-31.65	-33.79	111.5	Non-Acid Forming
AMDD021	2.0	4.3	SH	8.0	4130	35518	0.3	9.2	0.0070	0.2	19.3	-10.12	-19.09	90.1	Non-Acid Forming
AMDD021	4.3	5.9	SH	8.1	1960	16856	0.12	3.7	0.0060	0.2	3.7	-0.03	-3.52	20.2	Non-Acid Forming (Barren)
AMDD021	5.9	7.2	SH	7.3	1540	13244	0.14	4.3	0.0025	0.1	0.3	4.03	-0.17	3.3	Non-Acid Forming (Barren)
AMDD021	10.7	12.8	ST	7.5	387	3328	0.1	3.1	0.0060	0.2	3.1	-0.04	-2.92	16.9	Non-Acid Forming (Barren)
AMDD023	1.0	1.9	CL	7.7	4710	40506	0.84	25.7	0.0060	0.2	26.5	-0.80	-26.32	144.4	Non-Acid Forming
AMDD023	2.0	4.2	SH	6.3	2450	21070	0.09	2.8	0.0025	0.1	5.1	-2.35	-5.02	66.7	Non-Acid Forming (Barren)
AMDD023	4.2	5.2	ST	8.6	1790	15394	0.09	2.8	0.0060	0.2	113.0	-110.25	-112.82	615.7	Acid Consuming
AMDD024	0.9	3.0	SH	6.5	5540	47644	1.13	34.6	0.0070	0.2	5.4	29.17	-5.19	25.2	Non-Acid Forming
AMDD024	3.0	5.1	EV	7.6	4520	38872	3.08	94.2	0.0070	0.2	7.6	86.62	-7.39	35.5	Non-Acid Forming
AMDD024	7.9	10.9	SH	7.5	2060	17716	0.2	6.1	0.0050	0.2	2.6	3.52	-2.45	17.0	Non-Acid Forming (Barren)
AMDD024	14.0	14.9	CH	7.5	415	3569	0.24	7.3	0.0025	0.1	2.8	4.54	-2.72	36.6	Non-Acid Forming
AMDD024	17.4	18.4	ST	7.4	359	3087	0.11	3.4	0.0100	0.3	25.0	-21.64	-24.69	81.7	Non-Acid Forming (Barren)
AMDD026	1.8	4.1	SH	8.4	4610	39646	0.53	16.2	0.0070	0.2	173.0	-156.79	-172.79	807.9	Acid Consuming
AMDD026	4.2	5.9	SH	8.8	2100	18060	0.15	4.6	0.0025	0.1	106.0	-101.41	-105.92	1386.1	Acid Consuming
AMDD026	6.5	7.7	SH	8.5	3380	29068	0.22	6.7	0.0025	0.1	132.0	-125.27	-131.92	1726.1	Acid Consuming
AMDD026	12.5	14.9	CH	8.8	542	4661	0.14	4.3	0.0100	0.3	77.4	-73.12	-77.09	253.0	Non-Acid Forming
AMRC718	51.0	52.0	ST	5.0	1770	15222	2.22	67.9	1.3000	39.8	15.3	52.61	24.47	0.4	**Potentially Acid Forming**
AMRC728	51.0	52.0	ST	5.0	1930	16598	3.15	96.4	1.7200	52.6	19.9	76.46	32.71	0.4	**Potentially Acid Forming**
AMRC808	21.0	22.0	SH	3.7	1640	14104	1.1	33.6	0.7560	23.1	0.3	33.40	22.88	0.0	**Acid Forming**
AMRC815	47.0	48.0	ST	6.2	1050	9030	1.61	49.2	0.9270	28.4	46.4	2.85	-18.04	1.6	**Potentially Acid Forming**

Red values — Concentration is below detection limit
Blue values — TS value used in place of measured CRS value

Table 5-7: Geochemical abundance index of total metals and metalloids in the drill hole samples

Sample ID	S032	S033	S034	S035	S036	S001	S002	S003	S004	S005	S006	S007	S041	S037	S038	S039	S040
Drill Hole ID	AMDD021	AMDD021	AMDD021	AMDD021	AMDD021	AMDD023	AMDD023	AMDD023	AMDD024	AMDD024	AMDD024	AMDD024	AMDD024	AMRC718	AMRC728	AMRC808	AMRC815
From	1.7	2	4.3	5.9	10.7	1	2	4.15	0.9	3	7.9	14	17.35	51	51	21	47
To	2	4.3	5.9	7.2	11	1.9	2.6	4.7	1.1	3.1	10.85	14.35	18.35	52	52	22	48
Element																	
Al	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	0	0	2	0	1	0	0	0	2	1	0	1	0	1	2	1	2
Ba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Be	1	0	0	0	3	2	2	3	1	0	2	4	3	3	3	1	6
Bi	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Ca	0	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0	4
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Ce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Co	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Fe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0	0	0	0	1	0	0	0	0	0	0	0	2	1	1	1	1
In	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
La	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Li	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0	0	4	2	2	0	0	0	4	3	3	2	1	3	2	3	2
Nb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	0	0	0	0	2	0	0	4	1	1	2	3	4	3	4	0	5
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	0	1	0	0	0	3	0	0	3	4	1	1	0	4	5	3	4
Sb	0	0	3	3	0	0	0	0	1	1	1	1	0	0	0	1	0
Sc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Se	0	0	2	0	0	0	0	0	2	1	0	1	1	2	3	2	2
Sn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sr	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Ta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Te	2	2	3	3	3	2	3	3	2	2	3	2	2	2	2	3	2
Th	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tl	0	0	0	0	2	0	0	0	0	0	0	2	0	1	1	2	3
U	0	0	2	1	3	0	0	2	1	1	2	3	3	3	3	2	5
V	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y	0	0	0	0	0	0	0	2	0	0	0	1	1	0	1	0	3
Zn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Values of 3 not highlighted are due to rounding

6 Conclusion and recommendations

Ore and tailings streams

Results suggest that the provided ore and tailings samples are NAF and geochemically benign, with a relatively low risk of generating acidic or saline drainage. It is noted that during production on site the ore may be processed with saline groundwater. Under this approach the tailings may have a higher salt load. The presence of elevated calcium and phosphorous in the samples suggests that management of these elements will be a concern in any ore or tailings streams.

Overburden

The overburden samples (n=36) utilised in the is study were fresh samples (< 12 months old). All overburden samples had circum-neutral to mildly alkaline pH verifying the samples had not oxidise and produced acid between the time they were drilled and assayed. The sulfide sulfur analyses using CRS are therefore considered to reflect actual in-situ sulfide content.

The geochemical analyses of the overburden using measured sulfide sulfur to calculate the maximum potential acidity and resultant net acid producing potential verify that the samples are NAF-Barren, NAF or AC.

Of concern from an environmental perspective are the elevated electrical conductivity (EC) measurements in some samples that could also manifest as elevated salinity. The source of the elevated EC has not been determined but could be associated with NaCl or sulfate minerals and/or phosphate.

Footwall units

The footwall units evaluated have determined this material has a high potential to oxidise rapidly and produce acid, saline and metalliferous drainage. Management of footwall materials is likely to be required to minimise the potential for AMD during mining and post closure in the northern are, but in the southern area the overburden, ore and footwall sequence is completely oxidised and the likelihood of PAF material in this area is lower (negligible).

Associated geological units

Limestone and dolomite are present in the project area. The mining and use of these materials will enable adequate management of acid drainage issues either by crushing and adding fine ground limestone to PAF mine waste or using it to treat and manage acid water.

Forward works

Static testing

Static testing including radioactive testing is recommended on ore and tailings materials during project development to ensure that the geochemical characteristics of site produced material is quantified and tracked to measure any changes in these materials over time. The geochemical analysis should include measurement of pH, EC, TS, CRS and ANC. Selected samples should be analysed for soluble, exchangeable and total elemental concentrations.

Supplementary static testing should be undertaken on freshly drilled samples during resource drilling or the collection of representative samples from the proposed test to verify the outcomes of this study. The geochemical analysis should include measurement of pH, EC, TS, CRS and ANC. Selected samples should be analysed for soluble, exchangeable and total elemental concentrations.

Kinetic leach cell testing

Kinetic leach cells testing is required to be undertaken on mined materials that have the potential to produce acid, saline or metalliferous drainage.

RGS recommend that KLC testing should be done all major mine waste types and or beneficiation (ore and tailings) products and should be done for a minimum of 12 months using monthly leach cycles. This

test work should be commenced during subsequent stages of the project to verify the long-term performance of the materials that are removed during mining or that are produced on site from processing streams.

Management plans

A suitable management plan (e.g. AMD Management, Mine Waste Management or Progressive Rehabilitation and Closure Plan) should be developed for the project and include a sampling and analytical program to address the static and kinetic testing programs.

These data would be utilised in site water quality modelling that is utilised to evaluate the ability to meet water quality objectives for the project during operations and then into the closure phase.

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Appendix

Ore and tailings samples

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1807385**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 16-Mar-2018 09:40
Order number	:	Date Analysis Commenced	: 22-Mar-2018
C-O-C number	: ----	Issue Date	: 06-Apr-2018 18:32
Sampler	: SITE		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

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

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

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

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	EB1807385-002	--------	--------	--------
					Result	Result	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.70**	**7.46**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**263**	**1650**	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**36**	**29**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**36**	**29**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**38**	**167**	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**25**	**417**	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**14**	**71**	----	----	----
Magnesium	7439-95-4	1	mg/L		**6**	**24**	----	----	----
Sodium	7440-23-5	1	mg/L		**23**	**228**	----	----	----
Potassium	7440-09-7	1	mg/L		**2**	**3**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.01**	----	----	----
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	----	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	----	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.14**	**0.24**	----	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.078**	**0.322**	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.764**	**0.887**	----	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	EB1807385-002	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0004**	----	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	----	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	----	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.001**	**0.001**	----	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	----	----	----
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.001**	**0.003**	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.001**	**0.004**	----	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	----	----	----
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.004**	**0.005**	----	----	----
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.005**	**0.011**	----	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	----	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	----	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	----	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	----	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.01**	**0.01**	----	----	----

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	**EB1807385-002**	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		**0.040**	**0.141**	**----**	**----**	**----**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**----**	**----**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
					EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**8.1**	**7.9**	**8.5**	**----**	**----**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-58.0**	**-21.5**	**----**	**----**	**----**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**167**	**1030**	<1	**----**	**----**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**66.9**	**36.8**	**----**	**----**	**----**
ANC as CaCO3	----	0.1	% CaCO3		**6.8**	**3.8**	**----**	**----**	**----**
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**----**	**----**	**----**
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.015**	**0.019**	**----**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**60.4**	**1.1**	**----**	**----**	**----**
ED006: Exchangeable Cations on Alkaline Soils									
Exchangeable Calcium	----	0.2	meq/100g		**6.4**	**2.3**	**----**	**----**	**----**
Exchangeable Magnesium	----	0.2	meq/100g		**2.9**	**0.8**	**----**	**----**	**----**
Exchangeable Potassium	----	0.2	meq/100g		**0.2**	<0.2	**----**	**----**	**----**
Exchangeable Sodium	----	0.2	meq/100g		**0.4**	**0.8**	**----**	**----**	**----**
Cation Exchange Capacity	----	0.2	meq/100g		**10.0**	**3.8**	**----**	**----**	**----**
Exchangeable Sodium Percent	----	0.2	%		**4.5**	**20.5**	**----**	**----**	**----**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.29**	**0.50**	**----**	**----**	**----**
ED093T: Total Major Cations									
Sodium	7440-23-5	50	mg/kg		**1960**	**3210**	**----**	**----**	**----**
Potassium	7440-09-7	50	mg/kg		**3540**	**1820**	**----**	**----**	**----**
Calcium	7440-70-2	50	mg/kg		**198000**	**374000**	**----**	**----**	**----**
Magnesium	7439-95-4	50	mg/kg		**3610**	**1630**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**97100**	**111000**	**----**	**----**	**----**
EK074: Fluoride Extractable Phosphorus (Bray)									

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
					EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EK074: Fluoride Extractable Phosphorus (Bray) - Continued									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		**152**	**388**	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.10**	**0.07**	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	----	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	----	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	----	----	----
C29 - C36 Fraction	----	100	mg/kg		<100	<100	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg		<10	<10	----	----	----
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	----	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	----	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	----	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	----	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	----	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	----	----	----
Naphthalene	91-20-3	1	mg/kg		<1	<1	----	----	----
Sample Preparation Method									
Amount	----	0.1	g		**1.0**	**1.0**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**58.1**	**89.3**	----	----	----

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

				Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
Compound	CAS Number	LOR	Unit		EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	0.2	%		**60.3**	**87.2**	**----**	**----**	**----**
4-Bromofluorobenzene	460-00-4	0.2	%		**60.6**	**87.4**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

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CERTIFICATE BR18063906

Project: EB1807385

P.O. No.: ME- MS41

This report is for 2 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 23- MAR- 2018.

The following have access to data associated with this certificate:

SUB RESULTS - BRIS

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG- 22	Sample login - Rcd w/o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME- MS41	Ultra Trace Aqua Regia ICP- MS

To: ALS ENVIRONMENTAL
ATTN: SUB RESULTS - BRIS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
EB1807385-001		0.70	4.10	44.5	<0.02	40	800	13.40	0.59	19.90	1.83	371	20.9	113	2.89	140.5
EB1807385-002		0.57	2.01	36.2	<0.02	30	700	13.05	0.43	>25.0	2.26	417	17.2	62	1.16	91.8

***** See Appendix Page for comments regarding this certificate *****

RGS LEADERS IN MINING GEOCHEMISTRY

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method Analyte Units LOR	ME-MS41 Fe % 0.01	ME-MS41 Ca ppm 0.05	ME-MS41 Ce ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
EB1807385-001		2.69	9.25	0.84	0.29	0.04	0.090	0.51	207	19.2	0.36	333	12.25	0.19	0.60	72.6
EB1807385-002		1.92	5.56	0.68	0.72	0.04	0.047	0.23	250	8.2	0.16	315	10.05	0.34	0.33	41.6

***** See Appendix Page for comments regarding this certificate *****

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method Analyte Units LOR	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Tl % 0.005	ME-MS41 Tl ppm 0.02
EB1807385-001		>25000	49.6	27.8	<0.001	0.23	5.44	29.8	0.5	1.4	1175	0.01	0.26	18.2	0.018	0.95
EB1807385-002		>25000	34.5	12.9	0.001	0.39	3.75	27.4	0.2	0.6	1090	0.01	0.10	14.7	0.009	0.94

***** See Appendix Page for comments regarding this certificate *****

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	U	V	W	Y	Zn	Zr
	Units	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.05	1	0.05	0.05	2	0.5
EB1807385-001		99.3	508	1.02	600	336	5.2
EB1807385-002		93.4	346	0.58	670	246	24.2

***** See Appendix Page for comments regarding this certificate *****

RGS LEADERS IN MINING GEOCHEMISTRY

Australian Laboratory Services Pty. Ltd.
32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
www.alsglobal.com/geochemistry

ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: ME- MS41

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).

ACCREDITATION COMMENTS

Applies to Method: ME- MS41

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

LABORATORY ADDRESSES

Applies to Method: LOG- 22 ME- MS41

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 116 Delta Street, Geebung, QLD 4034, Australia

Overburden and footwall samples

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1808528**	Page	: 1 of 11
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 14-Mar-2018 09:30
Order number	:	Date Analysis Commenced	: 17-Apr-2018
C-O-C number	: ----	Issue Date	: 19-Apr-2018 15:31
Sampler	: SITE		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 42		
No. of samples analysed	: 42		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

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

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

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

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S001	S002	S003	S004	S005
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-001	EB1808528-002	EB1808528-003	EB1808528-004	EB1808528-005
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.7	6.3	8.6	6.5	7.6
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	-2.3	-110	29.2	86.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	4710	2450	1790	5540	4520
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	26.5	5.1	113	5.4	7.6
ANC as CaCO3	----	0.1	% CaCO3	2.7	0.5	11.6	0.6	0.8
Fizz Rating	----	0	Fizz Unit	1	0	2	0	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.84	0.09	0.09	1.13	3.08

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S006	S007	S008	S009	S010
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-006	EB1808528-007	EB1808528-008	EB1808528-009	EB1808528-010
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.5	7.5	8.4	8.8	8.5
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	3.5	4.5	-157	-101	-125
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	2060	415	4610	2100	3380
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.6	2.8	173	106	132
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.3	17.6	10.8	13.4
Fizz Rating	----	0	Fizz Unit	0	0	3	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.20	0.24	0.53	0.15	0.22

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S011	S012	S013	S014	S015
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-011	EB1808528-012	EB1808528-013	EB1808528-014	EB1808528-015
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.8	8.4	7.8	7.2	6.2
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-73.1	-114	-18.8	23.1	-0.8
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		542	1270	492	3950	1670
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		77.4	119	20.0	1.7	1.7
ANC as CaCO3	----	0.1	% CaCO3		7.9	12.1	2.0	0.2	0.2
Fizz Rating	----	0	Fizz Unit		2	2	1	0	0
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.14	0.17	0.04	0.81	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S016	S017	S018	S019	S020
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-016	EB1808528-017	EB1808528-018	EB1808528-019	EB1808528-020
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.3**	**7.7**	**8.5**	**8.1**	**8.6**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-2.0**	**-0.9**	**-27.8**	**-21.1**	**-119**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1420**	**1570**	**513**	**314**	**1000**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**2.6**	**1.5**	**30.2**	**22.6**	**120**
ANC as CaCO3	----	0.1	% CaCO3	**0.3**	**0.2**	**3.1**	**2.3**	**12.2**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**1**	**1**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	**0.08**	**0.05**	**0.02**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S021	S022	S023	S024	S025
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-021	EB1808528-022	EB1808528-023	EB1808528-024	EB1808528-025
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**8.6**	**8.6**	**6.3**	**5.8**	**6.1**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-40.0**	**-17.8**	**23.6**	**-0.4**	**2.2**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1050**	**627**	**3640**	**1880**	**2030**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**41.2**	**19.3**	<0.5	**1.6**	**0.9**
ANC as CaCO3	----	0.1	% CaCO3		**4.2**	**2.0**	<0.1	**0.2**	<0.1
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**0**	**0**	**0**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.04**	**0.05**	**0.77**	**0.04**	**0.10**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S026	S027	S028	S029	S030
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-026	EB1808528-027	EB1808528-028	EB1808528-029	EB1808528-030
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.9**	**8.4**	**8.6**	**8.1**	**7.6**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-22.1**	**-9.2**	**-21.3**	**-38.8**	**0.9**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**379**	**768**	**638**	**3310**	**1680**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**23.6**	**10.1**	**22.5**	**52.3**	**3.4**
ANC as CaCO3	----	0.1	% CaCO3	**2.4**	**1.0**	**2.3**	**5.3**	**0.3**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**2**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.05**	**0.03**	**0.04**	**0.44**	**0.14**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S031	S032	S033	S034	S035
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-031	EB1808528-032	EB1808528-033	EB1808528-034	EB1808528-035
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.1**	**8.3**	**8.0**	**8.1**	**7.3**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-8.4**	**-31.6**	**-10.1**	**-0.03**	**4.3**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1170**	**2540**	**4130**	**1960**	**1540**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**11.8**	**34.1**	**19.3**	**3.7**	<0.5
ANC as CaCO3	----	0.1	% CaCO3	**1.2**	**3.5**	**2.0**	**0.4**	<0.1
Fizz Rating	----	0	Fizz Unit	**1**	**2**	**1**	**0**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.11**	**0.08**	**0.30**	**0.12**	**0.14**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S036	S037	S038	S039	S040
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-036	EB1808528-037	EB1808528-038	EB1808528-039	EB1808528-040
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.5	5.0	5.0	3.7	6.2
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-0.04	52.6	76.5	33.7	2.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		387	1770	1930	1640	1050
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		3.1	15.3	19.9	<0.5	46.4
ANC as CaCO3	----	0.1	% CaCO3		0.3	1.6	2.0	<0.1	4.7
Fizz Rating	----	0	Fizz Unit		0	1	1	0	2
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.10	2.22	3.15	1.10	1.61

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S041	DI water	----	----	----
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1808528-041	EB1808528-042	--------	--------	--------
				Result	Result	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.4**	**5.6**	----	----	----
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-21.6**	----	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**359**	<1	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**25.0**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**2.6**	----	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.11**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1810208**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 23-Apr-2018 10:32
Order number	:	Date Analysis Commenced	: 01-May-2018
C-O-C number	: ----	Issue Date	: 03-May-2018 09:45
Sampler	: , MARY MACELROY		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 29		
No. of samples analysed	: 29		

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

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

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- General Comments
- Analytical Results

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Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Acid Sulphate Soils, Stafford, QLD

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED006 (Exchangeable Cations on Alkaline Soils): Magnesium/Potassium ratio could not be determined as both the Magnesium and Potassium results were less than reportable limits for some samples.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S001 EB1808528_001	S002 EB1808528_002	S003 EB1808528_003	S004 EB1808528_004	S005 EB1808528_005
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-001	EB1810208-002	EB1810208-003	EB1810208-004	EB1810208-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.006**	<0.005	**0.006**	**0.007**	**0.007**
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**14.7**	----	----	----	**4.0**
Exchangeable Magnesium	----	0.2	meq/100g	**6.6**	----	----	----	**2.4**
Exchangeable Potassium	----	0.2	meq/100g	**0.4**	----	----	----	**0.3**
Exchangeable Sodium	----	0.2	meq/100g	**4.0**	----	----	----	**1.4**
Cation Exchange Capacity	----	0.2	meq/100g	**25.8**	----	----	----	**8.1**
Exchangeable Calcium Percent	----	0.2	%	**57.1**	----	----	----	**49.3**
Exchangeable Magnesium Percent	----	0.2	%	**25.8**	----	----	----	**29.2**
Exchangeable Potassium Percent	----	0.2	%	**1.5**	----	----	----	**3.8**
Exchangeable Sodium Percent	----	0.2	%	**15.6**	----	----	----	**17.6**
Calcium/Magnesium Ratio	----	0.2	-	**2.2**	----	----	----	**1.7**
Magnesium/Potassium Ratio	----	0.2	-	**17.4**	----	----	----	**7.6**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	**9.7**	----	**31.2**	----
Exchangeable Magnesium	----	0.1	meq/100g	----	**4.3**	----	**1.7**	----
Exchangeable Potassium	----	0.1	meq/100g	----	**0.4**	----	**0.3**	----
Exchangeable Sodium	----	0.1	meq/100g	----	**0.8**	----	**0.5**	----
Exchangeable Aluminium	----	0.1	meq/100g	----	**0.1**	----	**0.1**	----
Cation Exchange Capacity	----	0.1	meq/100g	----	**15.2**	----	**33.8**	----
Exchangeable Calcium Percent	----	0.1	%	----	**63.6**	----	**92.3**	----
Exchangeable Magnesium Percent	----	0.1	%	----	**28.0**	----	**5.0**	----
Exchangeable Potassium Percent	----	0.1	%	----	**2.6**	----	**1.0**	----
Exchangeable Sodium Percent	----	0.1	%	----	**5.1**	----	**1.4**	----
Exchangeable Aluminium Percent	----	0.1	%	----	**0.7**	----	**0.3**	----
Calcium/Magnesium Ratio	----	0.1	-	----	**2.2**	----	**18.4**	----
Magnesium/Potassium Ratio	----	0.1	-	----	**10.8**	----	**5.2**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S006 EB1808528_006	S007 EB1808528_007	S008 EB1808528_008	S009 EB1808528_009	S010 EB1808528_010
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-006	EB1810208-007	EB1810208-008	EB1810208-009	EB1810208-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.005**	<0.005	**0.007**	<0.005	<0.005
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**1.7**	**----**	**4.8**	**1.9**	**4.4**
Exchangeable Magnesium	----	0.2	meq/100g	**1.7**	**----**	**4.9**	**3.6**	**4.3**
Exchangeable Potassium	----	0.2	meq/100g	**0.4**	**----**	<0.2	**0.2**	<0.2
Exchangeable Sodium	----	0.2	meq/100g	**1.5**	**----**	**2.9**	**2.9**	**3.0**
Cation Exchange Capacity	----	0.2	meq/100g	**5.3**	**----**	**12.9**	**8.5**	**11.9**
Exchangeable Calcium Percent	----	0.2	%	**32.6**	**----**	**37.4**	**21.8**	**36.8**
Exchangeable Magnesium Percent	----	0.2	%	**31.7**	**----**	**38.4**	**41.9**	**36.0**
Exchangeable Potassium Percent	----	0.2	%	**7.0**	**----**	**1.4**	**2.5**	**1.5**
Exchangeable Sodium Percent	----	0.2	%	**28.6**	**----**	**22.8**	**33.7**	**25.6**
Calcium/Magnesium Ratio	----	0.2	-	**1.0**	**----**	**1.0**	**0.5**	**1.0**
Magnesium/Potassium Ratio	----	0.2	-	**4.5**	**----**	**----**	**16.6**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S011 EB1808528_011	S012 EB1808528_012	S014 EB1808528_014	S018 EB1808528_018	S023 EB1808528_023
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-011	EB1810208-012	EB1810208-013	EB1810208-014	EB1810208-015
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.010**	**0.007**	<0.005	**0.006**	**0.008**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**----**	**----**	**44.0**	**----**	**43.3**
Exchangeable Magnesium	----	0.1	meq/100g	**----**	**----**	**1.4**	**----**	**1.1**
Exchangeable Potassium	----	0.1	meq/100g	**----**	**----**	**0.2**	**----**	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	**----**	**----**	**0.4**	**----**	**0.3**
Exchangeable Aluminium	----	0.1	meq/100g	**----**	**----**	<0.1	**----**	**0.1**
Cation Exchange Capacity	----	0.1	meq/100g	**----**	**----**	**46.1**	**----**	**45.0**
Exchangeable Calcium Percent	----	0.1	%	**----**	**----**	**95.5**	**----**	**96.2**
Exchangeable Magnesium Percent	----	0.1	%	**----**	**----**	**3.1**	**----**	**2.5**
Exchangeable Potassium Percent	----	0.1	%	**----**	**----**	**0.5**	**----**	**0.4**
Exchangeable Sodium Percent	----	0.1	%	**----**	**----**	**0.8**	**----**	**0.6**
Exchangeable Aluminium Percent	----	0.1	%	**----**	**----**	**0.2**	**----**	**0.3**
Calcium/Magnesium Ratio	----	0.1	-	**----**	**----**	**31.4**	**----**	**39.4**
Magnesium/Potassium Ratio	----	0.1	-	**----**	**----**	**6.7**	**----**	**5.9**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S025 EB1808528_025	S029 EB1808528_029	S030 EB1808528_030	S031 EB1808528_031	S032 EB1808528_032
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-016	EB1810208-017	EB1810208-018	EB1810208-019	EB1810208-020
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.007	0.006	0.009	0.009	0.010
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	6.6	----	----	3.9
Exchangeable Magnesium	----	0.2	meq/100g	----	2.7	----	----	3.2
Exchangeable Potassium	----	0.2	meq/100g	----	0.2	----	----	0.2
Exchangeable Sodium	----	0.2	meq/100g	----	0.9	----	----	1.3
Cation Exchange Capacity	----	0.2	meq/100g	----	10.5	----	----	8.6
Exchangeable Calcium Percent	----	0.2	%	----	63.2	----	----	45.4
Exchangeable Magnesium Percent	----	0.2	%	----	25.5	----	----	36.7
Exchangeable Potassium Percent	----	0.2	%	----	2.3	----	----	2.5
Exchangeable Sodium Percent	----	0.2	%	----	8.9	----	----	15.4
Calcium/Magnesium Ratio	----	0.2	-	----	2.5	----	----	1.2
Magnesium/Potassium Ratio	----	0.2	-	----	10.9	----	----	14.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.2	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	1.2	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Aluminium	----	0.1	meq/100g	0.2	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	8.3	----	----	----	----
Exchangeable Calcium Percent	----	0.1	%	74.8	----	----	----	----
Exchangeable Magnesium Percent	----	0.1	%	13.9	----	----	----	----
Exchangeable Potassium Percent	----	0.1	%	4.9	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	4.3	----	----	----	----
Exchangeable Aluminium Percent	----	0.1	%	2.0	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	5.2	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	2.8	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S033 EB1808528_033	S034 EB1808528_034	S035 EB1808528_035	S036 EB1808528_036	S037 EB1808528_037
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-021	EB1810208-022	EB1810208-023	EB1810208-024	EB1810208-025
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.007**	**0.006**	<0.005	**0.006**	**1.30**
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**4.9**	----	----	----	----
Exchangeable Magnesium	----	0.2	meq/100g	**1.6**	----	----	----	----
Exchangeable Potassium	----	0.2	meq/100g	<0.2	----	----	----	----
Exchangeable Sodium	----	0.2	meq/100g	**1.0**	----	----	----	----
Cation Exchange Capacity	----	0.2	meq/100g	**7.7**	----	----	----	----
Exchangeable Calcium Percent	----	0.2	%	**63.9**	----	----	----	----
Exchangeable Magnesium Percent	----	0.2	%	**21.1**	----	----	----	----
Exchangeable Potassium Percent	----	0.2	%	**2.3**	----	----	----	----
Exchangeable Sodium Percent	----	0.2	%	**12.7**	----	----	----	----
Calcium/Magnesium Ratio	----	0.2	-	**3.0**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S038 EB1808528_038	S039 EB1808528_039	S040 EB1808528_040	S041 EB1808528_041	----
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit	EB1810208-026	EB1810208-027	EB1810208-028	EB1810208-029	--------
				Result	Result	Result	Result	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**1.72**	**0.756**	**0.927**	**0.010**	**----**

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CERTIFICATE BR18094590

Project: EB1810208

P.O. No.: MS41

This report is for 17 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 26-APR-2018.

The following have access to data associated with this certificate:

SUB RESULTS - BRIS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG-22	Sample login - Rcd w/o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME-MS41	Ultra Trace Aqua Regia ICP-MS

To: ALS ENVIRONMENTAL
ATTN: SUB RESULTS - BRIS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.01	0.01	0.1	0.02	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
S001		0.10	2.32	3.3	<0.02	250	1.31	0.15	1.99	0.03	43.2	8.3	31	1.71	15.4	2.25
S002		0.02	1.02	2.7	<0.02	380	1.30	0.37	0.25	0.09	61.4	4.6	21	1.18	39.9	2.51
S003		0.15	1.35	1.7	<0.02	120	4.17	0.41	6.98	0.67	94.2	11.4	43	3.02	35.0	0.56
S004		0.09	1.50	25.1	<0.02	110	0.71	0.37	1.25	0.04	45.1	1.1	37	0.71	13.4	2.17
S005		0.17	1.01	17.0	<0.02	30	0.63	0.25	2.73	0.03	31.4	0.6	22	0.70	20.7	1.83
S006		0.11	1.05	8.9	<0.02	70	2.52	0.57	0.32	0.14	57.7	2.0	31	1.32	28.7	1.56
S007		0.07	1.87	11.9	<0.02	200	7.22	0.36	0.76	0.19	48.7	5.0	50	1.10	27.4	1.27
S032		0.33	1.25	3.8	<0.02	380	0.89	0.32	1.46	0.06	43.2	5.0	23	0.60	15.1	0.76
S033		0.17	0.64	2.2	<0.02	180	0.47	0.24	1.10	0.03	26.0	0.9	19	0.31	9.0	0.16
S034		0.15	0.47	27.3	<0.02	80	0.46	0.28	0.17	0.17	32.7	3.0	27	0.27	86.1	2.02
S035		0.13	0.52	4.6	<0.02	230	0.62	0.58	0.07	0.07	87.9	2.3	25	0.33	58.9	0.53
S036		0.21	1.14	10.8	0.04	710	4.35	0.37	0.47	0.46	58.4	21.7	94	0.62	49.1	1.48
S037		0.30	0.50	18.2	<0.02	60	3.10	0.37	2.20	1.34	33.5	12.6	59	1.74	36.3	1.60
S038		0.28	0.78	22.2	<0.02	50	3.96	0.30	5.23	1.02	53.2	10.3	78	2.51	53.3	2.14
S039		0.64	0.42	15.5	<0.02	240	1.19	0.52	0.09	0.09	103.5	10.7	23	0.65	69.2	1.45
S040		0.25	0.45	24.6	<0.02	220	27.5	0.10	>25.0	0.18	140.0	2.7	39	1.39	21.4	1.17
S041		0.55	0.58	6.8	<0.02	390	4.64	0.15	4.58	0.73	39.5	2.5	72	1.01	48.7	0.73

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method / Analyte / Units / LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
S001		6.85	0.06	0.39	0.01	0.029	22.5	10.1	0.56	230	0.70	0.12	17.3	550	9.0	15.8
S002		3.67	0.06	0.41	0.01	0.022	31.2	9.3	0.29	57	0.75	0.11	25.5	320	15.0	7.6
S003		4.60	0.16	0.11	0.02	0.034	75.4	25.1	0.52	204	0.43	0.18	57.7	19900	14.3	15.2
S004		5.26	0.09	0.16	0.01	0.027	24.1	6.8	0.25	24	21.0	0.11	4.2	3030	14.9	7.8
S005		3.83	0.05	0.28	0.04	0.029	16.5	5.6	0.13	12	14.55	0.15	2.7	1880	10.7	4.8
S006		5.22	0.08	0.10	0.05	0.021	28.9	2.8	0.08	22	10.40	0.13	11.6	3780	26.9	6.4
S007		2.78	0.08	0.04	0.07	0.017	31.8	4.2	0.06	82	8.07	0.10	6.3	10600	12.5	6.9
S032		4.36	0.06	0.27	0.01	0.029	23.5	5.5	0.42	130	1.88	0.09	8.2	1640	24.9	7.9
S033		2.69	<0.05	0.32	0.01	0.034	13.2	3.1	0.20	19	1.20	0.05	3.1	720	13.6	4.2
S034		4.76	0.05	0.40	0.03	0.085	17.1	1.5	0.07	20	21.7	0.11	14.3	390	10.4	3.7
S035		3.15	0.08	0.30	0.04	0.041	51.5	1.8	0.08	19	7.79	0.08	11.6	820	27.4	4.0
S036		3.08	0.07	0.03	0.25	0.032	38.4	5.1	0.04	290	5.49	0.13	53.9	5620	20.6	4.2
S037		2.02	0.10	0.21	0.21	0.014	22.0	4.7	0.06	40	14.70	0.12	53.4	10600	20.0	6.4
S038		2.40	0.21	0.22	0.23	0.019	40.4	8.8	0.09	39	8.83	0.15	50.5	24600	13.7	10.3
S039		3.66	0.12	0.48	0.24	0.020	45.4	2.0	0.05	29	19.55	0.12	31.8	990	24.2	5.2
S040		2.77	0.39	0.30	0.15	0.010	138.0	7.6	0.10	152	7.40	0.13	25.6	>25000	37.0	10.4
S041		1.92	0.11	0.21	0.33	0.014	31.9	2.7	0.05	43	3.19	0.10	16.0	22500	6.5	6.3

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Tl	Tl	U	V	W	Y
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
S001		0.98	0.24	5.0	0.4	1.1	80.0	<0.01	0.04	6.6	0.013	0.24	2.36	70	0.23	23.5
S002		0.08	1.15	3.6	0.7	0.8	38.8	<0.01	0.07	11.1	0.005	0.17	3.63	63	0.18	18.40
S003		0.08	1.10	6.2	0.5	1.0	185.0	0.01	0.10	9.8	0.008	0.31	12.95	224	0.48	184.0
S004		1.03	3.31	5.7	1.7	0.8	368	<0.01	0.04	8.6	0.006	0.24	8.39	212	0.33	15.45
S005		2.23	3.64	4.9	1.4	0.7	152.5	<0.01	0.03	6.8	0.005	0.34	8.21	216	0.26	8.93
S006		0.19	2.62	4.6	0.4	0.9	158.0	<0.01	0.09	10.1	0.005	0.35	11.65	152	0.25	21.6
S007		0.21	3.56	5.1	1.2	0.5	606	<0.01	0.05	6.1	<0.005	1.59	21.9	257	0.19	108.0
S032		0.05	0.68	3.2	0.8	1.0	131.5	<0.01	0.03	7.2	0.007	0.11	4.15	51	0.63	22.9
S033		0.27	0.74	1.8	0.2	0.6	74.1	<0.01	0.04	6.0	<0.005	0.07	2.70	34	0.32	8.88
S034		0.03	10.70	5.9	1.7	0.8	90.9	<0.01	0.06	15.0	0.008	0.10	10.10	230	0.20	50.2
S035		0.04	9.03	7.4	<0.2	0.9	255	<0.01	0.09	21.7	<0.005	0.13	8.42	169	0.23	46.5
S036		0.08	1.21	5.9	0.3	0.5	454	<0.01	0.08	11.9	<0.005	0.99	20.2	161	1.10	31.4
S037		1.92	1.81	2.9	2.7	0.4	130.0	<0.01	0.05	3.9	<0.005	0.76	22.0	102	0.89	46.5
S038		2.71	1.48	3.9	3.5	0.5	188.5	<0.01	0.04	5.2	0.005	0.84	30.5	134	0.77	105.5
S039		1.08	3.07	6.9	2.5	0.7	225	<0.01	0.08	10.6	<0.005	1.22	11.25	138	0.18	49.2
S040		1.55	1.77	5.0	2.3	0.3	686	0.02	0.04	5.2	<0.005	2.09	98.1	85	0.32	375
S041		0.10	0.98	5.3	1.3	0.4	344	0.01	0.03	4.0	<0.005	0.26	26.9	151	2.61	101.5

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	ME-MS41 B ppm 10
S001		30	13.1	10
S002		77	12.2	10
S003		122	4.9	20
S004		11	4.9	10
S005		7	7.9	10
S006		40	3.8	10
S007		88	1.0	20
S032		17	8.5	10
S033		6	8.7	10
S034		32	15.9	<10
S035		30	9.9	<10
S036		176	1.1	10
S037		152	7.7	10
S038		161	8.4	10
S039		26	14.3	<10
S040		21	11.9	20
S041		100	8.3	10

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: ME- MS41

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).

ACCREDITATION COMMENTS

Applies to Method: ME- MS41

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

LABORATORY ADDRESSES

Applies to Method: LOG- 22 ME- MS41

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 116 Delta Street, Geebung, QLD 4034, Australia



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APPENDIX C

Air and Noise Technical Report

APPENDIX D

Ecology Technical Reports

APPENDIX E

Surface Water Technical Report

APPENDIX F

Groundwater Technical Report

APPENDIX G

Traffic Technical Report

APPENDIX H

Socio-Economic Baseline Report

APPENDIX I

Environmental Management Plan - Start-up Operation

APPENDIX J

Important Information Relating to this Report

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APPENDIX C

Tailings Storage Facility – Preliminary conceptual design (Start-up Operation)

Land & Marine Geological Services Pty Ltd (L&MGSPL)

ABN 15 009 320 870

CENTREX PHOSPHATE LIMITED

Ardmore Phosphate Project

Tailings Storage Facility – Start-up Operation

Ref: **Ardmore Phosphate Start-up Operation TSF Rev 1 20181119.docx**

Date: **19 November, 2018**

Prepared by: **L&MGS P/L**
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Prepared for: **Centrex Phosphate Pty Ltd**
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19 November, 2018

Centrex Phosphate Pty Ltd
Level 6, 44 Waymouth Street
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Attention: Steve Klose

Dear Steve

RE: ARDMORE PHOSPHATE PROJECT – TAILINGS STORAGE FACILITY START-UP OPERATION

Land & Marine Geological Services Pty Ltd (L&MGSPL) is pleased to provide the report for the Tailings Storage Facility for Ardmore Phosphate Start-up Operation, Dajarra, Central Western Queensland.

Should you require further information or clarification of any details, please do not hesitate to contact this office.

Yours faithfully
pp L&MGSPL

Christopher Lane
PRINCIPAL

Our Ref: Ardmore Phosphate Start-up Operation TSF Rev 1 20181119.docx

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Document Control

Date	Revision	Purpose	Author
06 November 2018	A	Internal Review	C Lane
08 November 2018	B	Issued for Client Review	C Lane
10 November 2018	0	Issued for use	C Lane
19 November 2018	1	Renamed for consistency with other project documents	C Lane

TERMINOLOGY AND ABBREVIATIONS

The following terminology and abbreviations have been used in this document:

AEP	Annual Exceedance Probability
ANCOLD	Australian National Committee on Large Dams
AS	Australian Standard
BOM	Bureau of Meteorology
CPL	Centrex Phosphate Limited
DEHP	Department of Environment and Heritage Protection (Queensland)
DEWS	Department of Energy and Water Supply (Queensland)
DSA	design storage allowance
ESS	extreme storm storage
FS	Feasibility Study
GA	Golder Associates
GRES	G R Engineering Services Ltd
H:V	horizontal to vertical
IFD	Intensity Frequency Duration
JORC	Joint Ore Reserves Committee
ktpa	Kilo tonnes per annum
kms	kilometres
LoM	Life of Mine
Mtpa	Million tonnes per annum
Mt	Million tonnes
NAF	Non-Acid Forming
NATA	National Association of Testing Authorities
OMC	Optimum Moisture Content
PAF	Potentially Acid Forming
PAR	Population at Risk
RL	Reduced Level
SC	Scoping Study
SG	Specific Gravity
t/m^3	Tonnes per cubic metre
SuO	Start-up Operation
TSF	Tailings Storage Facility
USCS	Unified Soil Classification System

TABLE OF CONTENTS

Page no.

TERMINOLOGY AND ABBREVIATIONS ii

1 INTRODUCTION 1

2 GENERAL INFORMATION 2

3 GUIDELINES 2

4 SCOPE 2

5 BACKGROUND INFORMATION 3

5.1 TSF Design Information 3

5.2 TSF Site Selection 3

5.3 Tailings Assessment 3

5.3.1 Geochemical Assessment 3

5.3.2 Geotechnical Tailings Testing 3

5.3.3 Test Results and Implications for Tailings Management 4

5.3.4 Design Insitu Dry Density of the Deposited Tailings 4

5.4 Geotechnical Site Investigation Works 4

6 Hazard Category Assessment and Regulatory Requirements 5

6.1 Assessment Criteria 5

6.2 Potential Failure Mechanisms 8

6.2.1 Failure to contain - seepage 8

6.2.2 Failure to contain - overtopping 8

6.2.3 Dam Break – loss of confinement embankments 9

6.3 Harm to Humans 9

6.4 General Environmental Harm 9

6.5 Economic Loss or Property Damage 9

6.6 Summary of Consequence Categories 17

6.7 Hydraulic Performance Criteria 17

6.8 Extreme Storm Storage and Design Storage Allowances 18

7 TSF DESIGN CONCEPT 20

7.1 General 20

7.1.1 Embankment Geometry 20

7.1.2 Liner 20

7.1.3 Underdrainage System 20

7.1.4 Decant System 20

7.1.5 Tailings Deposition 20

8 SEEPAGE AND STABILITY ANALYSIS 20

9 OPERATION 21

10 MONITORING AND INSTRUMENTATION 21

11 CLOSURE AND REHABILITATION 21

12 REFERENCES 21

List of Tables

Table 5.1 - Design Parameters 3

Table 6.1 - Consequence Category Assessment Criteria extracted from Table 1 in the "Manual for assessing consequence categories and hydraulic performance of structures" 6

Table 6.2 - Hydraulic Performance of Regulated Structures extracted from Table 2 in the "Manual for assessing consequence categories and hydraulic performance of structures" 7

Table 6.3 - Operation and Closure Consequence Category Rating Harm to Humans 10

Table 6.4 - Operation and Closure Consequence Category General Environmental Harm 13

Table 6.5 - Economic Loss or Property Damage 15

Table 6.6 - Consequence Categories 17

Table 6.7 - Hydraulic Performance 17

Table 6.8 – Annual Exceedance Probability (%) 18

List of Figures

Figure 1-1 – Project Location
Figure 6-1 – Rainfall Intensity Frequency Duration

List of Appendices (behind text)

Appendix 1 Drawings

Appendix 2 Statement of Certification

Project: **Ardmore Phosphate**

Subject: **Tailings Storage Facility – Start-up Operation**

1 INTRODUCTION

This report provides the details for the Tailings Storage Facility (TSF) for the Start-up Operation (SUO) for the Ardmore Phosphate Project. Figure 1-1 shows the location of the project.

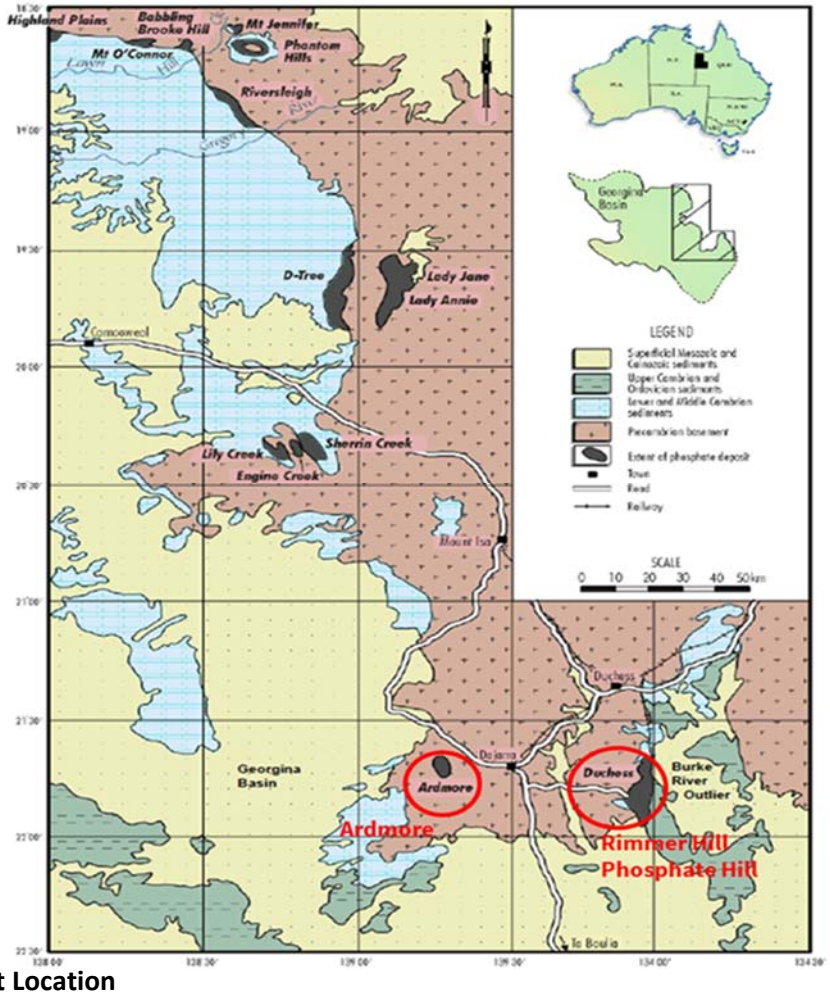


Figure 1-1 – Project Location

The following Appendices complete this report:

- Appendix 1 Drawings
- Appendix 2 Statement of Certification

This report is based on and extends the details presented in the Scoping Study executed in December 2017 and Feasibility Study executed in September 2018.

2 GENERAL INFORMATION

According to the information provided by CPL:

i) The Ardmore sedimentary rock phosphate deposit is located on Mining Lease 5542 approximately 26 kms (by road) west of the town of Dajarra, and 128 km south of Mount Isa within the Georgina Basin in Central Western Queensland. The project currently has a JORC 2012 mineral resource of 14.2 Mt at 29.3% P_2O_5 (19% cut-off) based on historic and current drilling programs.

ii) The Ardmore deposit occurs in the Ardmore Outlier (a part of the Georgina Basin). The deposit occurs just within the range country east of the Barkly Tableland. Relief in the area is low, though it is surrounded by rugged hills up to 50 m above the valley bases. The deposit is split into two lodes, known as the Northern and Southern Zones. Split Creek (a dry creek, 30 m to 40 m wide) splits the two zones and drains westward towards the Georgina River.

iii) The Project is a small-scale pit and demonstration plant to be constructed within the Southern Zone of the ML 5542, held by Centrex. The SUO is a component of a broader project to develop the high-grade phosphate deposit located at Ardmore. This project will target extracting approximately 70,000 t of ore using shallow open-cut strip mining over a 2 to 3 month period. Ore concentrate produced will be approximately 30,000 t. The aim of the operation is to supply phosphate rock concentrate to fertiliser plants in Australia (which are currently reliant on imported phosphate) and export throughout the region. At the completion of the project, the viability and economic merits of the Full-scale Operation will be considered by Centrex to determine whether to expand in the future. The current EA BRMN0037 authorises the mining activities for Start-up Operation only.

iv) The TSF for the SUO comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m. The excavation will be surrounded by a 1.38 m high bund to prevent any runoff entering the TSF.

3 GUIDELINES

The conceptual design for the TSF utilised the guiding principles in the following documents:

- DEHP[1] document titled, *'Guideline, Environmental Protection Act 1994, Structures which are dams or levees constructed as part of environmentally relevant activities'*, dated 5 July 2017.
- DEHP[2] document titled, *'Manual for Assessing consequence categories and hydraulic performance of structures'*, dated March 2016.
- ANCOLD[3] document titled, *'Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure',* as dated May 2012; and

4 SCOPE

CPL has requested the assistance of L&MGSPL to prepare the assessment consequence category for the TSF for the SUO. L&MGSPL executed a site visit to the Ardmore Project in January 2018 and is familiar with the site.

Our advice is based on the information stated, and on the assumptions expressed herein. Should that information or the assumptions be incorrect, then L&MGSPL shall accept no liability in respect of the advice Whether Under Law of Contract, Tort or Otherwise.

5 BACKGROUND INFORMATION

5.1 TSF Design Information

Design data for the proposed TSF for the SUO, provided by CPL, is presented in Table 5.1.

Table 5.1 - Design Parameters

Data	50 ktpa plant
Life of Mine – (months) most likely April to June 2019	2 to 3
Plant Operating Hours (estimated)	800
ROM Feed - tph	70
Concentrate Production - tph	47
Mass recovery to Concentrate - %	67
Tailings - tph	23
Total Tailings Production - t	15,000
Tailings Slurry Density – t/m³ (ex-plant)	1.30
Tailings Density to TSF - % solids w/w	34-37
Tailings Specific Gravity – t/m³	2.95
Tailings density – t/m^3 (min settled in TSF)	0.46
Annual Evaporation - mm	3,185
Annual Rainfall - mm	303

5.2 TSF Site Selection

The location of the TSF for the project is adjacent to the proposed SUO processing facility, refer to the drawings in Appendix 1.

5.3 Tailings Assessment

5.3.1 Geochemical Assessment

Geochemical investigations of overburden, footwall units, ore and tailings were executed by RGS and a copy of the report dated May 2018 is located in Appendix 4 of the Feasibility Study Report. The tailings are classified as NAF and due to the salinity of the ore and processing using a combination of fresh water and saline groundwater, the tailings are expected to have an elevated salinity. An impervious geofabric/polymer liner is to be placed inside the excavation to limit seepage losses.

5.3.2 Geotechnical Tailings Testing

TriLab Pty Ltd, Brisbane, executed geotechnical testing for the Feasibility Study which comprised the following tests:

- Particle Size Distribution (PSD) with hydrometer (AS 1289 3.6.3, 3.5.1 and 2.1.1)
- Atterberg Limits (AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1)
- Emerson Class Number (AS 1289 3.8.1)
- Air Drying Test (non-AS test method)
- Settling Test – Drained (non-AS test method) x 1

- Settling Test – Undrained (non-AS test method) x 1
- Oedometer Test – (AS1289.6.6.1, 3.5.1)

Copies of the test results are presented in Appendix 4 of the Feasibility Study Report and are not included in this document.

5.3.3 Test Results and Implications for Tailings Management

The following commentary is provided for the tailings, based on the soil classification approach detailed in AS1726:2017 Geotechnical site investigations.

The results of the PSD and Atterberg Limits testing indicate that the tailings can be classified as a high plasticity clay, with silt Unified Soil Classification (USC) group symbol CH. The Emerson Class Number Test indicates that the materials are non-dispersive. The air drying and settling tests, drained and undrained, indicate that the tailings will settle out of suspension very slowly. The objective of the drained and undrained settling test is to monitor the tailings settlement and the development of clear supernatant water. By monitoring the height of the solids and the achieved dry density over time, an indication of the speed at which this water is released can be assessed. The points to note from the results of the undrained settling test, undertaken on tailings slurry with a slurry density of 30% solids, are:

i) At discharge, the tailings slurry has an equivalent dry density of nominally 0.375 t/m^3 for both settling tests.

ii) After a period of 7 days, the dry density increases to nominally 0.635 t/m^3 for the undrained test, whereas the drained test reaches a dry density of 0.836 t/m^3 after approximately 14 days. The shape of the curves in both tests suggests some water release can be expected within the first 1.4 days following tailings deposition.

iii) The airdrying test indicates water is available to decant for up to 2 days after deposition.

iv) Under field conditions it is likely that supernatant water recovery would be very low, given the hot dry conditions at the project site.

v) The oedometer testing (consolidation testing) indicates a slow consolidation rate which will result in an increase in dry density. However, the increase in dry density is not going to make a substantial difference to the consolidation and settlement of the tailings, given the relatively low total height of the tailings stack.

5.3.4 Design Insitu Dry Density of the Deposited Tailings

For the purposes of the SUO, a low, conservative settled density, 0.46 t/m^3, has been adopted to reflect the intermittent operation of the SUO. Actual settled density used in the Feasibility Study for planning purposes for the full-scale operation is in the range of 0.75 t/m^3 to 0.85 t/m^3.

5.4 Geotechnical Site Investigation Works

CMW Geosciences were contracted by Centrex to execute the geotechnical investigation works for the Feasibility Study (Ref PER2018-0169AF Rev 0 dated September 2018). It is understood from the CMW geotechnical investigation report that the proposed site for the TSF, which is adjacent to the plant site, comprises colluvium (fine to medium grained, brown sand with medium to coarse grained, sub-angular gravel with low plasticity clay and trace rock fragments) to depths ranging from 0.2 m to 1.8 m overlying medium to very high strength weathered siltstone.

6 HAZARD CATEGORY ASSESSMENT AND REGULATORY REQUIREMENTS

6.1 Assessment Criteria

A hazard category assessment has been undertaken for the proposed SUO TSF using the details provided in the following documents:

- DEHP[1]
- Table 1, DEHP[2]
- Table 1 and Table 2 of ANCOLD[3]

According to the DEHP Manual, all structures that are classified as dams or levees must have their consequence category assessed, based on the potential environmental harm that would result from failure event scenarios. A Hazard Consequence Assessment has been completed as part of this study by a suitably qualified employee of L&MGSPL, James Christopher Lane (RPEQ 13083) who is a Registered Professional Engineer of Queensland in the field of Geotechnical (mining) with more than 35 years of professional experience in the mining industry, specifically devoted to the design and auditing of tailings storage facilities. The Statement of Certification together with a CV of James Christopher Lane and certified copies of the RPEQ documentation are attached in Appendix 2.

The consequence category 'High', 'Significant', or 'Low' will determine whether the structure is a 'regulated structure'. A structure is regulated if it is of 'High' or 'Significant' consequence classification. The consequence category of any structure is the highest consequence category determined under any of the assessment criteria set out in the DEHP 'Manual for assessing consequence categories and hydraulic performance of structures' 2016 (the Manual). The consequence category of a structure must be assessed by a suitably qualified and experienced person and must account for each of the following failure events:

i) 'Failure to contain – seepage' – spills or releases to ground and/or groundwater via seepage from the floor and/or structure sides.

ii) 'Failure to contain – overtopping'– spills or releases from the structure that result from loss of containment due to overtopping.

iii) 'Dam break' – collapse of the structure due to any possible cause.

Table 1 from the Manual has been summarised for reference to the guideline requirements for the Consequence Category Assessment; this is shown below in Table 6.1. The Consequence Category Assessment Criteria has been applied in relation to the design stages of the TSF, including the construction, mining operating conditions, and final closure. In addition, the hydraulic performance must be assessed at each stage; the requirements are given in Table 6.2.

The Consequence Category Assessment is a desktop assessment. Extensive modelling of the seepage and stability of the TSF has not been performed since the facility is formed by an excavation of approximately 40,500 m3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m surrounded by a 1.38 m bund to prevent runoff entering the facility. According to ANCOLD[3] the proposed TSF would have a severity level of minor, with a consequence category of very low.

Table 6.1 - Consequence Category Assessment Criteria extracted from Table 1 in the "Manual for assessing consequence categories and hydraulic performance of structures"

Environmental Harm		Consequence Category		
		High	**Significant**	**Low**
Harm to Humans	Loss of Life	>10 people	1- 10 people	0 people
	Water Contamination	20 or more people affected	10 – 20 people affected	<10 people affected
General Environmental Harm		Location such that: a) Contaminants may be released to areas of MNES, MSES, or HEV waters that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment; and b) Adverse effects of Significant Values are likely; and c) The adverse effects are likely to cause at least one of the following: i) Loss or damage costs greater than $50,000,000; or ii) Remediation of damage is more likely to take 3 years or more; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage is likely to be at least 5 km^2.	Location such that contaminants may be released so that adverse effects (that are not already authorised to be disturbed to at least the same extent under other conditions of the authority subject to any applicable offset commitment) either: a) Would be likely to be caused to Significant Values but those adverse effects would not be likely to meet the threshold for the High consequence category and instead would be likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000 or ii) Remediation of damage is likely to take more than 6 months but less than 3 years; or iii) Significant alteration to existing ecosystems or iv) The area of damage is likely to be at least 1 km^2 but less than 5 km^2; or b) Would be likely to be caused to environmental values classes as slightly or moderately disturbed water, wetland of general ecological significance, riverine areas, springs or lakes and associated flora and fauna and the adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $20,000,000 or ii) Remediation of damage is likely to take more than 1 year, or iii) Significant alteration to existing ecosystems or iv) The area of damage (including downstream effects) is likely to be at least 2 km^2.	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas, but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects

Environmental Harm	Consequence Category		
	High	Significant	Low
General economic loss or property damage	Third party assets in the failure path would be expected to require $10 million or greater in rehabilitation compensation, repair or rectification costs	Third party assets in the failure path would be expected to require at least $1 million, but no greater than $10 million in rehabilitation, compensation, repair, or rectification costs	Location such that harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, repair, or rectification costs

Table 6.2 - Hydraulic Performance of Regulated Structures extracted from Table 2 in the "Manual for assessing consequence categories and hydraulic performance of structures"

Design criteria	Adequate containment and detection measures		
Regulated structure classifications	Containment	Leakage detection and/or monitoring	Rectification
High Consequence	Designed with a floor and sides of material that will contain the wetting front and any entrained contaminates within the bounds of the containment system during its operational life	Have a system that will detect any passage of the wetting front or entrained contaminates through either the floor or sides of the dam	Either be capable of repair to rectify any passage of the wetting front through either the floor or sides of the dam, or else be decommissioned and rehabilitated.
Significant Consequence	Designed with a floor and sides of material that will minimise (or reduce) seepage to avoid the environmental harm in the significant consequence category in Table 1 (the Manual) and ensure that the environmental harm likely to occur is only as in the low consequence category of that table.	Have a system that is appropriate to demonstrate that significant harm as per Table 1 (the Manual) will not occur	N/A

6.2 Potential Failure Mechanisms

The TSF for the SUO comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m, surrounded by a 1.38 m high bund to prevent entry of runoff.

Potential failure mechanisms considered in this assessment are presented below, together with a discussion relevant to each mechanism.

6.2.1 Failure to contain - seepage

The particle size distribution with hydrometer testing of the minus 75-micron fraction of the tailings and Atterberg Limits tests indicate that the tailings are very fine, being classified as a high plasticity silty clay with 100% passing 38 microns and more than 40% passing 2 microns. As a consequence, the deposited tailings are likely to have a very low permeability, expected to be in the order of less than 1.0×10^{-9} m/sec. As such, the tailings are effectively acting as a low permeability barrier and the seepage losses are likely to be very low. In addition, the TSF is lined with an impervious geofabric/polymer liner, which enhances the low permeability of the proposed facility.

The process water which forms part of the tailings slurry, which is the site ground water, is understood to have a TDS in the order of 6,000 mg/l, well above the level acceptable in potable water for human consumption. Therefore, in addition to the very low permeability of the tailings and the liner, the salinity should not impact the site in terms of seepage, as the groundwater quality is the same as the process water.

With respect to the discharge water, if and when such an event which exceeds the design criteria occurs, the water quality is likely to be significantly diluted, given the small size of the trial and the size of an event required to exceed the freeboard of the TSF.

The actual volume of any discharge is a function of the available storage on the TSF at the time the event occurred and the volume of water from adjacent and downstream catchments.

Given the low permeability of the tailings and the fact that the proposed TSF is lined with an impervious geofabric/polymer liner and surrounded by a 1.38 m high bund to prevent entry of any runoff, the potential for seepage losses is considered to be very low to unlikely, classified as 'Low' in accordance with DEHP[2].

6.2.2 Failure to contain - overtopping

The site is located in a semi-arid savannah environment and is dependent on external water sources for continuity of operations. Any rainfall runoff likely to collect within the impoundment area will be recovered for use in processing operations in preference to water from external sources. The TSF for the SUO comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m, surrounded by a 1.38 m high bund to prevent entry of runoff.

Any spillage is only likely to occur if a significant rainfall event exceeds the design storage requirements, refer to Section 6.8. The details of the operation of the TSF to avoid spillage and ensure that the TSF is managed to meet the project requirements are presented in Section 9.

Given the design of the TSF, where the freeboard allowance of 1 m exceeds the design storm event and the presence of a 1.38 m high bund to prevent entry of external runoff, the potential for loss of containment due to over topping is considered to be very low to unlikely, classified as 'Low' in accordance with DEHP[2].

6.2.3 Dam Break – loss of confinement embankments

Geotechnical site investigations and geotechnical laboratory testing of both the potential containment embankment materials and the tailings have been executed to define their engineering characteristics. The TSF for the SUO comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m, surrounded by a 1.38 m high bund to prevent entry of runoff.

Adequate factors of safety exist for the proposed excavation forming the containment facility. The details of the operation of the TSF to avoid spillage and ensure that it is managed to meet the project requirements, are presented in Section 9. These measures are designed to minimise the potential for loss of confinement, which results in a dam break. The potential for loss of confinement due to failure of the containment is considered to be very low to unlikely, classified as 'Low' in accordance with DEHP[2].

6.3 Harm to Humans

An assessment of the Consequence Category of the operational and closure conditions, with respect to Harm to Humans is presented in Table 6.3 based on the information presented in Section 6.2.

6.4 General Environmental Harm

The tailings contained within the TSF will likely have a varied geochemical composition and are expected to be Non-Acid Forming (NAF). No surface runoff is expected and seepage, if any, would likely be pH neutral. An assessment of the Consequence Category of the operational and closure conditions, with respect to General Environmental Harm, is presented in Table 6.4.

6.5 Economic Loss or Property Damage

The results of the assessment of economic loss or property damage are summarised in Table 6.5.

Table 6.3 - Operation and Closure Consequence Category Rating Harm to Humans

Facility Stage	Scenario	Criteria	Consequence Category	Justification
TSF Operations	Failure to Contain - Seepage	Loss of Life	Low	The TSF poses a very low risk with respect to seepage since it is formed by an excavation into the ground, which is lined with an impervious geofabric/polymer liner, and will contain very low permeability tailings. There is no groundwater below the TSF site. Exploration drilling by Centrex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 mbgl. The existing water quality in the general area around the project, at 6,000 ppm TDS, is not suitable for human consumption without treatment, refer to Section 6.2.1.
		Drinking water impact	Low	As above. There is no direct connection with respect to any discharge from the TSF and water sources used by humans. Any discharge from the TSF in high rainfall events would result in mixing and dilution, ultimately to a water quality similar to that of adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Failure to Contain - Overtopping	Loss of Life	Low	Assuming that the TSF is operated in accordance with the design and operational requirements as detailed in Section 9, it is considered unlikely that overtopping would occur. The site is located in a sparsely populated rural, semi-arid savannah environment with no permanent human presence within 20 km downstream of the TSF. The project is dependent on two water supply bores which will be located to the north of the Project, within the ML, These bores are within the Beetle Creek Formation which is an unconfined aquifer. Any rainfall runoff likely to collect within the impoundment area would be recovered for use in processing operations in preference to water from external sources. The spillage is only likely to operate if the rainfall event exceeds the design storage requirements. During extreme rainfall events, personnel involved in the operation could be removed from the TSF area to ensure safety. Potential for loss of life is recognised, but no loss of life is expected. *Recommendation:* *1. Conduct a risk assessment to determine if personnel should remain in the TSF area during extreme rain events and determine what events and procedures, if any, are needed to notify others downstream of the TSF.*
		Drinking water impact	Low	As above, overtopping is unlikely to occur. In the extreme case it did occur, the water outflow would be mixing with water from adjacent catchments and diluted. Ultimately the mixing and dilution would result in a quality of water similar to the adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.

Facility Stage	Scenario	Criteria	Consequence Category	Justification
TSF Operations	Dam Break	Loss of Life	Low	The TSF is an excavation into the ground which is lined, has 1 m freeboard below ground and is surrounded by a 1.38 m high bund. Instability of the containment is very unlikely given the ground conditions and construction and operation must be executed in accordance with the design requirements. *Recommendations:* *1. QA/QC practices to be implemented during construction to ensure that the construction meets the intent of the design requirements.* *2. The operation of the TSF to be in accordance with the operational requirements as detailed in Section 9 of this document.* *3. Conduct a risk assessment to determine if personnel should remain in the TSF area during extreme rain events and determine what events and procedures, if any, are needed to notify others downstream of the TSF.*
		Drinking water impact	Low	A Dam Break scenario is unlikely to occur given that the TSF is an excavation into the ground which is lined, has 1 m freeboard below ground and is surrounded by a 1.38 m high bund. In the extreme case that a dam break did occur, the water outflow would be mixing with water from adjacent catchments and diluted. Ultimately the mixing and dilution would result in a quality of water similar to the adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.

Facility Stage	Scenario	Criteria	Consequence Category	Justification
Facility Closure	Failure to Contain Seepage	Loss of Life	Low	The deposited tailings will be covered with mine waste once the life of the SuP is reached. With a very flat top surface slope which is armoured, the flow from it is expected to have a velocity of well less than 1 m/sec. The TSF poses a very low risk with respect to seepage since it is formed by an excavation into the ground, which is lined with an impervious geofabric/polymer liner, and will contain very low permeability tailings. There is no groundwater below the TSF site and the existing water quality in the area, at 6,000 ppm TDS, is not suitable for human consumption without treatment, refer to Section 6.2.1.
		Drinking water impact	Low	See comments above.
	Failure to Contain - Overtopping	Loss of Life	Low	The landform will be a self-shedding landform. No loss of life is expected.
		Drinking water impact	Low	The landform will be a self-shedding landform. In the extreme case overtopping did occur, the water outflow would be mixing with water from adjacent catchments and diluted. Ultimately the mixing and dilution would result in a quality of water similar to the adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Dam Break	Loss of Life	Low	The facility is a below ground structure. The deposited tailings will be covered with mine waste, back to the natural ground surface once the SUO life is reached. With a very flat top surface slope which is armoured, the flow from it is expected to have a velocity of well less than 1 m/sec. The TSF poses a very low risk with respect to closure. *Recommendation:* *1. The closure strategy must be executed with consideration of extreme rainfall and seismic conditions, to reduce the risk of accidental or purposeful damage to the TSF.*
		Drinking water impact	Low	See comments above. If a dam break did occur, particularly during extreme rainfall, the water outflow would be mixing with water from adjacent catchments and diluted. Ultimately the mixing and dilution would result in a quality of water similar to the adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.

Table 6.4 - Operation and Closure Consequence Category General Environmental Harm

Facility Stage	Scenario	Consequence Category	Justification
TSF Operations	Failure to Contain - Seepage	Low	The TSF poses a very low risk with respect to seepage since it is formed by an excavation into the ground, which is lined with an impervious geofabric/polymer liner, and will contain very low permeability tailings. There is no groundwater below the TSF site. Exploration drilling by Centrex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 mbgl. The existing water quality in the general area around the project, at 6,000 ppm TDS, is not suitable for human consumption without treatment, refer to Section 6.2.1. There is no direct connection in respect of the TSF and water sources used by stock. Any discharge from the TSF in high rainfall events would result in mixing and dilution to a water quality similar to adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Failure to Contain - Overtopping	Low	Assuming that the TSF is operated in accordance with the operational requirements as detailed in Section 9 of this document, it is considered unlikely that overtopping would occur. The site is located in a semi-arid savannah environment and is dependent on external water sources for continuity of operations. Spillage is only likely to operate if the rainfall event exceeds the design storage requirements. In the extreme case overtopping did occur, the water and solids outflow would be diluted with mixing, possibly to a water quality similar to adjacent catchments and the environmental impact may extend to 5 km^2. *Recommendation:* *1. Conduct a risk assessment to determine what events and procedures, if any, are needed to notify others downstream of the TSF.*
	Dam Break	Low	The facility is a below ground structure, surrounded by a 1.38 m high bund. A dam break scenario is unlikely to occur if the recommendations in relation to the operational requirements as detailed in Section 9 of this document are implemented. In the extreme case, if a dam break did occur, due to a rainfall event, the water and solids outflow would be mixed with water from adjacent catchments, diluting and ameliorating the potential damage. In the unlikely event of a dam break due to embankment failure the environmental impact may extend to 5 km^2. *Recommendations:* *1. The operation of the TSF to be in accordance with the operational requirements as detailed in Section 9 of this document.*

Facility Stage	Scenario	Consequence Category	Justification
Facility Closure	Failure to Contain Seepage	Low	The deposited tailings will be covered with mine waste once the project life is reached. With a very flat top surface slope which is armoured, the flow from it is expected to have a velocity of well less than 1 m/sec. The TSF poses a very low risk with respect to seepage to groundwater, due to the very low permeability of the deposited tailings, the presence of the liner and the existing water quality at 6,000 ppm TDS. The environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Failure to Contain - Overtopping	Low	The landform will be a self-shedding landform. No adverse permanent consequences to the environment are expected. In the extreme case, if a dam break did occur, due to a rainfall event, the water and solids outflow would be mixed with water from adjacent catchments diluting and ameliorating the potential damage and the environmental impact, if any, may extend to 5 km^2. *Recommendation:* *1. The closure strategy must be executed with consideration of extreme rainfall and seismic conditions, to reduce the risk of accidental or purposeful damage to the TSF.*
	Dam Break	Low	The performance of the final structure would need to be assessed under extreme rainfall and seismic conditions. In the extreme case a dam break did occur, due to a rainfall event, the water and solids outflow would mix with water from adjacent catchments, diluting and ameliorating the potential damage. In the unlikely event of a dam break due to embankment failure, the environmental impact may extend to 5 km^2. *Recommendation:* *1. The closure strategy must be executed with consideration of extreme rainfall and seismic conditions to reduce the risk of accidental or purposeful damage to the TSF.*

Table 6.5 - Economic Loss or Property Damage

Facility Stage	Scenario	Consequence Category	Justification
TSF Operations	Failure to Contain - Seepage	Low	The TSF poses a very low risk with respect to seepage since it is formed by an excavation into the ground, which is lined with an impervious geofabric/polymer liner, and will contain very low permeability tailings. There is no groundwater below the TSF site. Exploration drilling by Centrex has not intersected groundwater in the southern area of the ML to the maximum depths of between 48 and 53 mbgl. The existing water quality in the general area around the project, at 6,000 ppm TDS, is not suitable for human consumption without treatment, refer to Section 6.2.1. There is no direct connection in respect of the TSF and water sources used by stock. Any discharge from the TSF in high rainfall events would result in mixing and dilution to a water quality similar to adjacent catchments and the environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Failure to Contain - Overtopping	Low	Assuming that the TSF is operated in accordance with the design and operational requirements, as detailed in Section 9 of this document, it is considered unlikely that overtopping would occur. No adverse permanent consequences to the environment are expected. In the extreme case overtopping did occur, the water and solids outflow would be diluted by mixing with water in adjacent catchments. Harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair, or rectification costs. *Recommendation:* *1. Conduct a risk assessment to determine what events and procedures, if any, are needed to notify others downstream of the TSF.*
	Dam Break	Low	The facility is a below ground structure, surrounded by a 1.38 m high bund. A dam break scenario is unlikely to occur if the recommendations in relation to operational requirements, as detailed in Section 9 of this document, are implemented. In the extreme case a dam break did occur, due to a rainfall event the water and solids outflow would be mixed with water from adjacent catchments diluting and ameliorating the potential damage. Harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair, or rectification costs. *Recommendation:* *1. Conduct a risk assessment to determine what events and procedures, if any, are needed to notify others downstream of the TSF.* *2. The operation of the TSF must be in accordance with the operational requirements as detailed in Section 9 of this document.*

Facility Stage	Scenario	Consequence Category	Justification
Facility Closure	Failure to Contain Seepage	Low	The deposited tailings will be covered with mine waste once the SuP life is reached. With a flat top surface slope which is armoured, the flow from it is expected to have a velocity of well less than 1 m/sec. The TSF poses a very low risk in respect of seepage to groundwater, due to the very low permeability of the deposited tailings, presence of a liner and the existing water quality at 6,000 ppm TDS. The environmental impact would be unlikely to meet any of the minimum thresholds specified for significant or high consequences.
	Failure to Contain - Overtopping	Low	The landform will be a self-shedding landform. No adverse permanent consequences to the environment are expected. In the extreme case it did occur, due to a rainfall event, the water and solids outflow would be mixed with water from adjacent catchments diluting and ameliorating the potential damage. Harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair, or rectification costs. *Recommendation:* *1. The closure strategy must be executed with consideration of extreme rainfall and seismic conditions, to reduce the risk of accidental or purposeful damage to the TSF.*
	Dam Break	Low	The facility is a below ground structure, surrounded by a 1.38 m high bund. In the extreme case a dam break did occur, due to a rainfall event, the water and solids outflow would mix with water from adjacent catchments, diluting and ameliorating the potential damage and harm. Third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs. In the unlikely event of a dam break due to embankment failure, harm to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs. *Recommendation:* *1. Completion of a Dam Break Study prior to closure, to ensure any changes downstream since the construction of the facility are considered, to understand the scenarios and consequences under which such an event might occur.* *2. The closure strategy must be executed with consideration of extreme rainfall and seismic conditions, to reduce the risk of accidental or purposeful damage to the TSF.*

6.6 Summary of Consequence Categories

The summary of the consequence categories is presented in Table 6.6.

Table 6.6 - Consequence Categories

Facility Stage	Consequence Category
Operation	Low
Closure Profile	Low

6.7 Hydraulic Performance Criteria

Given that the TSF for the SUO comprises an excavation of approximately 40,500 m^3 (90 m x 90 m with a maximum depth of 5 m) which will be lined with an impervious geofabric/polymer liner with a minimum freeboard of 1 m, surrounded by a 1.38 m high bund to prevent entry of runoff, the hydraulic performance of the SUO TSF is rated as having a consequence of Low. The results of the assessment of hydraulic performance are summarised in Table 6.7.

Table 6.7 - Hydraulic Performance

Facility Stage	Consequence Category	Scenario	Design Criteria	Comment
Operations	Low	Containment	Floor and sides will contain the wetting front and any entrained containments within the bounds of the containment system during its operational life. Rainfall must be recovered from the TSF. The DSA must be observed as required by the design and operations manual.	The contained tailings have low permeability and the TSF includes a low permeability liner, refer to the comments in Section 6.2.1. Seepage from an operation with a duration of 2 to 3 months is not expected to develop.
		Leakage Detection and/or Monitoring	Have a system that will detect any passage of the wetting front or entrained containments through either the floor or sides of the dam.	A monitoring bore will be provided, if required, downstream of the TSF, if recommended by the project hydrogeologist. Monitoring can be undertaken of seepage, if any.
		Rectification	Either be capable of repair to rectify any passage of the wetting front through either the sides or floor of the dam, or else be decommissioned and rehabilitated.	Should the monitoring bores detect seepage from the base, remedial action (such as extraction bores) can be investigated and implemented as necessary.

6.8 Extreme Storm Storage and Design Storage Allowances

Under the 2016 Manual, the DSA, Extreme Storage Allowance (ESS), and MRL requirements must be addressed for dams that have been assessed as having a 'Significant' consequence for the 'failure to contain – overtopping' scenario.

The DSA requirements were based on the IFD data obtained from the Commonwealth of Australia 2016 Bureau of Meteorology (BOM) Site http://www.bom.gov.au/cgibin/hydro/has/CDIRSWebBasic, for Latitude (21° 40' 00") and Longitude (139° 15' 00") with 1 in 100, 168 hour AEP storm event or approximately 357 mm. The data is presented in Table 6.8 and Figure 6-1.

Table 6.8 – Annual Exceedance Probability (%)

Duration	Duration in min	63.20%	50%#	20%*	10%	5%	2%	1%
1 min	1	1.54	1.82	2.72	3.34	3.95	4.76	5.38
2 min	2	2.52	3	4.53	5.59	6.64	8.04	9.14
3 min	3	3.6	4.28	6.43	7.92	9.4	11.4	12.9
4 min	4	4.63	5.5	8.24	10.1	12	14.5	16.5
5 min	5	5.59	6.63	9.92	12.2	14.4	17.4	19.7
10 min	10	9.39	11.1	16.6	20.3	24	28.9	32.6
15 min	15	12	14.3	21.3	26	30.7	37	41.7
30 min	30	16.8	20	29.9	36.6	43.3	52.1	59
1 hour	60	21.7	25.8	38.6	47.5	56.3	68.1	77.3
2 hour	120	26.9	31.9	47.7	58.8	69.9	85	96.8
3 hour	180	30.4	35.9	53.6	66.1	78.7	95.8	109
6 hour	360	37.7	44.2	65.5	80.7	96	117	134
12 hour	720	46.9	54.8	80.8	99.2	118	144	165
24 hour	1440	57.6	67.6	99.8	122	145	177	203
48 hour	2880	68.6	81.3	122	149	177	216	247
72 hour	4320	74.6	89.1	135	166	197	242	277
96 hour	5760	78.7	94.3	144	179	213	262	300
120 hour	7200	82	98.4	151	189	226	279	320
144 hour	8640	84.9	102	157	197	238	294	339
168 hour	10080	87.6	105	163	205	249	309	357

Note:

The 50% AEP IFD **does not** correspond to the 2-year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.

***** The 20% AEP IFD **does not** correspond to the 5-year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

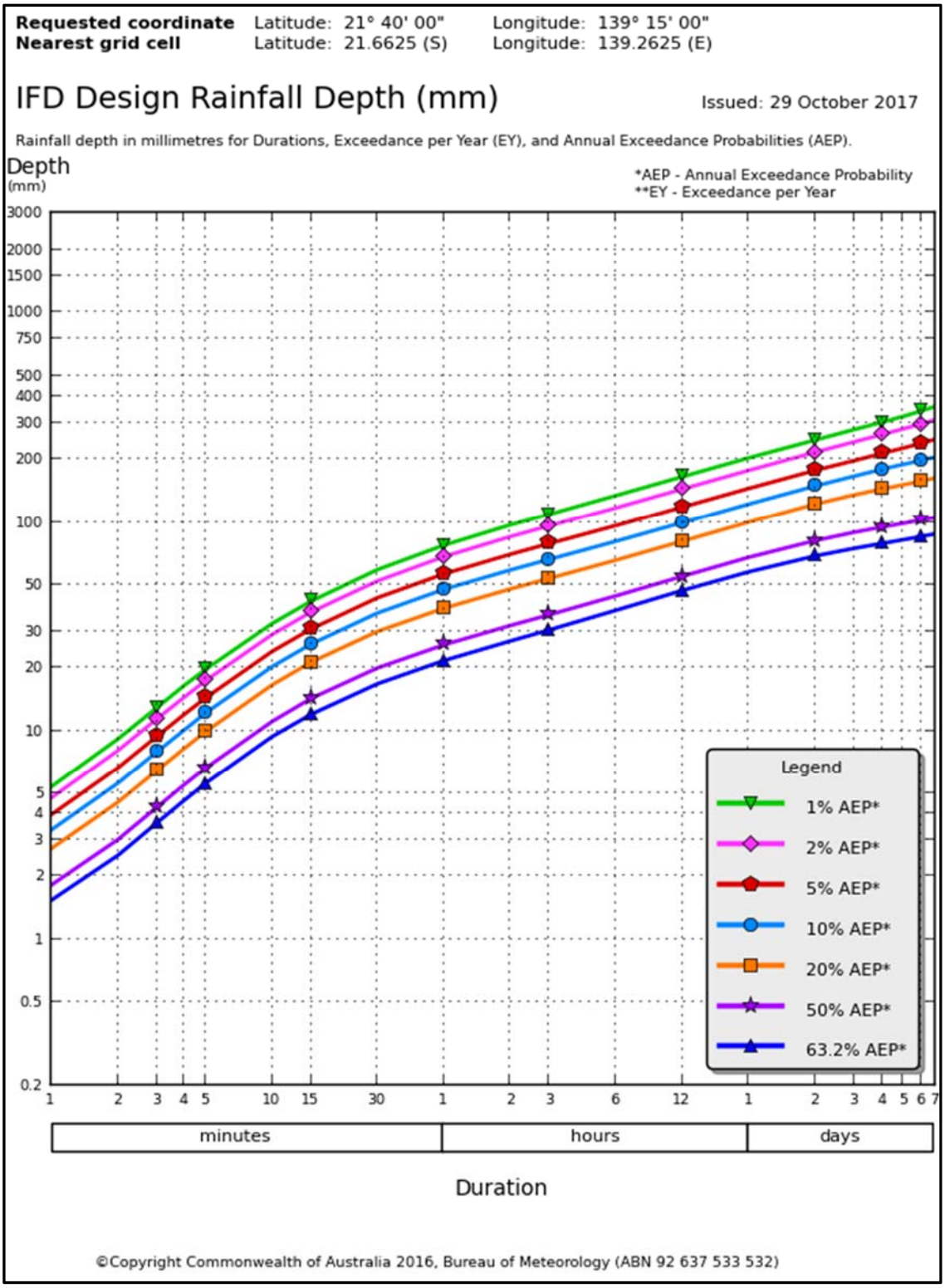


Figure 6-1 – Rainfall Intensity Frequency Duration

Analysis of rain events by Golder (Golder, 2018) indicates that a 1:100 AEP 72-hour event will not generate sufficient volume from direct fall to exceed the 1 m freeboard.

7 TSF DESIGN CONCEPT

7.1 General

The Ardmore TSF design is based on research of data from similar projects. The design of the TSF has been aimed at:

i) Optimising tailings storage capacity and maximising tailings density.

ii) Reducing environmental and societal impact.

With the tailings confirmed as being NAF, with a high plasticity silty clay composition, effectively providing a low permeability liner, supplemented with a low permeability liner as part of the construction and the local groundwater in the area assumed as being brackish (slightly brackish to saline), there is minimal potential for impacting the natural groundwater from the storage of tailings.

7.1.1 Embankment Geometry

The design concept adopted for the excavated embankment has downstream slopes of 3:1 (H:V) to allow for placement of the liner.

7.1.2 Liner

There is an impervious geofabric/polymer liner to the floor and walls of the TSF for this project.

7.1.3 Underdrainage System

At this stage, an underdrainage system has not been incorporated into the concept design to assist in the recovery of water. The value of such a system is not supported by the tailings testwork which indicate that the tailings are effectively a high plasticity silty clay which will seal the floor of the TSF. Given the characteristics of the deposited tailings and the inclusion of the impervious geofabric/polymer liner to the floor and walls of the TSF, an underdrainage system would do very little to reduce seepage losses from the TSF.

The primary mitigation measure to contain seepage is the well-constructed liner.

7.1.4 Decant System

A decant pump is to be utilised to facilitate surface water recovery.

The supernatant pond level must be actively maintained, so as to be kept around the decant pump and clear of the perimeter embankments. The position and extent of the supernatant pond is controlled by the water recovery which is to be maximised.

7.1.5 Tailings Deposition

Tailings will be deposited using sub-aerial deposition techniques from multi spigot locations on the perimeter deposition embankments. Tailings spigotting or deposition is to be executed in thin layers of not more than 300 mm to ensure a uniform tailings beach with a fall of 1% towards the decant. The spigotting sequence is to be formulated such that the supernatant water pond is always maintained around a decant structure.

8 SEEPAGE AND STABILITY ANALYSIS

No seepage and stability analyses have been executed as the TSF is excavated below ground level.

9 OPERATION

The following operational considerations have been incorporated into the design:

i) Tailings in the form of slurry will be discharged sub-aerially and cyclically into the facility in thin discrete layers. Deposition will take place via multiple spigots from around the facility.

ii) Spigotting of tailings is to be carried out such that the supernatant pond is maintained around the decant pump.

iii) Water will be removed from the facility and pumped back to the process plant via a decant pump.

The tailings storage area will assume the form of a truncated prism with a depressed cone on the top surface. The facility will have the capacity to store a considerable volume of water during a storm event. The minimum operational freeboard for the TSF under normal operating conditions is 1.0 m at the perimeter discharge embankments.

On eventual decommissioning, the facility will remain as a permanent feature of the landscape. The top surface and batters will be stabilised and rehabilitated according to the closure plan for the project.

10 MONITORING AND INSTRUMENTATION

A groundwater monitoring bore, if recommended by the project hydrogeologist, may be installed in the area downstream of the TSF to enable any deep-seated seepage beneath the perimeter embankment to be identified.

11 CLOSURE AND REHABILITATION

Following completion of deposition within the TSF, the deposited tailings are to be left to dry and consolidate. It is expected that the water liberated by consolidation and rainfall runoff will continue to pool where the decant is located. Periodic removal of this water will be required. The surface of the TSF will be covered with the materials removed to form the TSF and any other mine waste. Contouring of the final surface will aid in reducing the likelihood of rainwater run-off eroding the exposed surfaces. After completion of reshaping and contouring the TSF surface, topsoil can be placed over the facility to revegetate with local plant species. Spreading of any available timber cleared from the site prior to construction of the SUO will also aid in the establishment of vegetation. Contour ripping the exposed surfaces will also aid in enabling the vegetation to establish and reduce the risk of the topsoil being eroded by wind and runoff water.

12 REFERENCES

The following references were used in the preparation of this report.

1. Department of Environment and Heritage Protection (DEHP) *'Guideline, Environmental Protection Act 1994, Structures which are dams or levees constructed as part of environmentally relevant activities'*, dated 5 July 2017

2. Department of Environment and Heritage Protection (DEHP), *'Manual for Assessing consequence categories and hydraulic performance of structures'*, dated March 2016

3. Australian National Committee on Large Dams (ANCOLD) document titled, *'Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure'*, as dated May 2012

Appendix 1

Drawings

Centrex Phosphate Pty Ltd
Ardmore Phosphate Project
Tailings Storage Facility – Start-up Operation

PATH: \\golder.gds\GAP\Brisbane\GIS\01 Client\Centrex Phosphate Pty Ltd\1782517\99_PROJECTS\015\1782517-015-CM-F003-Rev0-Mining-Lease-Area-conceptual-layout.mxd PRINTED ON: 2018-08-23 AT: 2:22:17 PM

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7,608,000 7,606,000 7,604,000 7,602,000 7,600,000 7,598,000 7,596,000 7,594,000 7,592,000

BOULIA MOUNT ISA HIGHWAY

ML5542

KEY MAP



LEGEND

- Groundwater boreholes
- Water Pipeline and Access Track
- Watercourses
- Roads
- Start-up Operation Access Track
- Start-up Operation

Centrex Mining Lease

- ML5542

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994

0 500 1,000 1,500 2,000
1:50,000 at A3 METRES

CLIENT
CENTREX PHOSPHATE PTY LTD

CONSULTANT
GOLDER

DD/MM/YYYY	23/08/2018
DESIGNED	BG
PREPARED	BG
REVIEWED	JR
APPROVED	JR

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Roads, Watercourses: © State of Queensland (Department of Natural Resources and Mines - DNRM) 2017
Mining Lease: © State of Queensland (DNRM) 2018
Start-up Operation, Water Pipeline and Access Track, Start-up Operation Access Track: Provided by Centrex 2018.

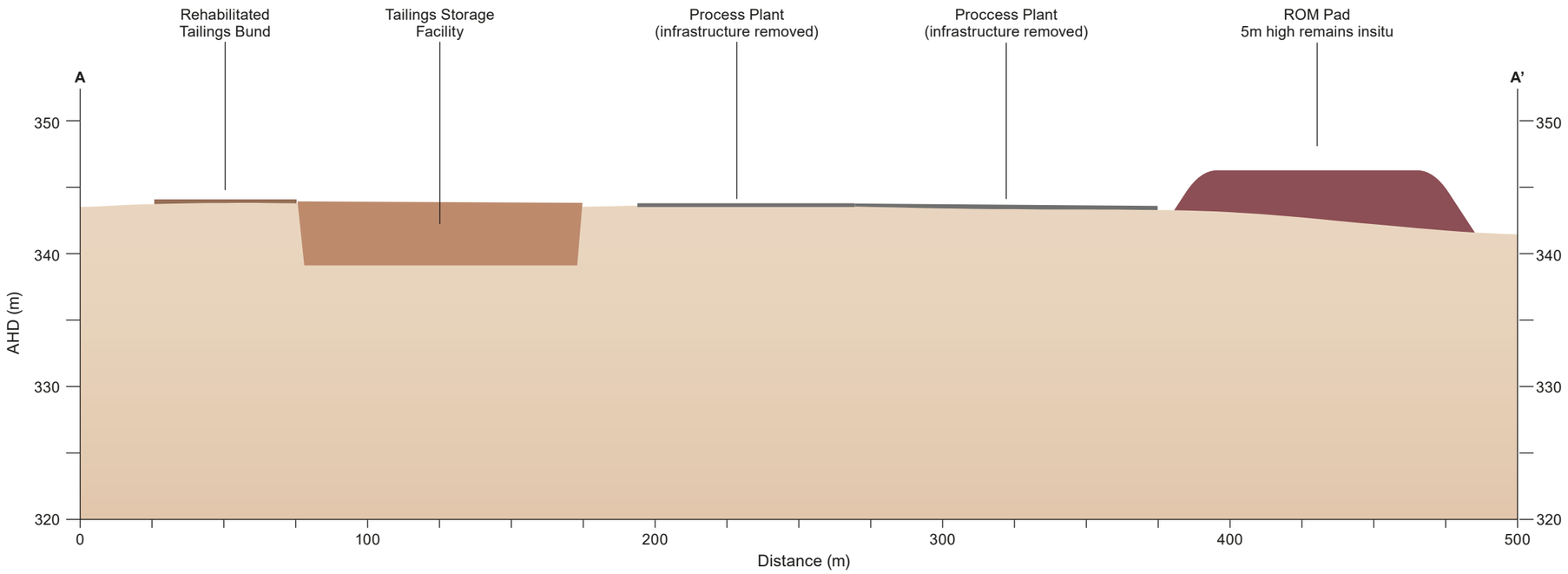
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CENTREX ARDMORE PHOSPHATE

TITLE
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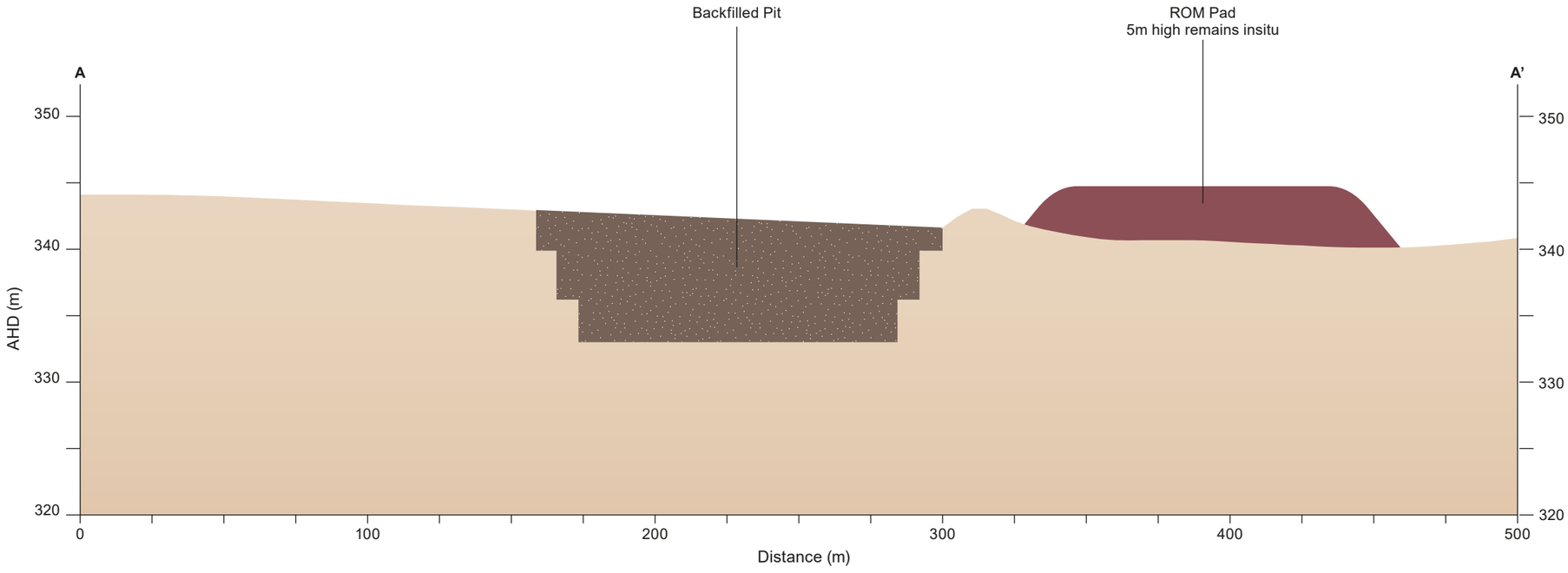
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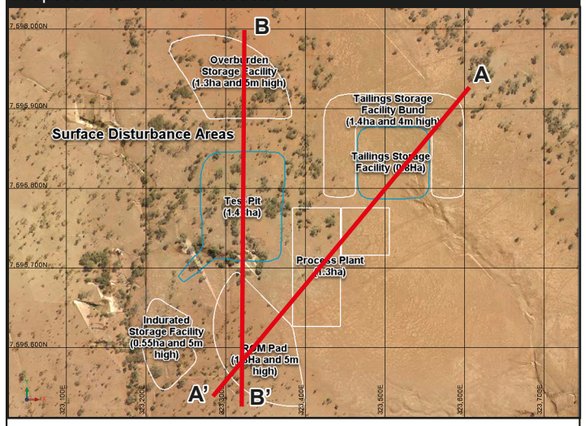
Section A-A’



Section B-B’



Proposed Trial Mine Infrastructure



DRAFT

NOTES

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CLIENT
CENTREX ARDMORE PTY LTD

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
CROSS SECTION OF SITE AT CLOSURE

CONSULTANT

GOLDER

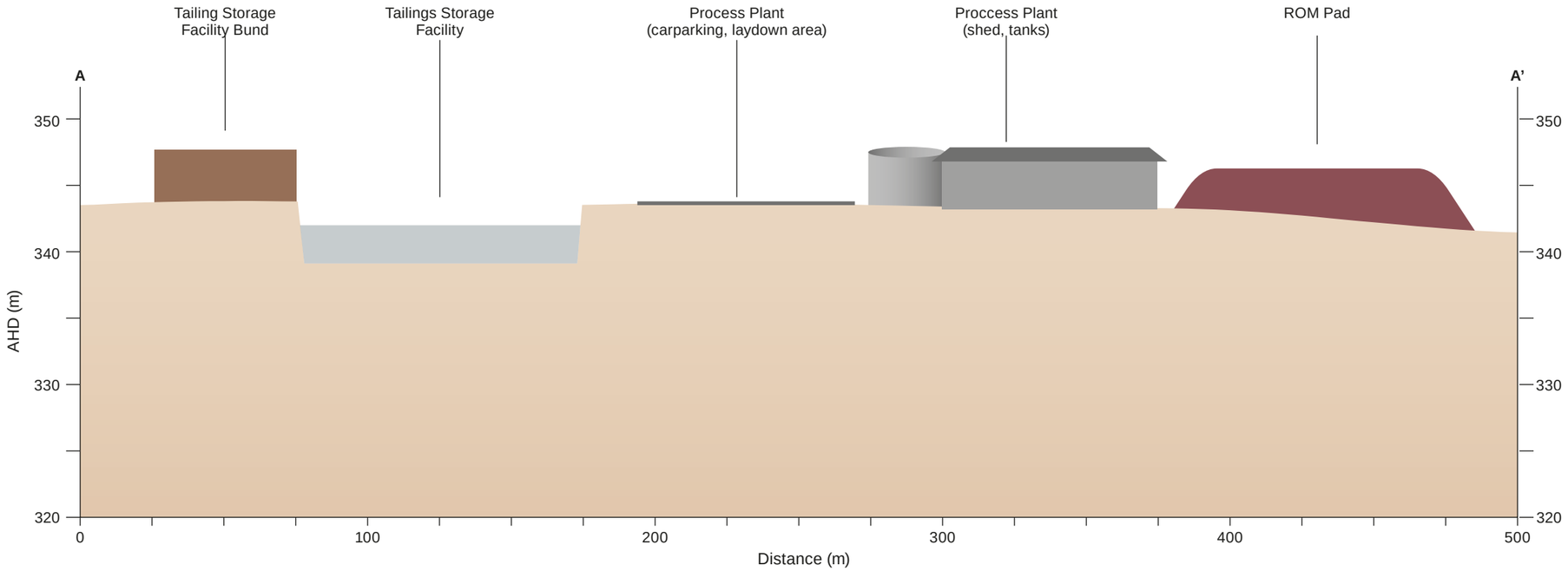
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APPROVED	JR

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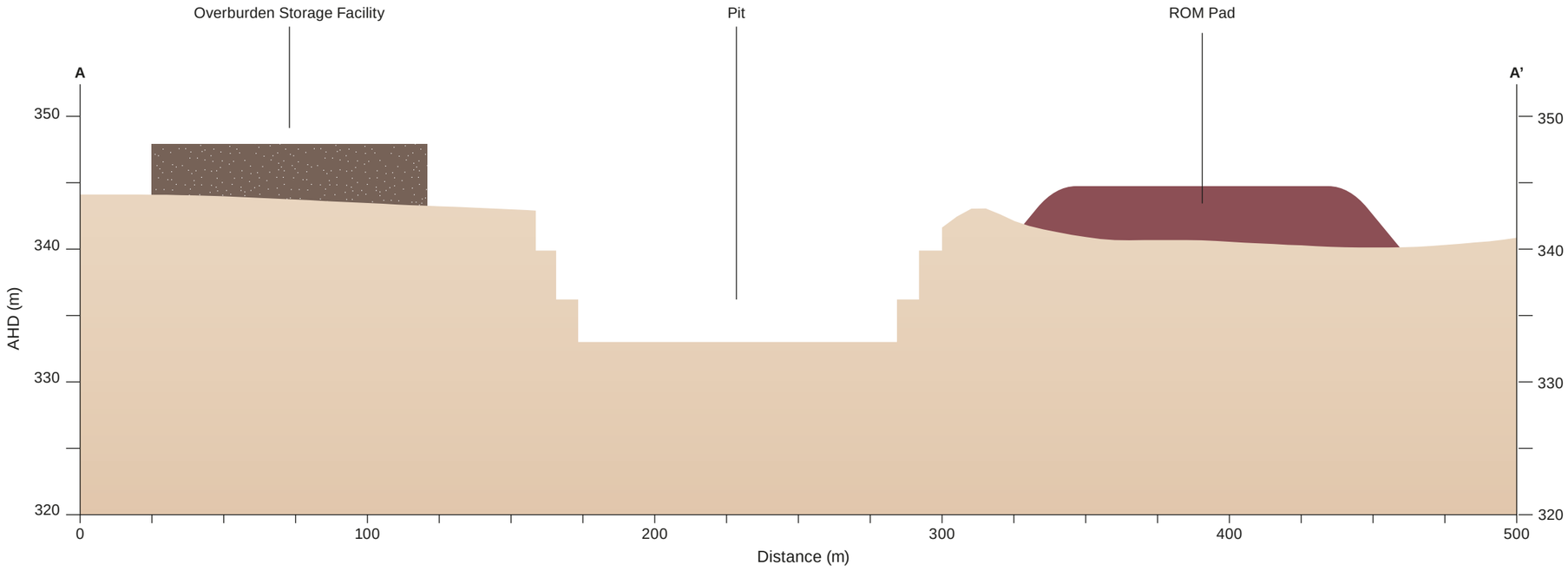
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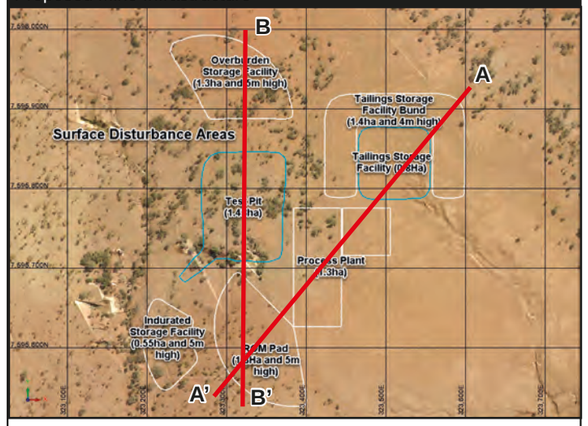
Section A-A’



Section B-B’



Proposed Mine Infrastructure



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3. Figure must be printed in colour.

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CLIENT
CENTREX

PROJECT
CENTREX ARDMORE PHOSPHATE

TITLE
CROSS SECTION OF SITE DURING MINING

CONSULTANT
GOLDER

YYYY-MM-DD	2018-05-15
PREPARED	AA
REVIEW	RK
APPROVED	JR

PROJECT NO.	REPORT	REV.	FIGURE
1782517	015	0	

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: A3

0 25 mm

Appendix 2

Statement of Certification

Centrex Phosphate Pty Ltd
Ardmore Phosphate Project
Tailings Storage Facility – Start-up Operation

L&MGSPL

Form of certification (consequence assessment/design plan)

Name of Registered Professional Engineer providing certification:

James Christopher Lane – RPEQ (13083).

Address of Registered Professional Engineer providing certification:

20 Daisy Rise Cowaramup Western Australia 6284.

Statement of relevant experience:

I hereby state that I am a Registered Professional Engineer of Queensland and meet the requirements of the definition of 'suitably qualified and experienced person' with more than 35 years of professional experience in the mining industry specifically devoted to the design and auditing of tailings storage facilities. My CV is attached.

Statement of certification:

All relevant material relied upon by me, including subsidiary certifications of specialist components, where required by the environmental authority, was provided in the report titled ***'Feasibility Study – Ardmore Phosphate Project Tailings Storage Facility Concept and Water Storage Facility Preliminary Concept'*** dated 12 September 2018.

I hereby certify that the attached report ***'Ardmore Phosphate Project, Tailings Storage Facility – Start-up Operation'*** dated 19 November, 2018 has been reviewed in terms of *'Assessment of Hazard Category'*. The results of this review and the assessment are as follows:

The design for the Tailings Storage Facility (TSF) has been assessed as 'Low' for the elements of:

i) "Harm to humans".

ii) "General environmental harm".

iii) "General economic loss or property damage". The expected rehabilitation, compensation, repair or rectification costs as a result of destruction of assets would be less than $1 million.

This certification relates to hazard category assessment for the Start-up Operation TSF which has an operating life of 2 to 3 months and which is proposed for regulatory approval.

I, James Christopher Lane, declare that the information provided as part of this certification is true to the best of my knowledge. I acknowledge that it is an offence under section 480 of the Environmental Protection Act 1994 to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed: _____ RPEQ 13083

Date: 19 November, 2018

APPENDIX D

Tailings testwork

Appendix D

Tailings Testwork

Centrex Phosphate Limited
Feasibility Study – Ardmore Phosphate Project
Tailings Storage Facility Concept and Water Storage Facility Preliminary Concept

Trilab
Soil Rock Calibration

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346A Bilsen Road,
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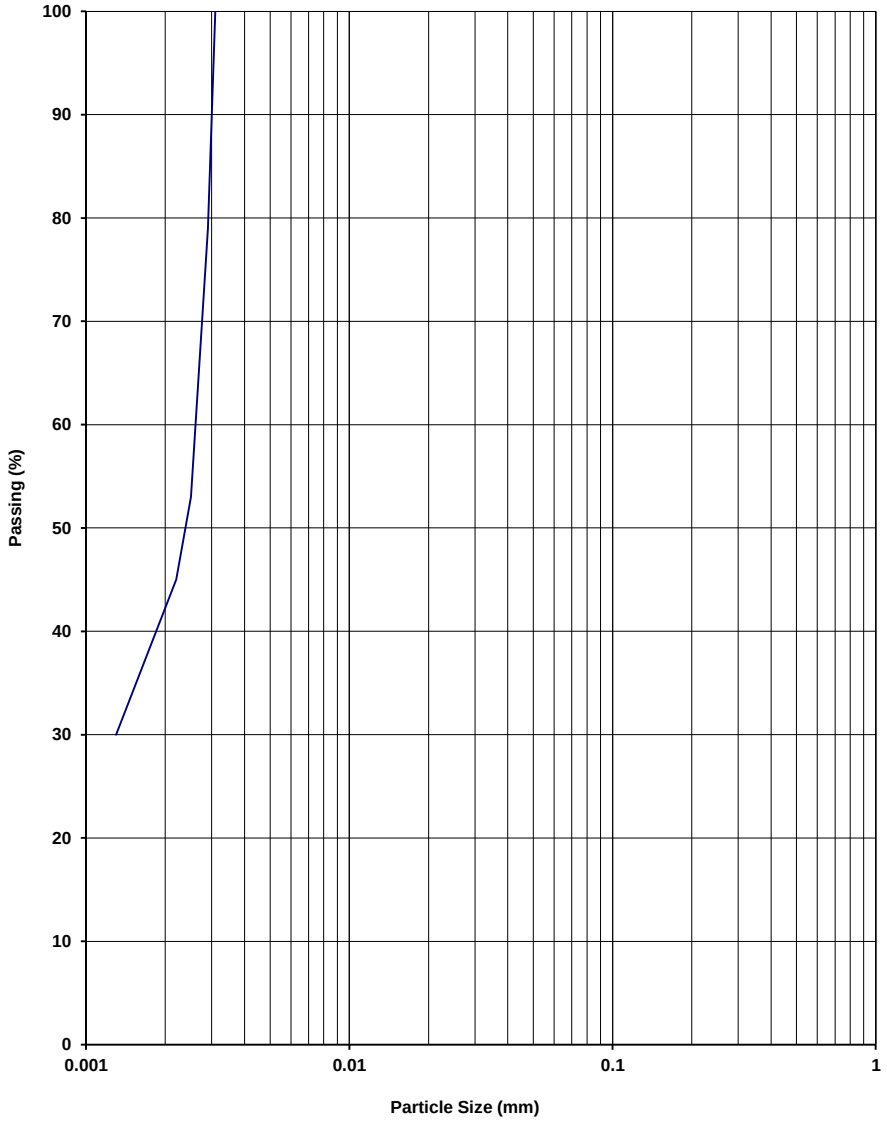
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Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Centrex Metals Ltd	**Report No.**	18030598-G
		Workorder No.	0003961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date**	4/4/18-10/4/18
		Report Date	16/4/2018
Project	Ardmore Phosphate Project - Tailings Test Work		
Client ID	Master Composite Bulk Tailings	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	100
0.056	100
0.04	100
0.028	100
0.02	100
0.015	100
0.011	100
0.0077	100
0.0054	100
0.0038	100
0.0031	100
0.0029	79
0.0025	53
0.0022	45
0.0013	30



NOTES/REMARKS: Site water used during the testing

-2.36mm Soil Particle Density(t/m^3) 2.81

Sample and site water supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory
J. Russell

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

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ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	Centrex Metals Ltd	**Report No.**	18030598-AL
		Workorder No.	0003961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Report Date**	17/04/2018
Project	Ardmore Phosphate Project - Tailings Test Work		

Sample No.	18030598					
Test Date	28/03/2018					
Client ID	Master Composite Bulk Tailings					
Depth (m)	Not Supplied					
Liquid Limit (%)	68					
Plastic Limit (%)	23					
Plasticity Index (%)	45					
Linear Shrinkage (%)	17.0 *					
Moisture Content (%)	-					

Sample No.						
Test Date						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

NOTES/REMARKS: The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory
J. Russell

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	Centrex Metals Ltd	**Report No.**	18030598-EM
		Workorder No.	3961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date**	28/03/2018
		Report Date	29/03/2018
Project	Ardmore Phosphate Project - Tailings Test Work		

Sample No.	18030598	-	-	-	-	-	-
Client ID	Master Composite Bulk Tailings	-	-	-	-	-	-
Depth (m)	Not Supplied	-	-	-	-	-	-
Description	SLURRY - brown	-	-	-	-	-	-
Emerson Class Number	**6**	**-**	**-**	**-**	**-**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

NOTES/REMARKS:

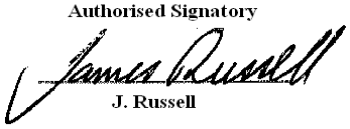
Sample/s supplied by the client

Tested with Distilled water at 21.6°C

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory



J. Russell

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Laboratory No. 9926

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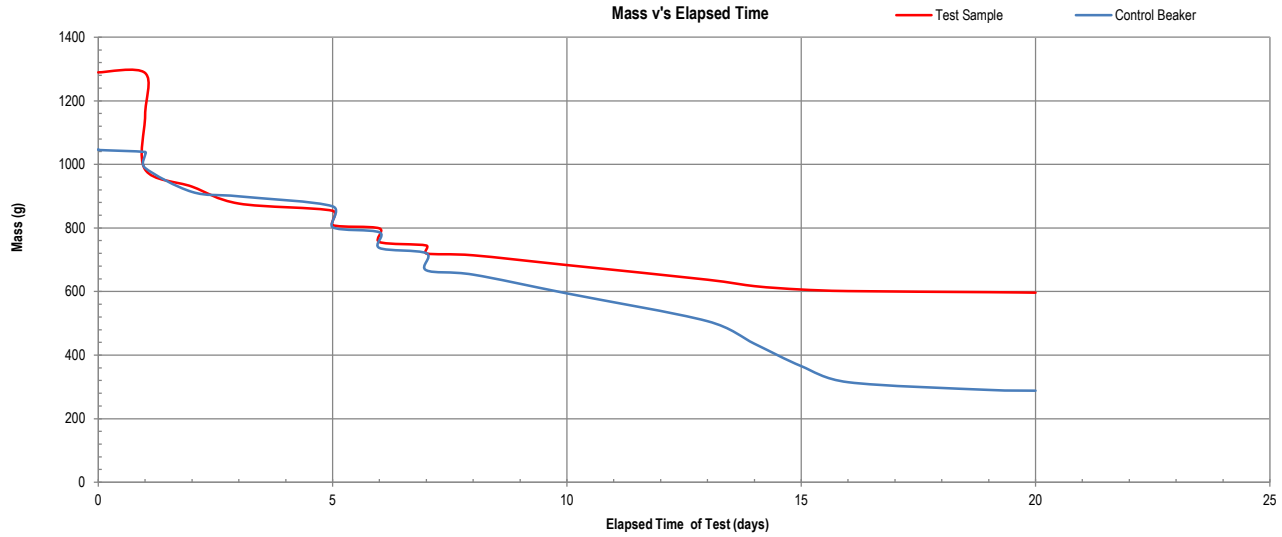
AIR DRYING TEST REPORT

Air Drying Test Procedure - as Supplied by Client

Client	Centrex Metals Ltd	**Report No.**	18030598-AD
		Workorder No.	0003961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date**	21/03/2018
		Report Date	16/04/2018
Project	Ardmore Phosphate Project - Tailings Test Work		
Client ID	Master Composite Bulk Tailings	**Depth (m)**	Not Supplied
Description	CLAY- pale brown	**Sample Type**	Tailings at 30% solids

RESULTS OF TESTING

Date	Control Beaker			Test Sample		Decant	
	Temperature (° C)	Mass (g)	Evaporation (g)	Mass (g)	Evaporation (g)	Mass (g)	Decantation (g)
21/03/2018 Start Date	21.4	1047.3	-	1289.4	-	0.0	-
21/03/2018	21.2	1045.3	2.0	1289.4	0.0	0.0	
22/03/2018	21.0	1039.1	8.2	1287.4	2.0	1160.7	126.7
22/03/2018	41.5	1029.8	17.5	1154.7	134.7	993.8	160.9
22/03/2018	41.5	988.6	58.7	983.6	305.8	972.0	11.6
23/03/2018	42.0	913.4	133.9	930.0	359.4	0.0	
24/03/2018	30.8	899.4	147.9	876.7	412.7	0.0	
26/03/2018	23.0	868.0	179.3	854.0	435.4	0.0	
26/03/2018	38.9	802.3	245.0	809.1	480.4	0.0	
27/03/2018	35.0	786.3	261.0	798.6	490.8	0.0	
27/03/2018	44.2	737.0	310.3	755.6	533.8	0.0	
28/03/2018	37.3	720.5	326.8	744.8	544.6	0.0	
28/03/2018	42.6	666.9	380.4	719.9	569.5	0.0	
29/03/2018	21.8	653.2	394.1	713.9	575.5	0.0	
31/03/2018	21.6	594.2	453.2	683.3	606.1	0.0	
3/04/2018	39.2	506.7	540.6	637.2	652.2	0.0	
4/04/2018	42.6	435.9	611.4	617.0	672.4	0.0	
5/04/2018	43.3	365.4	681.9	606.4	683.1	0.0	
6/04/2018	45.2	314.8	732.6	601.4	688.0	0.0	



Remarks:

Sample/s supplied by client

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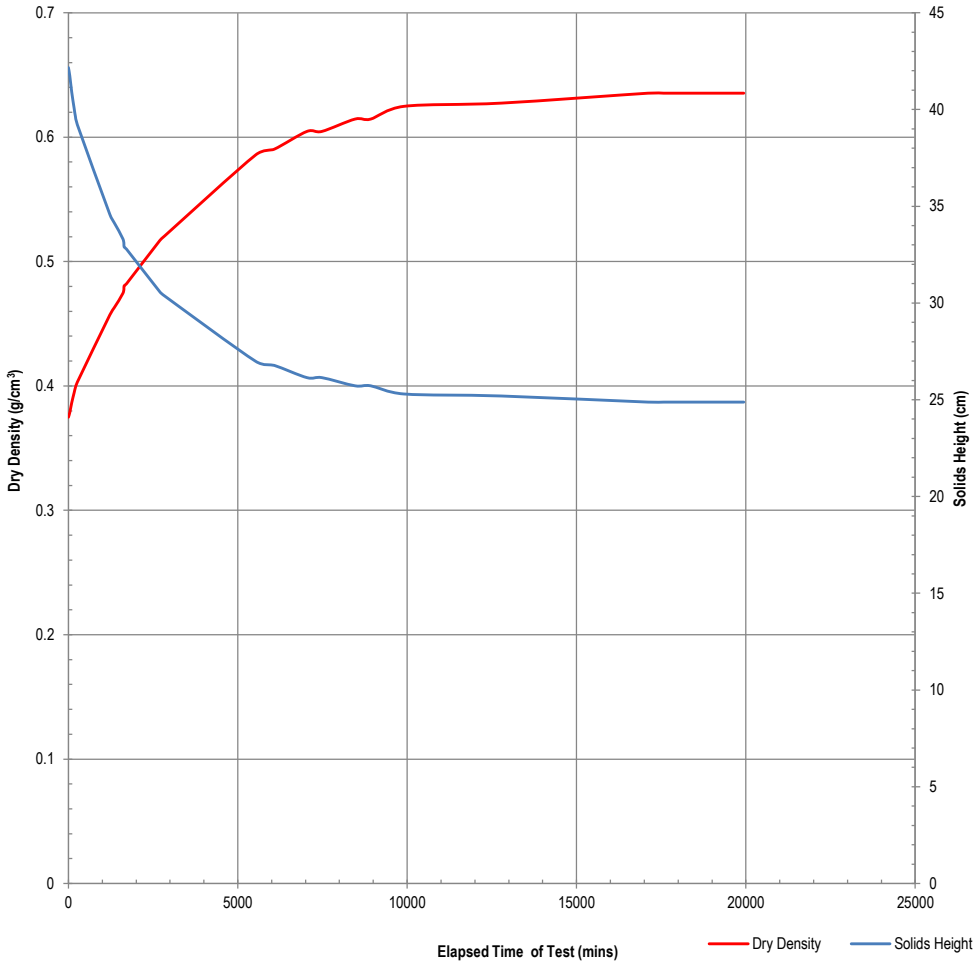
SETTLING TEST REPORT

Settling Test Procedure - as Supplied by Client

Client	Centrex Metals Ltd	**Report No.**	18030598-SETL
		Workorder No.	0003961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date**	21/03/2018
		Report Date	13/04/2018
Project	Ardmore Phosphate Project - Tailings Test Work		
Client ID	Master Composite Bulk Tailings	**Depth (m)**	Not Supplied
Description	CLAY- pale brown	**Sample Type**	Tailings mixed to a target of 30% solids, as requested by the client.

RESULTS OF TESTING

Initial Mass of Slurry (g):	2475.2	**Volume of water in Cylinder (ml)**		2000.0
Settling Test Type:	Undrained	**Mass of dry waste material (g)**		749.7



Elapsed Time (min)	Solids Height (cm)	Dry Density (g/cm^3)
0	42.17	0.375
40	41.74	0.379
97	40.90	0.386
169	40.06	0.395
207	39.64	0.399
263	39.21	0.403
1223	34.58	0.457
1350	34.15	0.463
1609	33.31	0.474
1646	32.89	0.481
1715	32.78	0.482
2702	30.57	0.517
2842	30.36	0.521
5528	26.99	0.586
6078	26.78	0.590
7043	26.14	0.605
7483	26.14	0.605
8460	25.72	0.615
8923	25.72	0.615
9900	25.30	0.625
12785	25.19	0.627
17112	24.88	0.635
17571	24.88	0.635
18509	24.88	0.635
19017	24.88	0.635
19937	24.88	0.635

Remarks:

Sample/s supplied by client

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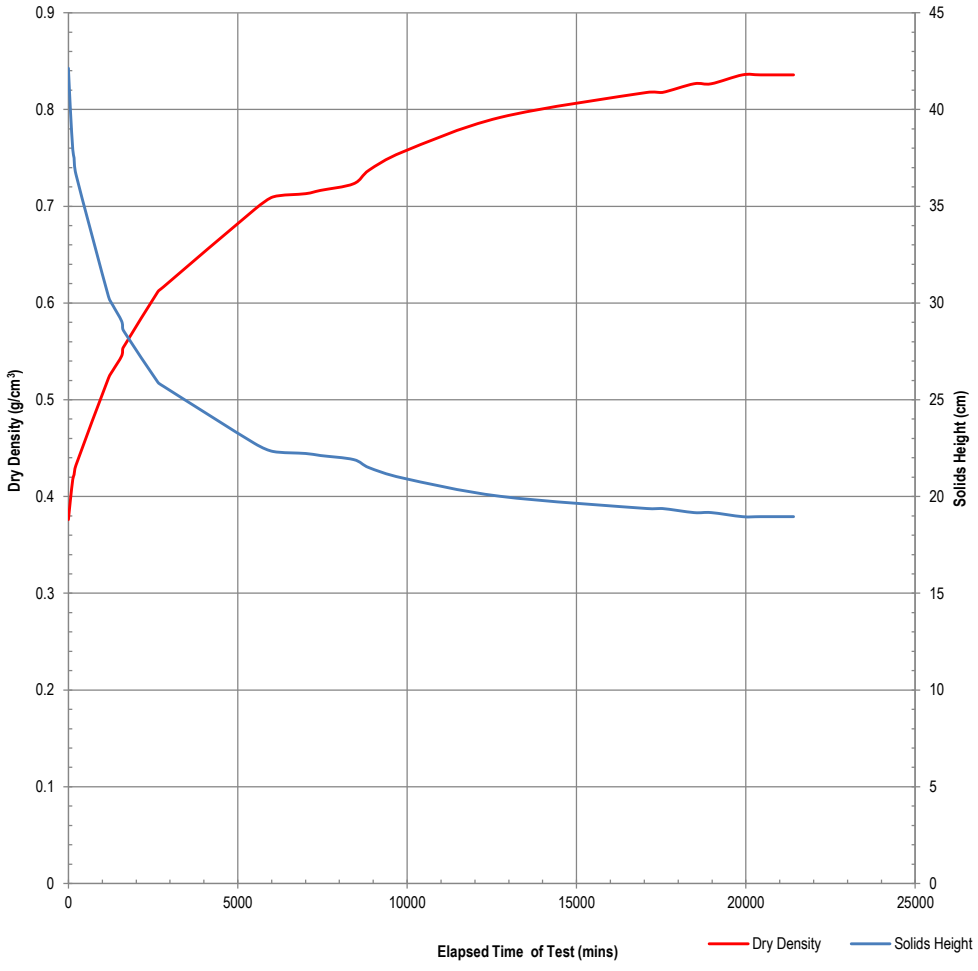
SETTLING TEST REPORT

Settling Test Procedure - as Supplied by Client

Client	Centrex Metals Ltd	**Report No.**	18030598-SETL
		Workorder No.	0003961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date**	21/03/2018
		Report Date	16/04/2018
Project	Ardmore Phosphate Project - Tailings Test Work		
Client ID	Master Composite Bulk Tailings	**Depth (m)**	Not Supplied
Description	CLAY- pale brown	**Sample Type**	Tailings mixed to a target of 30% solids, as requested by the client.

RESULTS OF TESTING

Initial Mass of Slurry (g):	2524.84	**Volume of water in Cylinder (ml)**		2000.0
Settling Test Type:	Drained	**Mass of dry waste material (g)**		752.2



Elapsed Time (min)	Solids Height (cm)	Dry Density (g/cm³)
0	42.13	0.376
57	40.02	0.396
129	37.92	0.418
167	37.49	0.423
222	36.65	0.432
1183	30.33	0.522
1301	29.91	0.530
1569	29.07	0.545
1606	28.65	0.553
1675	28.44	0.557
2638	25.91	0.612
2802	25.70	0.617
5488	22.75	0.696
6038	22.33	0.710
7003	22.22	0.713
7443	22.12	0.716
8420	21.91	0.723
8881	21.49	0.737
9859	20.96	0.756
12745	20.01	0.792
17072	19.38	0.818
17531	19.38	0.818
18469	19.17	0.827
18977	19.17	0.827
19897	18.96	0.836
20434	18.96	0.836
21407	18.96	0.836

Remarks:

Sample/s supplied by client

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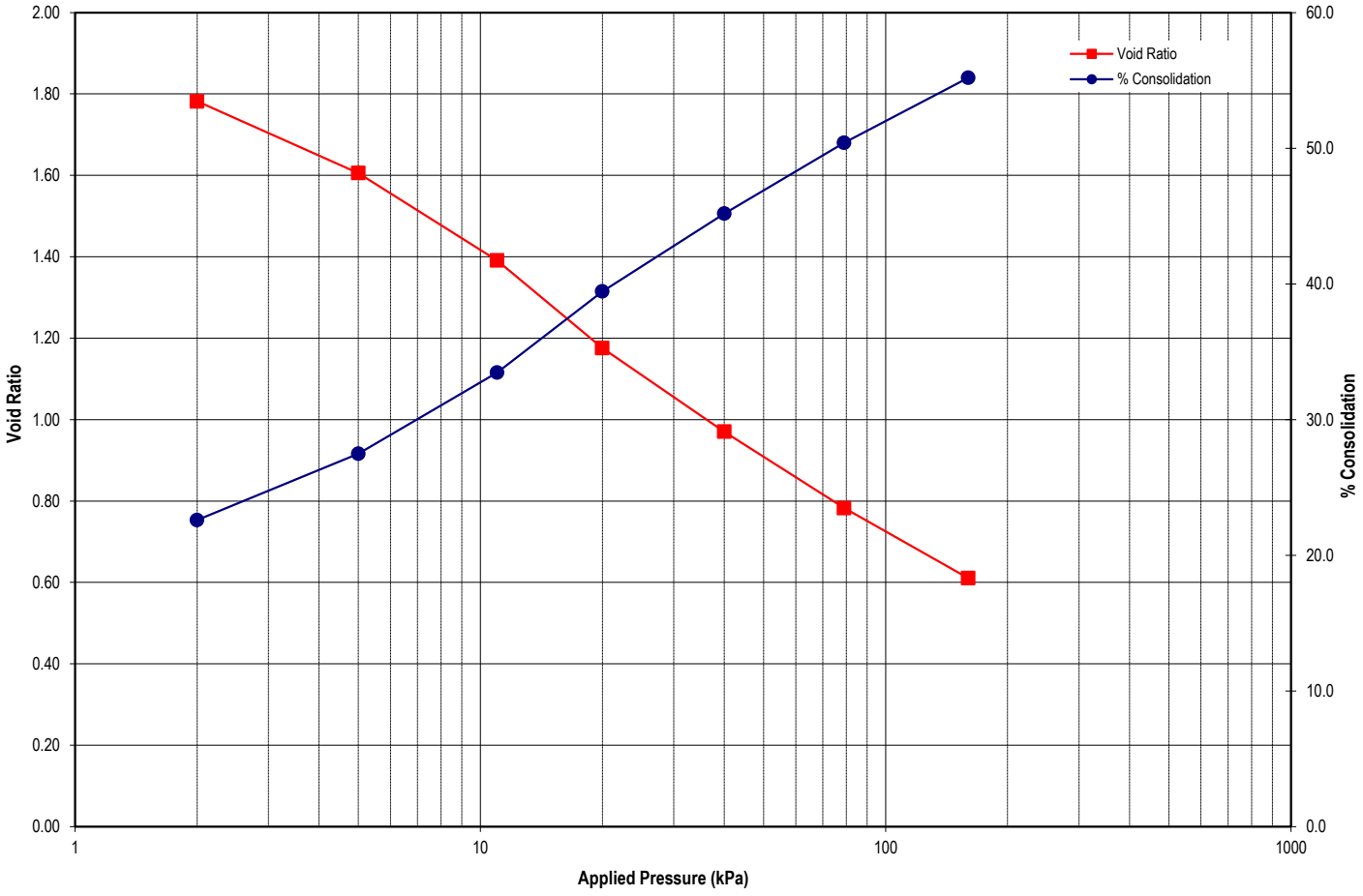
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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Centrex Metals Ltd	**Report No.:**	18030598-OED
		Workorder No.	3961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date:**	27/03/2018
		Report Date:	24/04/2018
Project:	Ardmore Phosphate Project - Tailings Test Work		
Client Id.:	Master Composite Bulk Tailings	**Depth (m):**	Not Supplied
Description:	CLAY- pale brown		



Wet Density (t/m^3):	2.42	Initial Moisture (%):	209.1	Test Condition: Inundated on load	
Particle Density (t/m^3):	2.81	Initial Voids Ratio:	2.594	Initial Degree of Saturation (%):	100.0
Slurry sample supplied by the client		Remarks:	Mixed to a target of 30% Solids		Page 1 of 2

REP03102

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Centrex Metals Ltd	**Report No.:**	18030598-OED
		Workorder No.	3961
Address	Level 6, 44 Waymouth Street Adelaide SA 5000	**Test Date:**	27/03/2018
		Report Date:	24/04/2018
Project:	Ardmore Phosphate Project - Tailings Test Work		
Client Id.:	Master Composite Bulk Tailings	**Depth (m):**	Not Supplied
Description:	CLAY- pale brown		

TEST RESULTS

Stage	Load (kPa)	Cc	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	0-2	-	-	-	-	-	22.6
2	2-5	0.442	2.03	1.91	21.095	20.67	27.5
3	5-11	0.627	2.06	2.23	13.742	15.15	33.5
4	11-20	0.828	2.51	3.16	9.994	5.76	39.5
5	20-40	0.683	2.75	3.13	4.726	13.98	45.2
6	40-79	0.634	2.75	3.07	2.440	8.61	50.4
7	79-160	0.562	2.81	2.77	1.193	7.02	55.2

Remarks: Mixed to a target of 30% Solids

REP03102

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TECHNICAL REPORT

Geochemical investigation of overburden, footwall units, ore and tailings

Ardmore Phosphate Mine

Prepared for: **Centrex Metals**

RGS

LEADERS IN MINING GEOCHEMISTRY

TECHNICAL REPORT

Geochemical investigation of overburden, footwall units, ore and tailings

Ardmore Phosphate Mine

Prepared for: **Centrex Metals**

DOCUMENT CONTROL	
Report Title	**Geochemical investigation of overburden, footwall units, ore and tailings**
Project Name	**Centrex Ardmore Phosphate Project**
Report Number	**2018002_RevB**

DOCUMENT DISTRIBUTION			
Document File Name	**Document Status**	**Distributed to**	**Date distributed**
Geochemical investigation of overburden, footwall units, ore and tailings _2018002_RevA	**RevA for discussion**	**Golder Associates**	**11-05-2018**
Geochemical investigation of overburden, footwall units, ore and tailings _2018002_Rev0	**Rev0 Final Report**	**Golder Associates**	**14-05-2018**
Geochemical investigation of overburden, footwall units, ore and tailings _2018002_Rev1	**Rev1 Final Report**	**Golder Associates**	**18-05-2018**

Limitations

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Executive summary

The purpose of the geochemical investigation was to evaluate the potential of the material that will be mined and processed, or utilised for progressive rehabilitation to produce acid, neutral or alkaline drainage with associated saline or metalliferous drainage potential.

Fresh samples of overburden (n=36) and footwall (n=5) samples were collected from drill core and reverse circulation chips drilled from August 2017. Representative samples, ore (n=1) and tailings (n=1) from bulk metallurgical were also provided by Centrex.

The overburden samples were found to be acid consuming (AC (n=6)), non-acid forming – barren (NAF-Barren (n=20) or non-acid forming (NAF (n=10)). The footwall samples were found to be non-acid forming – barren (NAF-Barren (n=1), potentially non-acid forming (PAF (n=3)) or acid forming (AF (n=1). The ore and tailings samples were both NAF.

Based on the total elemental concentrations and soluble leachate analyses the potential for acid and metalliferous is considered to be low. However, the overburden does have elevated salinity. The ore may also be processed using a combination of fresh water and saline groundwater with a total dissolved solids concentration of 17,000 mg/L. Because of this the tailings produced at the site are likely to have a higher salinity than the samples analysed in this study.

The development and implementation of a sampling and static and kinetic analytical program should be developed as part of a site management plan to enable the geochemical properties of the overburden, ore, tailings and footwall samples to be tracked over subsequent stages of the project to verify the findings of this study.

When there is sufficient kinetic leach cell data the outputs from these tests can be used as geochemical source terms with the site water balance model to evaluate if water quality objectives for the project will be met to minimise the potential for environmental harm.

Contents

1 Introduction 1
1.1 Purpose of the investigation 1
2 Geology 2
2.1 Regional geology 2
2.2 Local geology 2
3 Geochemical assessment 5
3.1 Maximum potential acidity 5
3.2 Actual acidity 5
3.3 Potential acidity 5
3.4 Total acid neutralising capacity 6
3.5 Reactive acid neutralising capacity 6
3.6 Net acid producing potential and neutralisation potential ratio 7
3.7 Net acid generation 7
3.8 Metalliferous drainage potential 7
3.9 Saline drainage potential 8
3.10 AMD classification 8
4 Sampling and analytical program 10
5 Interpretation 14
5.1 Ore and tailings samples 14
5.1.1 Net acid producing potential 14
5.1.2 Saline drainage potential 14
5.1.3 Metalliferous drainage potential 15
5.2 Organic geochemistry 17
5.3 Radioactivity 17
5.4 Overburden and footwall samples 17
5.4.1 Net acid producing potential 17
5.4.2 Saline drainage potential 20
5.4.3 Metalliferous drainage potential 20
6 Conclusion and recommendations 23
7 References 25

Figures

Figure 2-1: Mining lease area and geology of Ardmore Phosphate Mine 3
Figure 2-2: Ardmore local geology 4
Figure 4-1: Sampled drill hole locations 12
Figure 5-1: Drill hole samples ANC vs MPA plot 19
Figure 5-2: A comparison of total sulfur vs. chromium reducible sulfur in the drill hole samples 19

Tables

Table 3-1: Relative Mineral Reactivity 6
Table 3-2 Geochemical Abundance Index (GAI) values and Enrichment Factor 7
Table 4-1: Drill hole samples 10
Table 4-2: Analytical Program 13
Table 5-1: Static geochemical properties of the Ardmore tailings samples 14
Table 5-2: Soluble and exchangeable saline properties of the Ardmore tailings samples 15
Table 5-3: Total major cation and phosphorous concentrations in tailings samples 15
Table 5-3: Geochemical Abundance Index of metals and metalloids in the ore and tailings samples 16
Table 5-5: Drill hole samples potential acid mine drainage classification 18
Table 5-6: Drill hole sample acid/base accounting and potential acid formation classification 21
Table 5-7: Geochemical abundance index of total metals and metalloids 22

Glossary of terms and acronyms

AC	Acid consuming mine waste that has the potential to consume substantial acidity.
AF	Acid forming mine waste typified as having an existing pH < 5.
bgl	Below ground level.
Acid Base Account	Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity. See also "NMD".
ANC	Acid Neutralising Capacity, expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC: MPA Ratio	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
CRS	Chromium reducible sulfur. Analytical procedure to determine the sulfide sulfur concentration in a sample.
EA	Environmental authority.
EC	Electrical Conductivity, expressed as µS/cm.
eCEC	Effective cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample.
eH	A measure of the redox (oxidation-reduction) state of a solute. eH is a measurement of electrical potential and thus commonly expressed in volts.
DES	Department of Environment and Science (Queensland).
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
LoM	Life of Mine.
IOR	Intrinsic oxidation rate.
Kinetic Test	Procedure used to measure the geochemical/weathering behaviour of a sample of mine material over time.
KLC	Kinetic leach column.
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material over time.
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (CRS) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.

NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.
NMD	Neutral and metalliferous drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate and metals.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
pH	A measure of hydrogen ion (H^+) concentration; generally expressed as pH.
pH_{Ox}	Hydrogen ion concentration of the oxidised NAG solution.
ROM	Run-of-Mine. Ore as it comes from the mine prior to screening or processing.
S	Sulfur.
SS	Sulfide sulfur.
S_{PYR}	Sulfur as Pyrite.
S_{SO4}	Sulfur as Sulfate.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
Tailings	Fine-grained mineral waste materials produced from the processing of coal or ore.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
TDS	Total dissolved solids is a measurement of the dissolved solids (major ions or salts) concentration in a water sample.
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.

1 Introduction

RGS Environmental Pty Ltd (RGS) was engaged by Golder Associates Pty Ltd (Golder) to undertake a geochemical assessment of overburden, tailings and ore associated with the Ardmore Phosphate Project.

The Ardmore deposit was discovered in the 1960s with comprehensive exploration conducted through the 1970s. The deposit was acquired by Centrex Metals Ltd (Centrex) from Southern Cross Fertilisers Pty Ltd, a subsidiary of Incitec Pivot Limited in 2017. The Ardmore Phosphate Project (Ardmore) is a high-grade phosphate rock deposit located 128 km south of the City of Mount Isa and 25 km west of Dajarra. It is understood that the deposit outcrops and is very shallow with the target phosphorate unit hanging wall and footwall average contact depths being 8.3 m and 12.0 m respectively. It is proposed that the phosphate ore will be mined from a shallow 25 m deep pit and will have a waste:ore stripping ratio of 3:1. The life of mine is approximately 10 years.

Ardmore's deposits are covered by Mining Lease ML5542, held by Centrex. As part of the Feasibility Study, reverse circulation and diamond drilling was undertaken. Samples from 10 diamond drill and 4 reverse circulation holes were submitted to ALS Environmental Pty Ltd (ALS) for testing. The results of this analysis are presented and discussed in this report.

1.1 Purpose of the investigation

The purpose of the geochemical investigation discussed in this report was to evaluate the potential of the material that will be mined and processed, or utilised for progressive rehabilitation to produce:

- acid, neutral or alkaline drainage;
- saline drainage; and,
- metalliferous drainage.

The data from this work will lead to mined material from the soil to the footwall units being classified into deleterious and beneficial material classes. The geochemical data can be combined with the geological model and mine plan to produce a life of mine material balance and material placement schedule to ensure that all practicable measures are considered during development of the project to minimise the potential for environmental harm.

The approach to geochemical characterisation in this report is consistent with Australian and International guidelines (AMIRA, 2002 and COA, 2016, INAP, 2017) to confirm that the sampling and analytical process was appropriate, risk based and focused on obtaining representative samples of regolith units in the overburden above the ore, footwall units below the ore and representative samples of ore and tailings. RGS adopted a phased approach to geochemical characterisation, allowing for the baseline program to develop at a level and pace that complements the development of the Project.

The Stage 1 testing discussed in this report includes static geochemical characterisation of 43 samples to ensure appropriate spatial and compositional assessment of the deposit. Stage 2 would be commenced when the next stage of the project development is approved and is likely to require long-term kinetic leach tests conducted on a limited sample set to quantify sulfide oxidation rates and the rate that major, minor and trace elements may be released from the samples over time under the influence of chemical and physical weathering processes. Stage 2 testing may also include supplemental static test work on fresh rock samples to validate the results of Stage 1 testing.

The results of Stage 1 and Stage 2 are likely to be required to be incorporated into robust conceptual site models and then into numerical models to quantify potential site water quality during mining and through the progressive phase of site rehabilitation through to site closure and relinquishment.

2 Geology

2.1 Regional geology

The Georgina Basin, which stretches across Queensland and the Northern Territory is host to Australia's significant phosphate rock deposits. The basin is a northwest-southeast trending extensional basin which covers an area of 325,000 km^2 across the Northern Territory and western Queensland. Middle Cambrian marine sediments (505 - 515 million years ago) around the edge of the basin are the host to sedimentary phosphorite deposits such as Ardmore (Centrex Metals Limited, 2018).

The Ardmore deposit is located approximately 120 km SSW of Mt Isa within the Ardmore Outlier. It is block bounded to the east by the large regional north-south orientated Rufus fault zone. A lessor fault bounds the deposit to the west (**Figure 2-1**).

2.2 Local geology

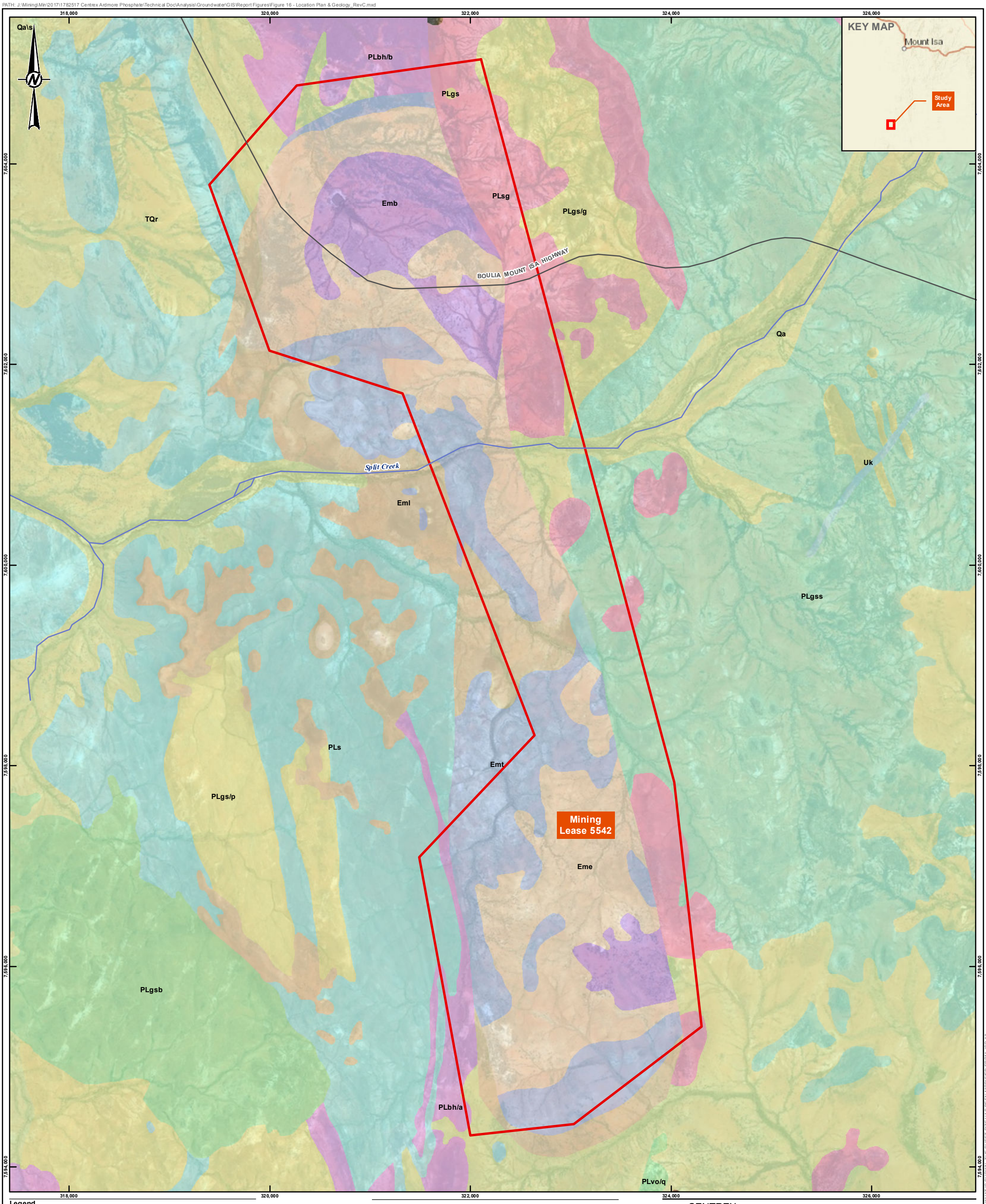
The geological setting of the project area is a well-defined stratigraphic sequence that includes a Pre-Cambrian Footwall. The Eastern Creek Volcanics and the Sybella Granite form a basement of crystalline Pre-Cambrian rocks around the Ardmore Outlier. The stratigraphy from youngest to oldest is as follows (Golder Associates, 2017):

- Alluvium (Quaternary): clay, silt, sand gravel; flood-plain alluvium
- Blazan Shale (middle Cambrian): siliceous shale, chert, siltstone, fine arenite, conglomerate, dolomitic and bituminous limestone, phosphorate
- Beetle Creek Formation (middle Cambrian): chert, siliceous shale with trilobite fossils, basal conglomerate
- Thorntonia Limestone (middle Cambrian): Grey crystalline limestone
- Riversdale Formation (early Cambrian): Conglomerate, arenite sandstone, arkose sandstone, shale, mudstone, dolomite
- Sulieman Gneiss (Palaeo Proterozoic): Felsic gneiss, augen gneiss, hornblende schist, amphibolite, quartzite

Phosphate mineralisation is located within the Beetle Creek Formation, as succession of cherts, phosphatic siltstones, phosphate rock and minor shales that outcrops in some areas within the project area (**Figure 2-1**). Within the Beetle Creek Formation, the upper Simpson Creek Phosphorite Member hosts high-grade mineralisation while the underlying Lower Siltsone or Chert Member sub-units have lower grade phosphatic siltstones and shales. The Thorntonia Limestone underlies the Beetle Creek Formation, while the Blazan Shale overlies it (Centrex Metals Limited, 2018).

The Simpson Creek Phosphorite Member is an average of 4.3 m thick across the project. The unit dips shallowly across most of the deposit, although the dip becomes steeper along the eastern bounding fault (Centrex Metals Limited, 2018).

PATH: J:\Mining\Min\2017\1782517 Centrex Ardmore Phosphate\Technical Doc\Analysis\Groundwater\GIS\Report Figures\Figure 16 - Location Plan & Geology_RevC.mxd



Legend

- Watercourse
- **Transport**
- Main Roads
- Mining Lease 5542
- **Surface Geology**
- Alluvium - Qa, Qa/s
- TQr-QLD - TQr
- Blazan Shale - Emb
- Beetle Creek Formation - Eme
- Thorntonia Limestone - Emt
- Riversdale Formation - Eml
- Sulieman Gneiss - PLsg
- Sybella Granite - PLgs/p
- Briar Granite - PLgsb
- Steeles Granite - PLgss
- Meta Volcanics - PLbh/a
- Oroopo Metabasalt - PLvo/q
- Saint Ronans Metamorphics - PLs
- Alpha Centauri Metamorphics - PLac
- Unknown Formation - Uk

0 1,000 2,000

SCALE: 1:35,000 @ A3 METRES
PROJECTION: GDA 1994 MGA Zone 54

REFERENCE(S)

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5. Main Roads: © State of Queensland (Department of Transport and Main Roads) 2017.

CLIENT CENTREX

PROJECT
ARDMORE PHOSPHATE ROCK PROJECT

TITLE
FIGURE 2-1: MINING LEASE AREA AND SURFACE GEOLOGY

CONSULTANT
Golder Associates

YYYY-MM-DD	14/11/2017
DESIGNED	SK
PREPARED	SK
REVIEWED	RM
APPROVED	RM

PROJECT NO.	CONTROL	REV.	FIGURE
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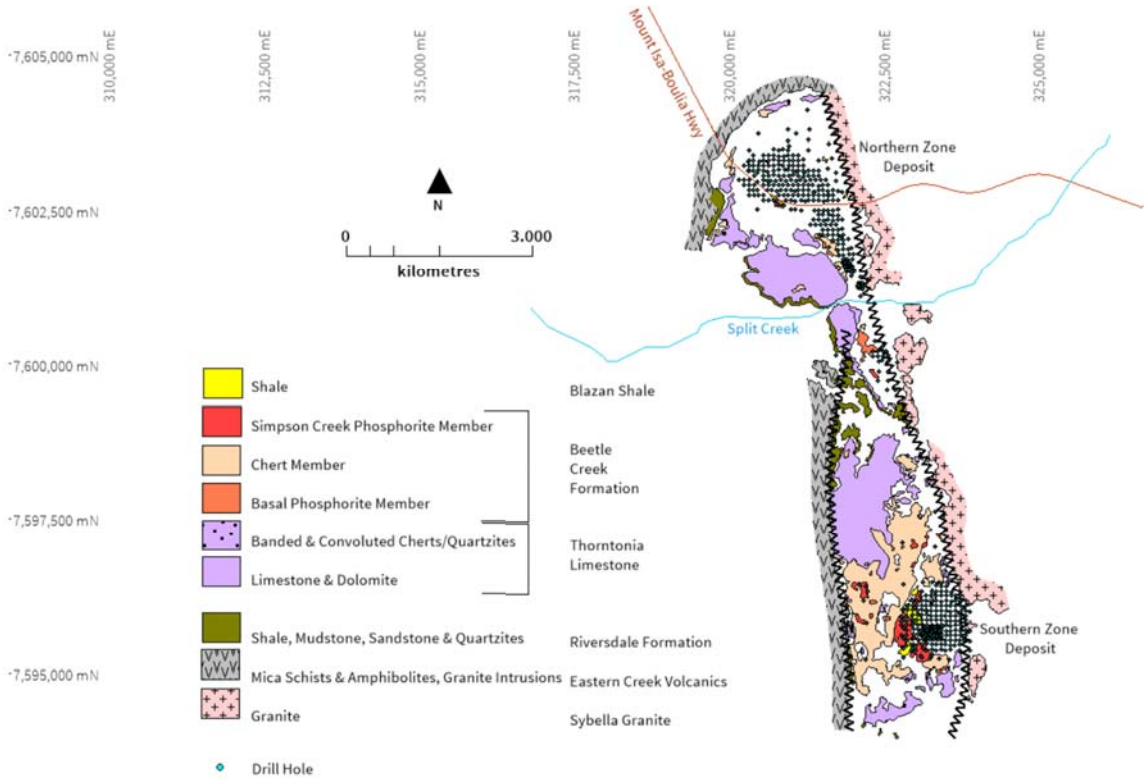


Figure 2-2: Ardmore local geology

3 Geochemical assessment

The most reliable method to characterise the acid producing potential of a sample would be to undertake a range of analyses that include total sulfur (TS), sulfide sulfur (SS) measured using the chromium reducible sulfur method (CRS), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), total acid neutralising capacity (ANC_T), reactive ANC using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertake pH, EC, TS and ANC_T on all samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an appropriate strategy for a project at this level.

3.1 Maximum potential acidity (MPA)

3.2 Actual acidity

Actual acidity can be divided into soluble acidity and retained acidity. Soluble acidity is defined here as acidity measured using a 1:5 (soil:water) extract whereas retained acidity is defined as the acidity that is not recorded in such an extraction . However, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water. Soluble acidity can be subdivided into active soluble acidity and buffered acidity. Active soluble acidity accounts for the activity of hydrogen ion (H^+) whereas buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+}, $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ion when they hydrolyse (Lin et al, 2002). Retained acidity can be sub-divided into (a) exchangeable acidity, (b) acidity carried by protonated variably charged particles, such as clays, and (c) acidity carried by basic sulfate minerals. These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, such as occur in liming or re-flooding with brackish tidal water. Exchangeable acidity is acidity that is retained through cation exchange reactions (Lin et al, 2002). Jarosite is the most common basic sulfate mineral in ASS. One mole of jarosite carries three moles of acidity that can be released by hydrolysis: $KFe_3(OH)_6(SO_4)_2 + 3OH^- \rightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$. Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g. $[Al(OH)]^{2+}\text{-}SO_4^{2-} + 2OH^- \rightarrow Al(OH)_3 + SO_4^{2-}$.

3.3 Potential acidity

TS is measured by combustion of the sample in a furnace at 1,350ºC in the presence of strong oxidants/catalysts. This method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate maximum potential acidity (MPA) is to assume that all sulfur in a sample is potentially reactive sulfide and therefore capable of generating acid. By convention in acid base accounting studies, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g. sulfate sulfur in gypsum and barite). As a result, the TS concentration may overestimate the acid generation potential of a sample which is expressed in kg H_2SO_4 / tonne.

Sulfur can be present within acid producing primary minerals such as Pyrite (FeS_2), Chalcopyrite ($CuFeS_2$) and Bornite (Cu_5FeS_4) and non-acid producing primary minerals such as Galena (PbS) and Sphalerite (ZnS). TS can also be also present as a large number of non-acid producing secondary minerals such as Alunite ($KAl_3(SO_4)2(OH)_6$), Gypsum ($CaSO_4 \bullet 2H_2O$) through to minerals such as Jarosite ($KFe^{3+}3(OH)_6(SO4)_2$) that can store and release acid and trace, minor and major elements.

To differentiate between total sulfur and sulfide sulfur the CRS method was used to measure the sulfide sulfur. The CRS method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the CRS test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic

sulfur it does not differentiate between acid producing (e.g. Pyrite) and non-acid producing (e.g. Sphalerite) minerals.

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum acid that could be generated by the sample by either directly determining the pyritic sulfur content or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction: $4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8H_2SO_4$.

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1% S as pyrite would be 30.6 kg H_2SO_4/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and, to a lesser extent, silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

3.4 Total acid neutralising capacity

The total acid neutralising capacity (ANC_T) can be measured by the peroxide siderite correction for the Sobek method that utilises digestion of a pulp sample with 0.5 M HCl, boiling and addition of 5mL of 30% H_2O_2. The sample is then back titrated with NaOH to measure the amount of acid consumed by reaction with the sample and provides the ANC_T in kg H_2SO_4/t. Acid neutralising capacity is expressed in kg H_2SO_4/t of material representing the capacity of the solids to neutralise acid but not necessarily implying that calcite ($CaCO_3$) is present. This is the method used for this work.

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates. Secondary neutralising minerals accounted for in the measurement of total acid neutralising capacity include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be small under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese do not report to the ANC measurement. The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 3-1**.

Table 3-1: Relative Mineral Reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite,	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm)

3.5 Reactive acid neutralising capacity

The reactive (available) ANC is determined using the ABCC (AMIRA, 2002) method that was derived from the British Columbia Research Incorporated Initial Neutralisation Potential method (Duncan and Bruynesteyn, 1979). The measurements of reactive (available) acid neutralising capacity ($ABCC_{ANC}$) involves slow titration of a sample with the addition of hydrochloric or sulfuric acid over set time intervals

while continuously measuring the pH. The method is used to estimate the ANC of the material and the buffering capacity available at a pre-determined pH value. When acid is added to finely ground particles or aggregates the material will react with the acid neutralising components and reduce the pH of the solution. The amount of acid required to reach each pH interval is dependent on the amount of neutralisation present. 'Buffering' occurs where a significant amount of acid is added before the pH drops, thereby producing a 'step-like' curve in a plot of pH versus volume of acid added. RGS has not included reactive ANC testing in this assessment.

3.6 Net acid producing potential and neutralisation potential ratio

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from acid base accounting (ABA) procedures (DITR, 2007). The NAPP value is derived as the difference between the maximum potential acidity (MPA) and total acid neutralising capacity (ANC_T) of a sample.

The ANC_T/MPA ratio (or Neutralising Potential Ratio (NPR)) is also used as a means of assessing the risk of acid generation from mine waste materials. The purpose of the ANC_T/MPA ratio is to provide an indication of the relative margin of safety within a material. As a general rule, an ANC_T/MPA ratio of 2 or more signifies that there is a high probability that the material will remain circum-neutral in pH (AMIRA, 2002; INAP, 2009).

3.7 Net acid generation

The single addition NAG test involves a single addition of 250 ml of 15% H_2O_2 to a 2.5 g of pulverised (less than 75 µm) sample. The sample is then allowed to react overnight. The entire sample is heated until gently bubbling for approximately 1-2 h to remove excess H_2O_2 and encourage release of inherent neutralising capacity. Once the sample has cooled to room temperature, the pH and titrated acidity to pH 4.5 and 7.0 (in kg H_2SO_4/t of sample) of the solution are measured. A NAG_{pHOx} less than 4.5 generally indicates the sample is acid producing.

A NAG_{pHOx} value can be used in combination with NAPP values to classify the geochemical nature of samples. The Australian Government Leading Practice Handbook on Acid and Metalliferous Drainage COA, 2016 now states that, "the risks of misclassifying Non-Acid Forming (NAF) material as Potentially Acid Forming (PAF) and PAF material as NAF, are substantially reduced by conducting both NAPP and NAG tests."

The NAG method is also known to have a number of limitations that should be considered in the interpretation of data (MEND, 2009). RGS has not included NAG testing in this assessment.

3.8 Metalliferous drainage potential

The potential of a geological material to leach trace, minor or major elements (salts, metals and metalloids) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed. The static methods used in this assessment have measured the "total" and "water soluble" fractions of these elements.

The geochemical abundance index (GAI) quantifies a "total" assay result for a particular element in terms of the average crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times average crustal abundance, as shown in **Table 3-2**.

Table 3-2 Geochemical Abundance Index (GAI) values and Enrichment Factor

GAI	Enrichment factor	GAI	Enrichment factor
0	Less than 3-fold enrichment	4	24 – 48 fold enrichment
1	3 – 6 fold enrichment	5	48 – 96 fold enrichment
2	6 – 12 fold enrichment	6	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 2009). This is the case with some environmentally important 'trace' elements, such as As, Cd, Cu and Zn, rather than with major rock-forming elements, such as Ca, Mg, K and Na. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g. low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

A 1:3 (solid:solute) leach can be used to measure the pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts. It should be recognised that direct comparison of geochemical data from 1:3 water extracts with guideline values can be misleading.

RGS has a preference to evaluate the solubility of metals and major ions from mine waste and tailings using kinetic leach cell testing that provides the rate of weathering and associated concentration of elements in the leachate.

3.9 Saline drainage potential

Saline drainage is of concern to regulators in Queensland and other states and territories. Saline drainage can come from the release of major cations and anions from geological units due to weathering of the host rock, or from the accumulation of elements over time e.g. accumulation of NaCl in soil from rain.

Saline drainage can also be attributed to sulfide oxidation process that release sulfate and or the weathering of sulfate minerals such as gypsum. Sulfate and other major ions such as NaCl can be present under both acid and neutral pH conditions.

3.10 AMD classification

Terms used to **classify mined materials** can include the following.

- **AF** (Acid Forming) – sample is producing acidity (< pH 5), contains no ANC and has additional sulfide content that will oxidise and produce additional acid
- **PAF** (Potentially Acid Forming) – has a pH > 5 and has the potential to produce acid when all ANC is consumed
- **PAF-LC** (Low Capacity – Potentially Acid Forming) - has the potential to produce minor acidity
- **NAF-Barren** (Non-Acid Forming - Barren) - is geochemically inert in respect to total sulfur and will produce circum-neutral drainage in the range of 7 to 9 with low sulfate concentrations
- **NAF** (Non-Acid Forming) - will not produce acid but may leach salts and some metals/metalloids due to the presence of low sulfide bearing material
- **AC** (Acid Consuming) - has some ANC that will contribute to ongoing acid neutralisation e.g. calcite

Other terminology used to classify geological materials include the following.

- Saline - material may leach salts dominated by NaCl and or sulfate
- Sodic – this material has a proportionally high concentration of exchangeable Na and has the potential to disperse and tunnel

General industry terms that can be used to **describe water quality** at mines include the following.

- Acid Mine Drainage
- Acid Rock Drainage
- Acid and Metalliferous Drainage
- Neutral Drainage
- Saline Drainage
- Mine Impacted Water

In this report we use the term mine impacted water (MIW) as a general term to describe water that comes into contact with disturbed ground. Mine impacted water (MIW) can be classified as having:

- acid, neutral or alkaline pH
- variable concentrations of major ions (salts e.g. calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride, or in the instance of this project - phosphate)
- variable concentrations of metals (e.g. Al, Fe, Mn and Zn) or metalloids (e.g. Be, Mo, Se and V) with the concentrations often linked to pH.

Potential sources of acid in MIW at mine sites can include:

- oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009)
- oxidation of coal that can produce humic acid like materials and organic acid
- rainfall and leaching of cations such as Ca, Mg, K and Na that reduce soil acidification by atmospheric carbonic, nitric or sulfuric acid
- organic matter decay
- use of ammonium-based nitrogen fertilisers.

Potential sources of salts in MIW at mine sites can include:

- oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium (Ca^{2+})
- chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}) and chloride (Cl^-)
- the mobilisation of sodium chloride (NaCl) or sodium bi-carbonate ($NaHCO_3$) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms

Potential sources of metals (e.g. Al, Fe, Mn and Zn) and oxyanions (e.g. Mo, Se and V) in water at mine sites that can include elements present:

- as ancillary minerals within primary sulfide minerals like pyrite or marcasite that weather very slowly;
- in the solid phase of geological units in a range of minerals with increasing environmental mobility that include immobile oxide <<< carbonate << exchangeable < water soluble.
- in pore water.

4 Sampling and analytical program

Representative samples of ore and tailings samples were provided by Centrex. In addition, RGS reviewed the geological database and identified 41 samples of overburden from 10 diamond drill cores and 4 samples of footwall material from reverse circulation drill holes that were drilled in 2017. The diamond drill hole locations are shown in **Figure 4-1** and drill holes sampled and sampled intervals are detailed in **Table 4-1**. The analytical program was designed to identify the potential for acidic, saline, and metalliferous drainage (herein referred to as AMD) from the overburden and footwall material below the ore deposit (**Table 4-2**).

Table 4-1: Drill hole samples

Client ID	Area Hole ID	GDA94z54 X Coordinate	GDA94z54 Y Coordinate	Depth From	Depth To	Area Hole Interval	Lithology
RDS001	AMDD023	321684	7602514	1	1.9	Northern	CL
RGS002	AMDD023	321684	7602514	2	2.6	Northern	SH
				2.6	2.95	Northern	SH
				2.95	3.35	Northern	SH
				3.35	4.15	Northern	SH
RGS003	AMDD023	321684	7602514	4.15	4.7	Northern	ST
				4.7	4.75	Northern	CH
				4.75	5.1	Northern	SH
				5.1	5.2	Northern	SH
RGS004	AMDD024	320922	7603153	0.9	1.1	Northern	SH
				1.1	1.9	Northern	SH
				1.9	3	Northern	SH
RGS005	AMDD024	320922	7603153	3	3.1	Northern	EV
				3.1	5.05	Northern	SH
RGS006	AMDD024	320922	7603153	7.9	10.85	Northern	SH
RGS007	AMDD024	320922	7603153	14	14.35	Northern	CH
				14.35	14.45	Northern	ST
				14.45	14.75	Northern	ST
				14.75	14.85	Northern	MS
RGS008	AMDD026	322064	7601844	1.8	4.1	Northern	SH
RGS009	AMDD026	322064	7601844	4.2	5	Northern	SH
				5	5.4	Northern	SH
				5.4	5.9	Northern	SH
RGS010	AMDD026	322064	7601844	6.5	7.25	Northern	SH
				7.25	7.3	Northern	CH
				7.3	7.4	Northern	SH
				7.4	7.5	Northern	FC
				7.5	7.65	Northern	SH
RGS011	AMDD026	322064	7601844	12.5	12.6	Northern	CH
				12.6	12.7	Northern	FP
				12.7	13.1	Northern	CH
				13.1	13.2	Northern	CH
				13.2	13.5	Northern	FP
				13.5	14.9	Northern	ST
RGS012	AMDD005	322064	7601844	1.65	1.9	Southern	SH
				1.9	2.7	Southern	SH
RGS013	AMDD005	323431	7595556	8.04	8.06	Southern	CH
				8.06	8.2	Southern	ST
				8.2	8.35	Southern	IP
				8.35	8.65	Southern	ST
				8.65	8.75	Southern	CH
RGS014	AMDD006	323733	7595704	1.4	2.7	Southern	SH
RGS015	AMDD006	323733	7595704	2.73	4.4	Southern	SH
RGS016	AMDD006	323733	7595704	4.4	8.6	Southern	SH
RGS017	AMDD006	323733	7595704	8.6	12.7	Southern	SH

Client ID	Area Hole ID	GDA94z54 X Coordinate	GDA94z54 Y Coordinate	Depth From	Depth To	Area Hole Interval	Lithology
RGS018	AMDD006	323733	7595704	17.53	17.55	Southern	CH
				17.55	17.7	Southern	FP
				17.7	17.72	Southern	CH
				17.72	17.88	Southern	FP
				17.88	17.9	Southern	CH
RGS019	AMDD006	323733	7595704	17.9	19.23	Southern	ST
RGS020	AMDD008	323131	7595728	1.5	3.1	Southern	SH
RGS021	AMDD008	323131	7595728	3.1	3.13	Southern	SH
				3.13	3.15	Southern	CH
				3.15	3.27	Southern	SH
				3.27	3.32	Southern	CH
				3.32	3.71	Southern	SH
RGS022	AMDD008	323131	7595728	7.9	9.1	Southern	ST
RGS023	AMDD010	323475	7595790	1	2.4	Southern	SU
RGS024	AMDD010	323475	7595790	2.4	3.2	Southern	CL
				3.2	3.8	Southern	SC
				3.8	4.94	Southern	SH
RGS025	AMDD010	323475	7595790	4.94	4.96	Southern	CH
				4.96	5.45	Southern	SH
				5.45	5.55	Southern	SH
RGS026	AMDD010	323475	7595790	9.9	10.05	Southern	SH
				10.05	10.1	Southern	CH
				10.1	10.3	Southern	SH
				10.3	10.9	Southern	ST
				10.9	12	Southern	CH
RGS027	AMDD017	323118	7596031	2	3.2	Southern	SH
RGS028	AMDD017	323118	7596031	9	9.02	Southern	CH
				9.02	10	Southern	ST
RGS029	AMDD018	323574	7596175	0.6	2	Southern	SH
RGS030	AMDD018	323574	7596175	2	3	Southern	SH
				3	3.4	Southern	SH
				3.4	3.65	Southern	SH
RGS031	AMDD018	323574	7596175	6.25	6.35	Southern	FP
				6.35	6.55	Southern	ST
				6.55	6.65	Southern	SH
				6.65	6.75	Southern	FP
				6.75	8.5	Southern	CH
RGS032	AMDD021	323742	7596321	1.7	2	Southern	SH
RGS033	AMDD021	323742	7596321	2	4.3	Southern	SH
RGS034	AMDD021	323742	7596321	4.3	5.9	Southern	SH
RGS035	AMDD021	323742	7596321	5.9	7.2	Southern	SH
RGSO36	AMDD021	323742	7596321	10.7	11	Southern	ST
				11	12.7	Southern	CH
				12.7	12.8	Southern	FP
RGS037	AMRC718	321761	7603238	51	52	Northern	ST
RGS038	AMRC728	321683	7603402	51	52	Northern	ST
RGS039	AMRC808	320756	7603619	21	22	Northern	SH
RGS040	AMRC815	321804	7603166	47	48	Northern	ST
RGS041	AMDD024	320922	7603153	17.35	18.35	Northern	ST

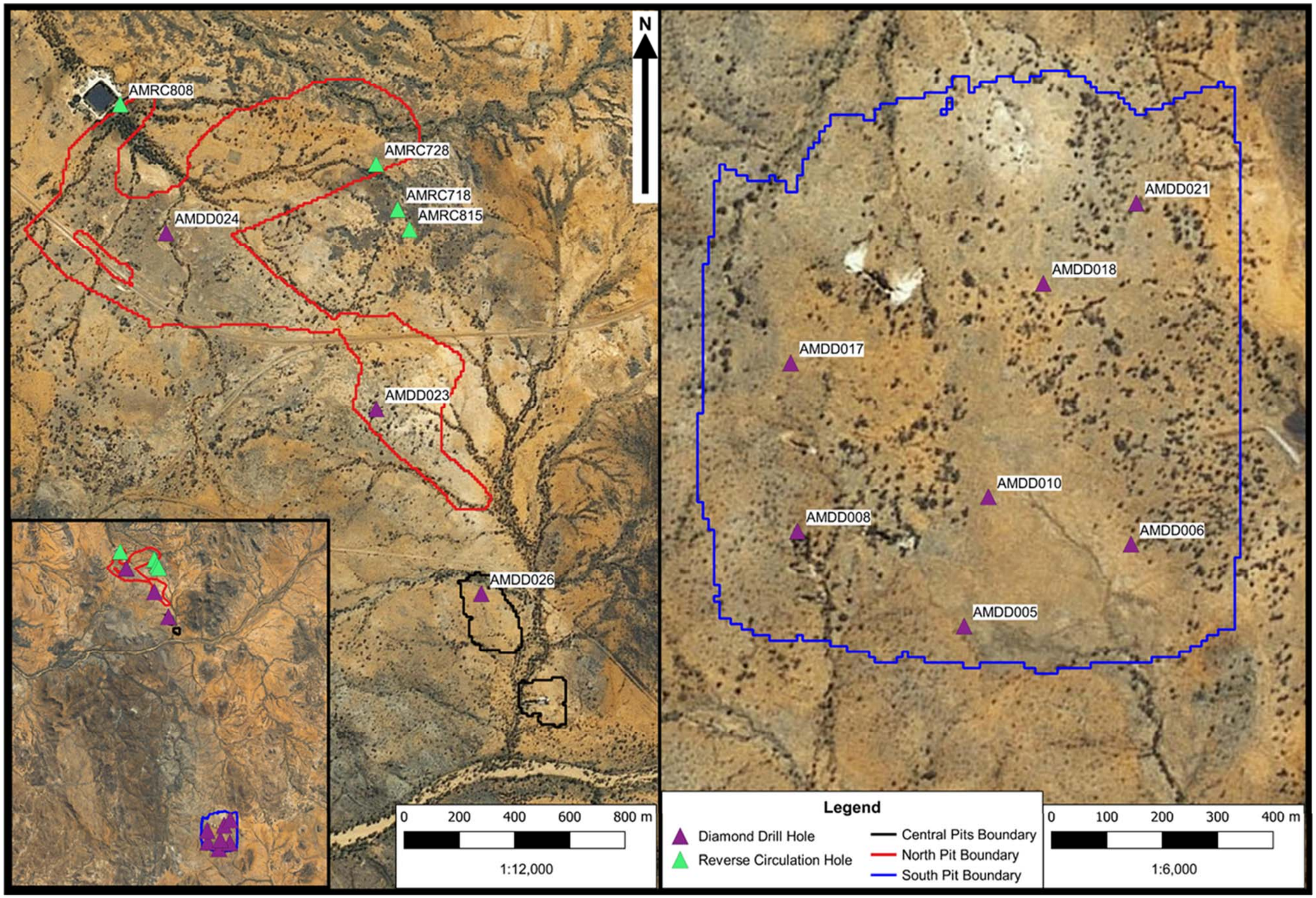


Figure 4-1: Sampled drill hole locations

Table 4-2: Analytical Program

Sample ID	Area Hole ID	Depth From	Depth To	Lithology	EA002: pH (Soils)	EA010: Conductivity (Soils)	EA009: Nett Acid Production Potential	EA013: Acid Neutralising Capacity	EA026: Chromium Reducible Sulfur	ED042T: Total Sulfur by LECO	MPA	NPR	ED006/ED008: Exchangeable Cations	EK067G: Total Phosphorus as P by Discrete Analyser	EK074: Fluoride Extractable Phosphorus (Bray)	EP003: Total Organic Carbon (TOC) in Soil	EP080/071: Total Petroleum Hydrocarbons	EP080/071: Total Recoverable Hydrocarbons -	EP080: Benzene, Toluene, Ethylbenzene, Xylene and Naphthalene	ME-MS41: Total Metals by ICP-MS
					pH Unit	µS/cm	kg H2SO4/t	kg H2SO4 equiv./t	%	%	kg H2SO4 equiv./t		meq/100g	mg/L	mg/kg	%	mg/kg	mg/kg	mg/kg	ppm
Balmore				Final Attrition Test work (Balmore)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tailings - 38µm fraction				Tailings - 38µm fraction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S012	AMDD005	1.65	2.7	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S013	AMDD005	8.04	8.75	CH	✓	✓	✓	✓		✓	✓	✓								
S014	AMDD006	1.4	2.7	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S015	AMDD006	2.73	4.4	SH	✓	✓	✓	✓		✓	✓	✓								
S016	AMDD006	4.4	8.6	SH	✓	✓	✓	✓		✓	✓	✓								
S017	AMDD006	8.6	12.7	SH	✓	✓	✓	✓		✓	✓	✓								
S018	AMDD006	17.53	17.9	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S019	AMDD006	17.9	19.23	ST	✓	✓	✓	✓		✓	✓	✓								
S020	AMDD008	1.5	3.1	SH	✓	✓	✓	✓		✓	✓	✓								
S021	AMDD008	3.1	3.71	SH	✓	✓	✓	✓		✓	✓	✓								
S022	AMDD008	7.9	9.1	ST	✓	✓	✓	✓		✓	✓	✓								
S023	AMDD010	1	2.4	SU	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S024	AMDD010	2.4	4.94	CL	✓	✓	✓	✓		✓	✓	✓								
S025	AMDD010	4.94	5.55	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S026	AMDD010	9.9	12	SH	✓	✓	✓	✓		✓	✓	✓								
S027	AMDD017	2	3.2	SH	✓	✓	✓	✓		✓	✓	✓								
S028	AMDD017	9	10	CH	✓	✓	✓	✓		✓	✓	✓								
S029	AMDD018	0.6	2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S030	AMDD018	2	3.65	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S031	AMDD018	6.25	8.5	FP	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S032	AMDD021	1.7	2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S033	AMDD021	2	4.3	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S034	AMDD021	4.3	5.9	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S035	AMDD021	5.9	7.2	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S036	AMDD021	10.7	12.8	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S001	AMDD023	1	1.9	CL	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S002	AMDD023	2	4.15	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S003	AMDD023	4.15	5.2	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S004	AMDD024	0.9	3	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S005	AMDD024	3	5.05	EV	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S006	AMDD024	7.9	10.85	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S007	AMDD024	14	14.85	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S041	AMDD024	17.35	18.35	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S008	AMDD026	1.8	4.1	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S009	AMDD026	4.2	5.9	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S010	AMDD026	6.5	7.65	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S011	AMDD026	12.5	14.9	CH	✓	✓	✓	✓	✓	✓	✓	✓	✓							
S037	AMRC718	51	52	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S038	AMRC728	51	52	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S039	AMRC808	21	22	SH	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓
S040	AMRC815	47	48	ST	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓

5 Interpretation

5.1 Ore and tailings samples

5.1.1 Net acid producing potential

The ore (Ardmore Ore) and tailings (Pilot plant test work) samples provided by Centrex have mildly alkaline pH measured using a 1:5 solid:water ratio 1 hour leach test. The percentage of the total sulfur (TS%) of 0.29% to 0.5% indicated there is some potential for the presence of sulfide minerals. Supplementary analysis undertaken using the chromium reducible sulfur (CRS) method verified that the actual sulfide concentration is < 0.02%. Based on these results the acid producing potential is therefore very low. Coupled with the presence of minor acid neutralising capacity (ANC) in the range of 36 to 66 kg H_2SO_4/t, the maximum potential acidity (MPA) of the samples using the CRS method was < 1 kg H_2SO_4/t.

The net acid producing potential (NAPP) and neutralisation potential ratio (NPR) of the samples using CRS was:

- -66 kg H_2SO_4/t (NAPP) with an NPR of 148 for the -38 µm geotechnical tailings sample; and,
- -36 kg H_2SO_4/t (NAPP) with an NPR of 63 for the Balmore ore sample.

This analysis verifies that both the ore tailings samples are non-acid forming (NAF) and therefore, there is negligible potential for the samples to produce acidic drainage (**Table 5-1)**.

Table 5-1: Static geochemical properties of the Ardmore tailings and ore samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
$pH_{1:5}$ (EA002)	pH Unit	8.1	7.9
TS	%	0.29	0.5
MPA_{TS}	kg H_2SO_4/t	8.87	15.29
CRS	%	0.015	0.019
MPA_{CRS}	kg H_2SO_4/t	0.45	0.58
ANC	kg H2SO4 equiv./t	66.9	36.8
$NAPP_{TS}$	kg H_2SO_4/t	-58.03	-21.51
NPR_{TS}		7.5	2.4
$NAPP_{CRS}$	kg H_2SO_4/t	-66.45	-36.22
NPR_{CRS}		148	63
Moisture Content	%	60.4	1.1

5.1.2 Saline drainage potential

The NAPP data coupled with (1) the EC measured using a 1:5 solid:water ratio 1 hour leach test (2) soluble major ion concentrations measured using a 1:3 solid:water 16 hour leach test and (3) the CEC of the samples suggests there is a low potential for saline drainage from the ore and tailings samples.

However, the exchangeable sodium percentage (ESP) of the Balmore sample verifies some potential for sodic conditions (slaking) to occur in this sample. The low saline drainage potential of the samples does not exclude the potential for saline drainage to become a management issue in an ore stockpile or tailings impoundment as the effects of evapoconcentration in the project environment will increase the salinity in surface water and seepage within the impoundments.

It is noted that the ore may be processed with saline groundwater, dam water or a combination of both for processing i.e. Centrex will not be processing only with non-saline (dam or reverse osmosis) water and will also be processing with saline water (17,000mg/L TDS) and rinsing with non-saline water (from site water dam or reverse osmosis plant). Either way, the TSF will end up holding a substantial salt load through water use.

Table 5-2: Soluble and exchangeable saline properties of the Ardmore ore and tailings samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
$EC_{1:5}$ (EA010)	µS/cm	167	1030
1:3 soluble Calcium	mg/L	14	71
1:3 soluble Magnesium	mg/L	6	24
1:3 soluble Sodium	mg/L	23	228
1:3 soluble Potassium	mg/L	2	3
1:3 soluble Chloride	mg/L	25	417
1:3 soluble Sulfate	mg/L	38	167
Exchangeable Calcium	meq/100g	6.4	2.3
Exchangeable Magnesium	meq/100g	2.9	0.8
Exchangeable Potassium	meq/100g	0.2	0.1
Exchangeable Sodium	meq/100g	0.4	0.8
Cation Exchange Capacity	meq/100g	10	3.8
Exchangeable Sodium Percent	%	4.5	20.5

The total concentration of major cations and phosphorous is in Error! Reference source not found.. The elevated concentration of the Ca and P in the tailings could present issues with these elements in seepage from stockpiles and impounded tailings.

Table 5-3: Total major cation and phosphorous concentrations in tailings samples

	Sample ID	Ardmore Phosphate Attrition (50Hx) **Tailings -38µm fraction** (Pilot plant test work)	Centrex Ardmore Phosphate Final Attrition Test work (**Ardmore Ore**)
	ALS 1st ID	EB1807385	EB1807385
Parameter	**ALS 2nd ID**	EB1807385001	EB1807385002
Sodium	mg/kg	1960	3210
Potassium	mg/kg	3540	1820
Calcium	mg/kg	198000	374000
Magnesium	mg/kg	3610	1630
Total Phosphorus as P	mg/kg	97100	111000
Fluoride Extractable P (Bray)	mg/kg	152	388

5.1.3 Metalliferous drainage potential

The geochemical abundance index (GAI) provides a comparison of total metal/metalloid concentrations compared to median soil values (Bowen, 1979). This can be useful in identifying samples with the potential to elevate metal/metalloid concentrations in the surrounding regolith. GAI values alone are not diagnostic but can be used to highlight metals/metalloids that require further investigation. The solubility of these elements over time is typically assessed using kinetic leach column tests. Total metal/metalloid analysis has been undertaken for the ore and tailings samples and the GAI values are presented in **Table 5-3**.

Nearly all metals and metalloids analysed were within median soil concentrations. While silver, beryllium and tellurium are elevated in comparison to soil concentrations in non-mineralised areas, they are still within the range of background concentrations found in soils. Elevated calcium is likely to be due to the presence of calcium orthophosphate ($Ca_3(PO4)_2$) and apatite ($Ca_5(PO_4)_3(F,Cl,OH)$).

Uranium was present in the ore and tailings samples at 99 and 93 mg/kg and is often elevated in association with phosphatic sediments in sedimentary rocks and may also be present as an accessory

element in detrital grains (Salminen, et al., 2005) possibly derived from the granites surrounding the outlier. Detrital minerals may contain yttrium (Salminen, et al., 2005) and the formation of xenotime (YPO_4) through diagenesis in phosphatic sediments has been observed (Vallini, Rasmussen, Krapež, Fletcher, & McNaughton, 2002).

Table 5-4: Geochemical Abundance Index of metals and metalloids in the ore and tailings samples

	EB1807385-001	EB1807385-002		EB1807385-001	EB1807385-002
Ag	3	3	Mo	3	2
Al	0	0	Na	0	0
As	3	2	Nb	0	0
Ba	0	0	Ni	0	0
Be	5	5	P	4	4
Bi	1	1	Pb	0	0
Ca	3	0	Rb	0	0
Cd	2	2	S	1	2
Ce	2	2	Sb	2	1
Co	1	1	Sc	2	1
Cr	0	0	Se	0	0
Cs	0	0	Sn	0	0
Cu	2	1	Sr	2	2
Fe	0	0	Ta	0	0
Ga	0	0	Te	5	3
Ge	0	0	Th	0	0
Hf	0	0	Ti	0	0
Hg	0	0	Tl	2	2
In	0	0	U	5	5
K	0	0	V	2	1
La	2	2	W	0	0
Li	0	0	Y	3	3
Mg	0	0	Zn	1	1
Mn	0	0	Zr	0	0

Values of 3 not highlighted are due to rounding.

Because of the GAI values and the fine-grained nature of the samples, the potential for metalliferous drainage was evaluated on these materials by subjecting the two samples to a 1:3 solid:water 16 hour leach test. The pH of the samples using this method was 7.7 and 7.46 and the EC was 263 and 1,650 µS/cm. The water-soluble analyses obtained minor concentrations of the metals/metalloids below:

- < 1.0 > 0.1 mg/L for B, Ba, Sr and Zn
- < 0.1 > 0.01 mg/L for Al, Mo and V
- < 0.01 > 0.001 mg/L for Cr, Li, Mn, Rb
- < 0.0001 mg/L for Cd

All other water soluble leachable elements were less than the laboratory limit of reporting (LoR): this included uranium. The low TS and CRS concentrations coupled with the NAPP and NPR values; and the soluble metal/metalloid concentrations measured on 48 major, minor, trace and rare earth elements using a 1:3 solid:water 16 hour leach test; verify there is a low potential for metalliferous drainage from the samples. However, as discussed above, this does not exclude the potential for metalliferous drainage issues to occur in a tailings impoundment due to evapoconcentration.

5.2 Organic geochemistry

The two tailings samples were analysed for total petroleum hydrocarbons, total recoverable hydrocarbons, BTEXN. All concentrations were less than the laboratory LoR. RGS included these analyses as they were requested by Centrex in the initial scope of work developed with Golder.

5.3 Radioactivity

Radioactive materials, like uranium and radium, are normal constituents of the earth's crust. The radioactivity of phosphate rock is enhanced by geological processes. Phosphate rocks of sedimentary origin contain Uranium (238), Thorium (232) and its decay products in addition to phosphate minerals.

Considerable variations are found in the chemical composition of rock phosphate from different mining areas (Roesseler, 1990 in Sahu *et al*., 2014). In general, sedimentary phosphate rocks, or phosphorites, that originated in a marine environment, are characterised by activity concentrations of uranium much higher than those of volcanic and biological rocks. These phosphates are largely used for the production of phosphoric acid, fertilizers and hence phosphate fertilizer industries are considered to be a potential source of natural radionuclide contamination.

This investigation has not evaluated the potential for radioactive emissions and this should be addressed in a subsequent stage of work, on the overburden, footwall units, ore, and tailings streams.

Radioactive emissions are considered unlikely but should be addressed to verify this assumption.

5.4 Overburden and footwall samples

5.4.1 Net acid producing potential

The majority of the 41 samples (n = 37) are circum-neutral or basic with a pH between 6 and 9. The pH of the deionised water used in the analysis of samples was 5.6. Only three samples have pH values below this, 2 at a pH of 5 and 1 with a pH of 3.7, and these are all within the footwall units below the overburden and ore.

Total sulfur concentrations range from 0.02% to 3.15% with a median of 0.12%. Of the 41 samples 16 have total sulfur concentrations below 0.1%. A further 22 samples with a total sulfur concentration of greater than 0.1% were subsequently determined to have sulfide sulfur concentrations measured using CRS of less than 0.1%. The median CRS concentration is notably lower at 0.007%. Only 4 samples had CRS results greater than 0.1%, these were all samples taken from below the maximum proposed pit depth in reverse circulation drill holes (AMRC718, AMRC728, AMRC808 and AMRC815).

In some cases where the samples utilised in the static acid base accounting analyses are older weathered samples there is a need to determine if the measured CRS results accurately reflect in-situ sulfide sulfur content. RGS consider it is probable that the CRS results reflect in-situ conditions. This is because if the samples did initially contain sulfide minerals and they oxidised they would have produced acid that would have resulted in acidic pH measured in the pH analysis, and this was not observed. The samples from this study were drilled in August 2017.

Verification of sulfide content in overburden can be undertaken with the collection and analysis of fresh samples from ongoing drilling that would be collected directly after drilling to ensure that any effects of sulfide oxidation can be accounted for.

Drill hole sample ANC ranges from below the laboratory LoR to the equivalent of 173 kg H_2SO_4/t. The median value is 19 kg H_2SO_4/t. There is no clear correlation between lithology or depth and ANC (at this stage), although this may become apparent with additional analyses over the life of the project.

When the CRS analyses were combined with the ANC results the NAPP and NPR results verified all overburden samples are NAF or AC (**Table 5-6**). These results indicate that the potential environmental risk associated with the mining, temporary stockpiling and ultimate placement of the overburden that would occur during progressive rehabilitation at the site is relatively low. These NAPP results (do not on their own) discount the potential for environmental issues associated with salinity (refer to **Section 5.3.2**).

Conversely the geochemical analyses of the footwall samples verify that the footwall material below the deposit may be PAF (**Table 5-6**). This suggests that the exposure of PAF waste rock below the ore may result in sulfide oxidation, and care must be taken to prevent acid production in the underlying strata exposed by mining. As all the deeper samples have been obtained from the area around the northern pit, further sampling is recommended in the area of the proposed southern and central pits to determine if potentially acid generating sulfide underlie these pits also. RGS note that the overburden / ore and footwall sequence in the southern deposit which will be exposed through mining is totally oxidised and the potential for PAF material in the footwall in this area is much lower (negligible).

The presence of PAF footwall units below the ore may have the following adverse impacts on water and mine waste management and rehabilitation.

- The removal of ore from the pits will result in (relatively) shallow pits that may nevertheless have exposed PAF material on the pit floor.
- Progressive backfilling of NAF overburden into the mined pits to pre-mine topography will enable parts of the pits to be rehabilitated through replacement of the NAF overburden and soil, reinstating the initial regolith profile. Under this style of progressive rehabilitation management, the potential for PAF footwall material to produce AMD may be substantially reduced.
- However, there will inevitably be residual shallow voids (pits) in the landscape and if these areas contain PAF footwall material the seasonal inundation of the pits with water during the wet season will produce acidic drainage. If the AMD in the pits is not contained in the voids it could seep laterally into the adjoining backfilled rehabilitated areas of the pits and this could have an adverse effect on these areas by introducing acid, salts and metals into backfilled NAF overburden.
- The presence of AMD in the residual pits may also affect surface or groundwater resources in the receiving environment.
- It would be advantageous during development of the project to drill, sample and analyse the footwall materials to ascertain if there are NAF footwall units. If there are, the NAF footwall units would be ideal as the residual voids.

Drill hole sample Acid Base Accounting analysis results are shown in **Table 5-6**. Total sulfur is typically used to calculate the MPA and used with ANC results to calculate the NAPP and the NPR. In this study the CRS% (and TS% in the absence of measured CRS) were used with the NAPP. NPR and pH were used to classify the samples for their acid producing or consuming potential (**Table 5-5)**. The bulk of the samples contain insufficient sulfide sulfur to have acid forming potential. The samples classified as PAF are hosted within siltstones and shales at a minimum depth of 21 m below ground level.

Table 5-5: AMD classification

Classification	1:5 pH	Total Sulfur %	Total Sulfide %	NAPP (kg H_2SO_4/t)	NPR	No. of Samples (n=41)
Acid Consuming (AC)	> 5	< 1.0		> -100	> 10	6
Non-Acid Forming - Barren	> 5	< 0.2	< 0.05	-ve		21
Non-Acid Forming	> 5		< 0.1	-ve	≥ 3	10
Potentially Acid Forming – Low Capacity (PAF-LC)	> 5	> 0.2			< 3 > 2	
Potentially Acid Forming (PAF)	> 5	> 0.2			< 2	3
Acid Forming (AF)	< 5	> 0.2	> 0.2	+ve	< 1	1

Figure 5-1 categorises the risk of acidic drainage and sulfate / saline from the drill hole samples. The data points have been coloured to match the classification colouring in **Table 5-5**. The ratio of ANC to MPA for the samples is used to help assess the level of risk of acidic drainage.

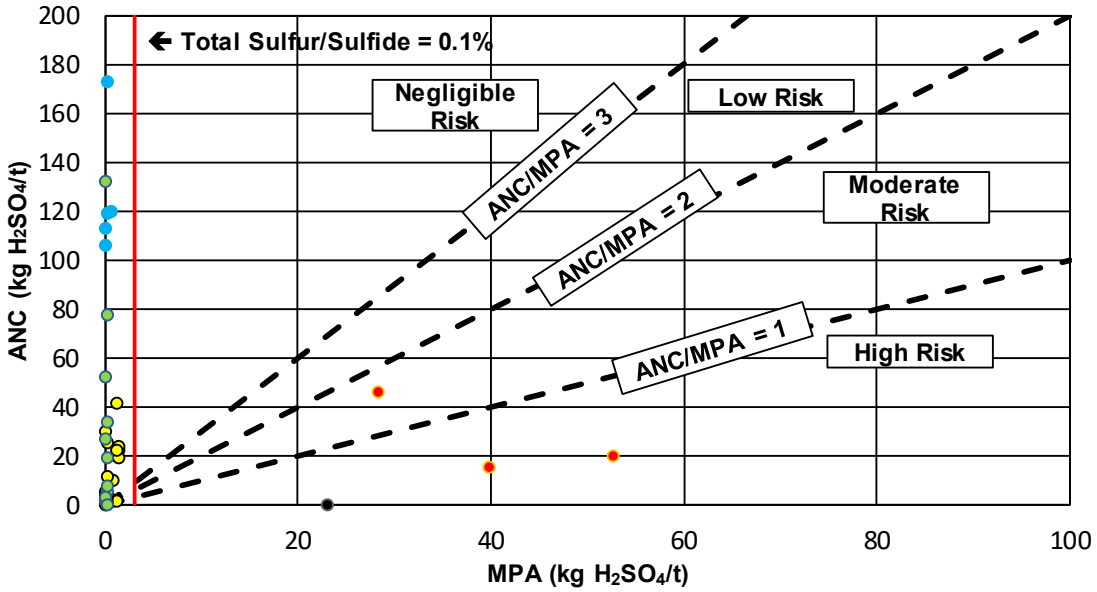


Figure 5-1: Drill hole samples ANC vs MPA plot

Figure 5-2 demonstrates the relationship between TS and CRS in the drill hole samples. All samples contain more sulfur than is present as sulfide sulfur. Lithology logging describes the presence of evaporite minerals thought to be gypsum ($CaSO_4 \bullet 2H_2O$) suggesting sulfur is potentially present as sulfate, and or other secondary sulfate minerals.

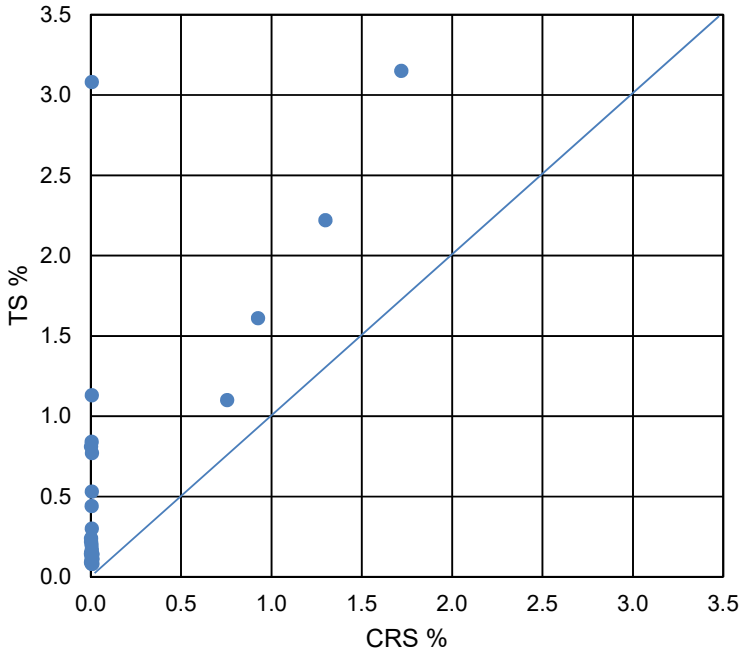


Figure 5-2: A comparison of TS vs. CRS in the drill hole samples

5.4.2 Saline drainage potential

Soil salinity refers to the presence of water soluble salts in a sample that are mainly of sodium, but also of potassium, calcium and magnesium chloride, sulfate or carbonate minerals (Hazelton & Murphy, 2007).

The electrical conductivity was measured using a 1:5 solid to water ratio ($EC_{1:5}$) that determines the salinity level in the samples at the time they were sampled. The $EC_{1:5}$ results are converted to ECe values based on the estimated water holding capacity of the soils that is based on textural classification. For determining EC it was assumed that the predominant texture of the finer graded mined material would be a silty clay.

Of the 41 samples the ECe results determined there are:

- (n=0) < 2,000 µS/cm are non-saline
- (n=5) 2,000 to 4,000 µS/cm are slightly-saline
- (n=6) 4,000 to 8,000 µS/cm are moderately saline
- (n=13) 8,000 to 16,000 µS/cm are highly saline
- (n=17) >16,000 µS/cm are extremely saline

Most samples (n = 30) have an EC result that is categorised as highly saline, i.e. greater than 8,000 µS/cm (Hazelton & Murphy, 2007).

The presence of elevated concentrations of salts in the overburden samples indicates that saline drainage could be a significant aspect for site water management. As there is no obvious correlation between major exchangeable cations and salinity it is hypothesised that salinity is predominately present in the form of sodium chloride and sulfate bearing minerals. The concentrations of total phosphorus suggest phosphate may also contribute to the elevated EC measured on the overburden and footwall samples.

The mining process applied to the soil and overburden will increase the particle size distribution of the samples and lead to an increased potential for elevated EC and saline drainage. If the overburden is not mined, stored and used effectively there could be adverse effects on vegetation from salts (and or excessive phosphorous) and compounding adverse effects on the ability of rehabilitated surfaces to develop resilient vegetative cover and resist erosion.

The risk associated with saline drainage and rehabilitation will be largely overcome through adoption of a strip mining and progressive rehabilitation mine plan that is being proposed by Centrix.

5.4.3 Metalliferous drainage potential

Total elemental analyses were undertaken on selected overburden and footwall samples to evaluate the level of mineralisation in these materials. The total elemental concentrations were compared with average soil concentrations to develop an understanding of potential metalliferous issues. The GAI results (**Table 5-7**) coupled with the elevated sulfide concentrations in footwall geological units verify that there may be some metalliferous issues associated with operational water management. However, the issues are likely to be driven by the presence of elements that are prone to be present at circum-neutral pH in the overburden such as Be, Mo and P. In the footwall materials the oxidation of sulfide minerals may produce acidic drainage that could be elevated in a broader range of elements including Al, Fe, Co, Cu, Fe, Mn and Zn.

The GAI values on their own do not infer these elements will be environmentally mobile. As discussed previously the potential for saline and metalliferous drainage should be evaluated using fresh drill core samples and kinetic leach cell testing.

Table 5-6: Drill hole sample Acid/Base Accounting and material classification

Area Hole ID	Depth From	Depth To	Lithology	pH	EC	ECe	Sulfur - Total as S (LECO)	MPA_{TS}	CRS	MPA_{CRS}	ANC as H_2SO_4	$NAPP_{TS}$	$NAPP_{CRS\ or\ TS}$	NPR_{CRS}	
	m bgl	m bgl		pH Unit	µS/cm	µS/cm	%	kg H_2SO_4/t	%	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t	kg H_2SO_4/t		**Classification**
AMDD005	1.7	2.7	SH	8.4	1270	10922	0.17	5.2	0.0070	0.2	119.0	-113.80	-118.79	555.7	Acid Consuming
AMDD005	8.0	8.8	CH	7.8	492	4231	0.04	1.2	0.0400	1.2	20.0	-18.78	-18.78	16.3	Non-Acid Forming (Barren)
AMDD006	1.4	2.7	SH	7.2	3950	33970	0.81	24.8	0.0025	0.1	1.7	23.08	-1.62	22.2	Non-Acid Forming
AMDD006	2.7	4.4	SH	6.2	1670	14362	0.03	0.9	0.0300	0.9	1.7	-0.78	-0.78	1.9	Non-Acid Forming (Barren)
AMDD006	4.4	8.6	SH	7.3	1420	12212	0.02	0.6	0.0200	0.6	2.6	-1.99	-1.99	4.2	Non-Acid Forming (Barren)
AMDD006	8.6	12.7	SH	7.7	1570	13502	0.02	0.6	0.0200	0.6	1.5	-0.89	-0.89	2.5	Non-Acid Forming (Barren)
AMDD006	17.5	17.9	CH	8.5	513	4412	0.08	2.4	0.0060	0.2	30.2	-27.75	-30.02	164.5	Non-Acid Forming (Barren)
AMDD006	17.9	19.2	ST	8.1	314	2700	0.05	1.5	0.0500	1.5	22.6	-21.07	-21.07	14.8	Non-Acid Forming (Barren)
AMDD008	1.5	3.1	SH	8.6	1000	8600	0.02	0.6	0.0200	0.6	120.0	-119.39	-119.39	196.1	Acid Consuming
AMDD008	3.1	3.7	SH	8.6	1050	9030	0.04	1.2	0.0400	1.2	41.2	-39.98	-39.98	33.7	Non-Acid Forming (Barren)
AMDD008	7.9	9.1	ST	8.6	627	5392	0.05	1.5	0.0500	1.5	19.3	-17.77	-17.77	12.6	Non-Acid Forming (Barren)
AMDD010	1.0	2.4	SU	6.3	3640	31304	0.77	23.6	0.0080	0.2	0.3	23.30	-0.01	1.0	Non-Acid Forming
AMDD010	2.4	4.9	CL	5.8	1880	16168	0.04	1.2	0.0400	1.2	1.6	-0.38	-0.38	1.3	Non-Acid Forming (Barren)
AMDD010	4.9	5.6	CH	6.1	2030	17458	0.1	3.1	0.0070	0.2	0.9	2.16	-0.69	4.2	Non-Acid Forming (Barren)
AMDD010	9.9	12.0	SH	7.9	379	3259	0.05	1.5	0.0500	1.5	23.6	-22.07	-22.07	15.4	Non-Acid Forming (Barren)
AMDD017	2.0	3.2	SH	8.4	768	6605	0.03	0.9	0.0300	0.9	10.1	-9.18	-9.18	11.0	Non-Acid Forming (Barren)
AMDD017	9.0	10.0	CH	8.6	638	5487	0.04	1.2	0.0400	1.2	22.5	-21.28	-21.28	18.4	Non-Acid Forming (Barren)
AMDD018	0.6	2.0	SH	8.1	3310	28466	0.44	13.5	0.0060	0.2	52.3	-38.84	-52.12	285.0	Non-Acid Forming
AMDD018	2.0	3.7	SH	7.6	1680	14448	0.14	4.3	0.0090	0.3	3.4	0.88	-3.12	12.4	Non-Acid Forming (Barren)
AMDD018	6.3	8.5	FP	8.1	1170	10062	0.11	3.4	0.0090	0.3	11.8	-8.44	-11.52	42.9	Non-Acid Forming (Barren)
AMDD021	1.7	2.0	SH	8.3	2540	21844	0.08	2.4	0.0100	0.3	34.1	-31.65	-33.79	111.5	Non-Acid Forming
AMDD021	2.0	4.3	SH	8.0	4130	35518	0.3	9.2	0.0070	0.2	19.3	-10.12	-19.09	90.1	Non-Acid Forming
AMDD021	4.3	5.9	SH	8.1	1960	16856	0.12	3.7	0.0060	0.2	3.7	-0.03	-3.52	20.2	Non-Acid Forming (Barren)
AMDD021	5.9	7.2	SH	7.3	1540	13244	0.14	4.3	0.0025	0.1	0.3	4.03	-0.17	3.3	Non-Acid Forming (Barren)
AMDD021	10.7	12.8	ST	7.5	387	3328	0.1	3.1	0.0060	0.2	3.1	-0.04	-2.92	16.9	Non-Acid Forming (Barren)
AMDD023	1.0	1.9	CL	7.7	4710	40506	0.84	25.7	0.0060	0.2	26.5	-0.80	-26.32	144.4	Non-Acid Forming
AMDD023	2.0	4.2	SH	6.3	2450	21070	0.09	2.8	0.0025	0.1	5.1	-2.35	-5.02	66.7	Non-Acid Forming (Barren)
AMDD023	4.2	5.2	ST	8.6	1790	15394	0.09	2.8	0.0060	0.2	113.0	-110.25	-112.82	615.7	Acid Consuming
AMDD024	0.9	3.0	SH	6.5	5540	47644	1.13	34.6	0.0070	0.2	5.4	29.17	-5.19	25.2	Non-Acid Forming
AMDD024	3.0	5.1	EV	7.6	4520	38872	3.08	94.2	0.0070	0.2	7.6	86.62	-7.39	35.5	Non-Acid Forming
AMDD024	7.9	10.9	SH	7.5	2060	17716	0.2	6.1	0.0050	0.2	2.6	3.52	-2.45	17.0	Non-Acid Forming (Barren)
AMDD024	14.0	14.9	CH	7.5	415	3569	0.24	7.3	0.0025	0.1	2.8	4.54	-2.72	36.6	Non-Acid Forming
AMDD024	17.4	18.4	ST	7.4	359	3087	0.11	3.4	0.0100	0.3	25.0	-21.64	-24.69	81.7	Non-Acid Forming (Barren)
AMDD026	1.8	4.1	SH	8.4	4610	39646	0.53	16.2	0.0070	0.2	173.0	-156.79	-172.79	807.9	Acid Consuming
AMDD026	4.2	5.9	SH	8.8	2100	18060	0.15	4.6	0.0025	0.1	106.0	-101.41	-105.92	1386.1	Acid Consuming
AMDD026	6.5	7.7	SH	8.5	3380	29068	0.22	6.7	0.0025	0.1	132.0	-125.27	-131.92	1726.1	Acid Consuming
AMDD026	12.5	14.9	CH	8.8	542	4661	0.14	4.3	0.0100	0.3	77.4	-73.12	-77.09	253.0	Non-Acid Forming
AMRC718	51.0	52.0	ST	5.0	1770	15222	2.22	67.9	1.3000	39.8	15.3	52.61	24.47	0.4	**Potentially Acid Forming**
AMRC728	51.0	52.0	ST	5.0	1930	16598	3.15	96.4	1.7200	52.6	19.9	76.46	32.71	0.4	**Potentially Acid Forming**
AMRC808	21.0	22.0	SH	3.7	1640	14104	1.1	33.6	0.7560	23.1	0.3	33.40	22.88	0.0	**Acid Forming**
AMRC815	47.0	48.0	ST	6.2	1050	9030	1.61	49.2	0.9270	28.4	46.4	2.85	-18.04	1.6	**Potentially Acid Forming**

Red values — Concentration is below detection limit
Blue values — TS value used in place of measured CRS value

Table 5-7: Geochemical abundance index of total metals and metalloids in the drill hole samples

Sample ID	S032	S033	S034	S035	S036	S001	S002	S003	S004	S005	S006	S007	S041	S037	S038	S039	S040
Drill Hole ID	AMDD021	AMDD021	AMDD021	AMDD021	AMDD021	AMDD023	AMDD023	AMDD023	AMDD024	AMDD024	AMDD024	AMDD024	AMDD024	AMRC718	AMRC728	AMRC808	AMRC815
From	1.7	2	4.3	5.9	10.7	1	2	4.15	0.9	3	7.9	14	17.35	51	51	21	47
To	2	4.3	5.9	7.2	11	1.9	2.6	4.7	1.1	3.1	10.85	14.35	18.35	52	52	22	48
Element																	
Al	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
As	0	0	2	0	1	0	0	0	2	1	0	1	0	1	2	1	2
Ba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Be	1	0	0	0	3	2	2	3	1	0	2	4	3	3	3	1	6
Bi	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Ca	0	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0	4
Cd	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Ce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Co	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cu	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Fe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0	0	0	0	1	0	0	0	0	0	0	0	2	1	1	1	1
In	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
La	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Li	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mo	0	0	4	2	2	0	0	0	4	3	3	2	1	3	2	3	2
Nb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	0	0	0	0	2	0	0	4	1	1	2	3	4	3	4	0	5
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	0	1	0	0	0	3	0	0	3	4	1	1	0	4	5	3	4
Sb	0	0	3	3	0	0	0	0	1	1	1	1	0	0	0	1	0
Sc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Se	0	0	2	0	0	0	0	0	2	1	0	1	1	2	3	2	2
Sn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sr	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Ta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Te	2	2	3	3	3	2	3	3	2	2	3	2	2	2	2	3	2
Th	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tl	0	0	0	0	2	0	0	0	0	0	0	2	0	1	1	2	3
U	0	0	2	1	3	0	0	2	1	1	2	3	3	3	3	2	5
V	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0
W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y	0	0	0	0	0	0	0	2	0	0	0	1	1	0	1	0	3
Zn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Values of 3 not highlighted are due to rounding

6 Conclusion and recommendations

Ore and tailings streams

Results suggest that the provided ore and tailings samples are NAF and geochemically benign, with a relatively low risk of generating acidic or saline drainage. It is noted that during production on site the ore may be processed with saline groundwater. Under this approach the tailings may have a higher salt load. The presence of elevated calcium and phosphorous in the samples suggests that management of these elements will be a concern in any ore or tailings streams.

Overburden

The overburden samples (n=36) utilised in the is study were fresh samples (< 12 months old). All overburden samples had circum-neutral to mildly alkaline pH verifying the samples had not oxidise and produced acid between the time they were drilled and assayed. The sulfide sulfur analyses using CRS are therefore considered to reflect actual in-situ sulfide content.

The geochemical analyses of the overburden using measured sulfide sulfur to calculate the maximum potential acidity and resultant net acid producing potential verify that the samples are NAF-Barren, NAF or AC.

Of concern from an environmental perspective are the elevated electrical conductivity (EC) measurements in some samples that could also manifest as elevated salinity. The source of the elevated EC has not been determined but could be associated with NaCl or sulfate minerals and/or phosphate.

Footwall units

The footwall units evaluated have determined this material has a high potential to oxidise rapidly and produce acid, saline and metalliferous drainage. Management of footwall materials is likely to be required to minimise the potential for AMD during mining and post closure in the northern are, but in the southern area the overburden, ore and footwall sequence is completely oxidised and the likelihood of PAF material in this area is lower (negligible).

Associated geological units

Limestone and dolomite are present in the project area. The mining and use of these materials will enable adequate management of acid drainage issues either by crushing and adding fine ground limestone to PAF mine waste or using it to treat and manage acid water.

Forward works

Static testing

Static testing including radioactive testing is recommended on ore and tailings materials during project development to ensure that the geochemical characteristics of site produced material is quantified and tracked to measure any changes in these materials over time. The geochemical analysis should include measurement of pH, EC, TS, CRS and ANC. Selected samples should be analysed for soluble, exchangeable and total elemental concentrations.

Supplementary static testing should be undertaken on freshly drilled samples during resource drilling or the collection of representative samples from the proposed test to verify the outcomes of this study. The geochemical analysis should include measurement of pH, EC, TS, CRS and ANC. Selected samples should be analysed for soluble, exchangeable and total elemental concentrations.

Kinetic leach cell testing

Kinetic leach cells testing is required to be undertaken on mined materials that have the potential to produce acid, saline or metalliferous drainage.

RGS recommend that KLC testing should be done all major mine waste types and or beneficiation (ore and tailings) products and should be done for a minimum of 12 months using monthly leach cycles. This

test work should be commenced during subsequent stages of the project to verify the long-term performance of the materials that are removed during mining or that are produced on site from processing streams.

Management plans

A suitable management plan (e.g. AMD Management, Mine Waste Management or Progressive Rehabilitation and Closure Plan) should be developed for the project and include a sampling and analytical program to address the static and kinetic testing programs.

These data would be utilised in site water quality modelling that is utilised to evaluate the ability to meet water quality objectives for the project during operations and then into the closure phase.

7 References

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Appendix

Ore and tailings samples

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1807385**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 16-Mar-2018 09:40
Order number	:	Date Analysis Commenced	: 22-Mar-2018
C-O-C number	: ----	Issue Date	: 06-Apr-2018 18:32
Sampler	: SITE		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

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

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

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

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	EB1807385-002	--------	--------	--------
					Result	Result	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.70**	**7.46**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**263**	**1650**	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**36**	**29**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**36**	**29**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**38**	**167**	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**25**	**417**	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**14**	**71**	----	----	----
Magnesium	7439-95-4	1	mg/L		**6**	**24**	----	----	----
Sodium	7440-23-5	1	mg/L		**23**	**228**	----	----	----
Potassium	7440-09-7	1	mg/L		**2**	**3**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.01**	----	----	----
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	----	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	----	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.14**	**0.24**	----	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.078**	**0.322**	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.764**	**0.887**	----	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	EB1807385-002	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0004**	----	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	----	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	----	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.001**	**0.001**	----	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	----	----	----
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.001**	**0.003**	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.001**	**0.004**	----	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	----	----	----
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.004**	**0.005**	----	----	----
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.005**	**0.011**	----	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	----	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	----	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	----	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	----	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.01**	**0.01**	----	----	----

Analytical Results

Sub-Matrix: **LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	----	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	----	----	----
					EB1807385-001	**EB1807385-002**	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		**0.040**	**0.141**	**----**	**----**	**----**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**----**	**----**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**----**	**----**	**----**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
					EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**8.1**	**7.9**	**8.5**	**----**	**----**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-58.0**	**-21.5**	**----**	**----**	**----**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**167**	**1030**	<1	**----**	**----**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**66.9**	**36.8**	**----**	**----**	**----**
ANC as CaCO3	----	0.1	% CaCO3		**6.8**	**3.8**	**----**	**----**	**----**
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**----**	**----**	**----**
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		**0.015**	**0.019**	**----**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**60.4**	**1.1**	**----**	**----**	**----**
ED006: Exchangeable Cations on Alkaline Soils									
Exchangeable Calcium	----	0.2	meq/100g		**6.4**	**2.3**	**----**	**----**	**----**
Exchangeable Magnesium	----	0.2	meq/100g		**2.9**	**0.8**	**----**	**----**	**----**
Exchangeable Potassium	----	0.2	meq/100g		**0.2**	<0.2	**----**	**----**	**----**
Exchangeable Sodium	----	0.2	meq/100g		**0.4**	**0.8**	**----**	**----**	**----**
Cation Exchange Capacity	----	0.2	meq/100g		**10.0**	**3.8**	**----**	**----**	**----**
Exchangeable Sodium Percent	----	0.2	%		**4.5**	**20.5**	**----**	**----**	**----**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.29**	**0.50**	**----**	**----**	**----**
ED093T: Total Major Cations									
Sodium	7440-23-5	50	mg/kg		**1960**	**3210**	**----**	**----**	**----**
Potassium	7440-09-7	50	mg/kg		**3540**	**1820**	**----**	**----**	**----**
Calcium	7440-70-2	50	mg/kg		**198000**	**374000**	**----**	**----**	**----**
Magnesium	7439-95-4	50	mg/kg		**3610**	**1630**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**97100**	**111000**	**----**	**----**	**----**
EK074: Fluoride Extractable Phosphorus (Bray)									

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
					EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EK074: Fluoride Extractable Phosphorus (Bray) - Continued									
Fluoride Extractable P (Bray)	----	1.0	mg/kg		**152**	**388**	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.10**	**0.07**	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	----	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	----	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	----	----	----
C29 - C36 Fraction	----	100	mg/kg		<100	<100	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg		<10	<10	----	----	----
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	----	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	----	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	----	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	----	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	----	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	----	----	----
Naphthalene	91-20-3	1	mg/kg		<1	<1	----	----	----
Sample Preparation Method									
Amount	----	0.1	g		**1.0**	**1.0**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**58.1**	**89.3**	----	----	----

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

				Client sample ID	Ardmore Phosphate Attrition (50Hx) -38µm Tailing Product (Geotech Test Work)	Centrex Ardmore Phosphate Final Attrition Test work (Balmore)	DI Water - pH & EC	----	----
				Client sampling date / time	13-Feb-2018 00:00	07-Mar-2018 00:00	22-Mar-2018 00:00	----	----
Compound	CAS Number	LOR	Unit		EB1807385-001	EB1807385-002	EB1807385-003	--------	--------
					Result	Result	Result	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	0.2	%		**60.3**	**87.2**	**----**	**----**	**----**
4-Bromofluorobenzene	460-00-4	0.2	%		**60.6**	**87.4**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

Australian Laboratory Services Pty. Ltd.

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www.alsglobal.com/geochemistry

ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

CERTIFICATE BR18063906

Project: EB1807385

P.O. No.: ME- MS41

This report is for 2 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 23- MAR- 2018.

The following have access to data associated with this certificate:

SUB RESULTS - BRIS

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG- 22	Sample login - Rcd w/o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME- MS41	Ultra Trace Aqua Regia ICP- MS

To: ALS ENVIRONMENTAL
ATTN: SUB RESULTS - BRIS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
EB1807385-001		0.70	4.10	44.5	<0.02	40	800	13.40	0.59	19.90	1.83	371	20.9	113	2.89	140.5
EB1807385-002		0.57	2.01	36.2	<0.02	30	700	13.05	0.43	>25.0	2.26	417	17.2	62	1.16	91.8

***** See Appendix Page for comments regarding this certificate *****

RGS LEADERS IN MINING GEOCHEMISTRY

Australian Laboratory Services Pty. Ltd.
32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
www.alsglobal.com/geochemistry

ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method Analyte Units LOR	ME-MS41 Fe % 0.01	ME-MS41 Ca ppm 0.05	ME-MS41 Ce ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
EB1807385-001		2.69	9.25	0.84	0.29	0.04	0.090	0.51	207	19.2	0.36	333	12.25	0.19	0.60	72.6
EB1807385-002		1.92	5.56	0.68	0.72	0.04	0.047	0.23	250	8.2	0.16	315	10.05	0.34	0.33	41.6

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method Analyte Units LOR	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Tl % 0.005	ME-MS41 Tl ppm 0.02
EB1807385-001		>25000	49.6	27.8	<0.001	0.23	5.44	29.8	0.5	1.4	1175	0.01	0.26	18.2	0.018	0.95
EB1807385-002		>25000	34.5	12.9	0.001	0.39	3.75	27.4	0.2	0.6	1090	0.01	0.10	14.7	0.009	0.94

***** See Appendix Page for comments regarding this certificate *****

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	U	V	W	Y	Zn	Zr
	Units	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.05	1	0.05	0.05	2	0.5
EB1807385-001		99.3	508	1.02	600	336	5.2
EB1807385-002		93.4	346	0.58	670	246	24.2

***** See Appendix Page for comments regarding this certificate *****

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Project: EB1807385

CERTIFICATE OF ANALYSIS BR18063906

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: ME- MS41

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).

ACCREDITATION COMMENTS

Applies to Method: ME- MS41

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

LABORATORY ADDRESSES

Applies to Method: LOG- 22 ME- MS41

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 116 Delta Street, Geebung, QLD 4034, Australia

Overburden and footwall samples

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1808528**	Page	: 1 of 11
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 14-Mar-2018 09:30
Order number	:	Date Analysis Commenced	: 17-Apr-2018
C-O-C number	: ----	Issue Date	: 19-Apr-2018 15:31
Sampler	: SITE		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 42		
No. of samples analysed	: 42		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

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

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

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

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S001	S002	S003	S004	S005
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-001	EB1808528-002	EB1808528-003	EB1808528-004	EB1808528-005
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.7	6.3	8.6	6.5	7.6
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.8	-2.3	-110	29.2	86.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	4710	2450	1790	5540	4520
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	26.5	5.1	113	5.4	7.6
ANC as CaCO3	----	0.1	% CaCO3	2.7	0.5	11.6	0.6	0.8
Fizz Rating	----	0	Fizz Unit	1	0	2	0	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.84	0.09	0.09	1.13	3.08

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S006	S007	S008	S009	S010
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-006	EB1808528-007	EB1808528-008	EB1808528-009	EB1808528-010
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.5	7.5	8.4	8.8	8.5
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	3.5	4.5	-157	-101	-125
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	2060	415	4610	2100	3380
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.6	2.8	173	106	132
ANC as CaCO3	----	0.1	% CaCO3	0.3	0.3	17.6	10.8	13.4
Fizz Rating	----	0	Fizz Unit	0	0	3	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.20	0.24	0.53	0.15	0.22

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S011	S012	S013	S014	S015
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-011	EB1808528-012	EB1808528-013	EB1808528-014	EB1808528-015
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		8.8	8.4	7.8	7.2	6.2
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-73.1	-114	-18.8	23.1	-0.8
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		542	1270	492	3950	1670
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		77.4	119	20.0	1.7	1.7
ANC as CaCO3	----	0.1	% CaCO3		7.9	12.1	2.0	0.2	0.2
Fizz Rating	----	0	Fizz Unit		2	2	1	0	0
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.14	0.17	0.04	0.81	0.03

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S016	S017	S018	S019	S020
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-016	EB1808528-017	EB1808528-018	EB1808528-019	EB1808528-020
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.3**	**7.7**	**8.5**	**8.1**	**8.6**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-2.0**	**-0.9**	**-27.8**	**-21.1**	**-119**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1420**	**1570**	**513**	**314**	**1000**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**2.6**	**1.5**	**30.2**	**22.6**	**120**
ANC as CaCO3	----	0.1	% CaCO3	**0.3**	**0.2**	**3.1**	**2.3**	**12.2**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**1**	**1**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	**0.08**	**0.05**	**0.02**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S021	S022	S023	S024	S025
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-021	EB1808528-022	EB1808528-023	EB1808528-024	EB1808528-025
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**8.6**	**8.6**	**6.3**	**5.8**	**6.1**
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-40.0**	**-17.8**	**23.6**	**-0.4**	**2.2**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1050**	**627**	**3640**	**1880**	**2030**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**41.2**	**19.3**	<0.5	**1.6**	**0.9**
ANC as CaCO3	----	0.1	% CaCO3		**4.2**	**2.0**	<0.1	**0.2**	<0.1
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**0**	**0**	**0**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.04**	**0.05**	**0.77**	**0.04**	**0.10**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S026	S027	S028	S029	S030
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-026	EB1808528-027	EB1808528-028	EB1808528-029	EB1808528-030
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.9**	**8.4**	**8.6**	**8.1**	**7.6**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-22.1**	**-9.2**	**-21.3**	**-38.8**	**0.9**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**379**	**768**	**638**	**3310**	**1680**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**23.6**	**10.1**	**22.5**	**52.3**	**3.4**
ANC as CaCO3	----	0.1	% CaCO3	**2.4**	**1.0**	**2.3**	**5.3**	**0.3**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**2**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.05**	**0.03**	**0.04**	**0.44**	**0.14**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S031	S032	S033	S034	S035
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1808528-031	EB1808528-032	EB1808528-033	EB1808528-034	EB1808528-035
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.1**	**8.3**	**8.0**	**8.1**	**7.3**
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-8.4**	**-31.6**	**-10.1**	**-0.03**	**4.3**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1170**	**2540**	**4130**	**1960**	**1540**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**11.8**	**34.1**	**19.3**	**3.7**	<0.5
ANC as CaCO3	----	0.1	% CaCO3	**1.2**	**3.5**	**2.0**	**0.4**	<0.1
Fizz Rating	----	0	Fizz Unit	**1**	**2**	**1**	**0**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.11**	**0.08**	**0.30**	**0.12**	**0.14**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	S036	S037	S038	S039	S040
				Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1808528-036	EB1808528-037	EB1808528-038	EB1808528-039	EB1808528-040
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.5	5.0	5.0	3.7	6.2
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-0.04	52.6	76.5	33.7	2.9
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		387	1770	1930	1640	1050
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		3.1	15.3	19.9	<0.5	46.4
ANC as CaCO3	----	0.1	% CaCO3		0.3	1.6	2.0	<0.1	4.7
Fizz Rating	----	0	Fizz Unit		0	1	1	0	2
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.10	2.22	3.15	1.10	1.61

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S041	DI water	----	----	----
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1808528-041	EB1808528-042	--------	--------	--------
				Result	Result	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.4**	**5.6**	----	----	----
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-21.6**	----	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**359**	<1	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**25.0**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**2.6**	----	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.11**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1810208**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Customer Services EB
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2018002 - Ardmore Project	Date Samples Received	: 23-Apr-2018 10:32
Order number	:	Date Analysis Commenced	: 01-May-2018
C-O-C number	: ----	Issue Date	: 03-May-2018 09:45
Sampler	: , MARY MACELROY		
Site	: ----		
Quote number	: BN/058/18 V3		
No. of samples received	: 29		
No. of samples analysed	: 29		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Acid Sulphate Soils, Stafford, QLD

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED006 (Exchangeable Cations on Alkaline Soils): Magnesium/Potassium ratio could not be determined as both the Magnesium and Potassium results were less than reportable limits for some samples.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S001 EB1808528_001	S002 EB1808528_002	S003 EB1808528_003	S004 EB1808528_004	S005 EB1808528_005
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-001	EB1810208-002	EB1810208-003	EB1810208-004	EB1810208-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.006**	<0.005	**0.006**	**0.007**	**0.007**
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**14.7**	----	----	----	**4.0**
Exchangeable Magnesium	----	0.2	meq/100g	**6.6**	----	----	----	**2.4**
Exchangeable Potassium	----	0.2	meq/100g	**0.4**	----	----	----	**0.3**
Exchangeable Sodium	----	0.2	meq/100g	**4.0**	----	----	----	**1.4**
Cation Exchange Capacity	----	0.2	meq/100g	**25.8**	----	----	----	**8.1**
Exchangeable Calcium Percent	----	0.2	%	**57.1**	----	----	----	**49.3**
Exchangeable Magnesium Percent	----	0.2	%	**25.8**	----	----	----	**29.2**
Exchangeable Potassium Percent	----	0.2	%	**1.5**	----	----	----	**3.8**
Exchangeable Sodium Percent	----	0.2	%	**15.6**	----	----	----	**17.6**
Calcium/Magnesium Ratio	----	0.2	-	**2.2**	----	----	----	**1.7**
Magnesium/Potassium Ratio	----	0.2	-	**17.4**	----	----	----	**7.6**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	**9.7**	----	**31.2**	----
Exchangeable Magnesium	----	0.1	meq/100g	----	**4.3**	----	**1.7**	----
Exchangeable Potassium	----	0.1	meq/100g	----	**0.4**	----	**0.3**	----
Exchangeable Sodium	----	0.1	meq/100g	----	**0.8**	----	**0.5**	----
Exchangeable Aluminium	----	0.1	meq/100g	----	**0.1**	----	**0.1**	----
Cation Exchange Capacity	----	0.1	meq/100g	----	**15.2**	----	**33.8**	----
Exchangeable Calcium Percent	----	0.1	%	----	**63.6**	----	**92.3**	----
Exchangeable Magnesium Percent	----	0.1	%	----	**28.0**	----	**5.0**	----
Exchangeable Potassium Percent	----	0.1	%	----	**2.6**	----	**1.0**	----
Exchangeable Sodium Percent	----	0.1	%	----	**5.1**	----	**1.4**	----
Exchangeable Aluminium Percent	----	0.1	%	----	**0.7**	----	**0.3**	----
Calcium/Magnesium Ratio	----	0.1	-	----	**2.2**	----	**18.4**	----
Magnesium/Potassium Ratio	----	0.1	-	----	**10.8**	----	**5.2**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S006 EB1808528_006	S007 EB1808528_007	S008 EB1808528_008	S009 EB1808528_009	S010 EB1808528_010
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-006	EB1810208-007	EB1810208-008	EB1810208-009	EB1810208-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.005**	<0.005	**0.007**	<0.005	<0.005
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**1.7**	**----**	**4.8**	**1.9**	**4.4**
Exchangeable Magnesium	----	0.2	meq/100g	**1.7**	**----**	**4.9**	**3.6**	**4.3**
Exchangeable Potassium	----	0.2	meq/100g	**0.4**	**----**	<0.2	**0.2**	<0.2
Exchangeable Sodium	----	0.2	meq/100g	**1.5**	**----**	**2.9**	**2.9**	**3.0**
Cation Exchange Capacity	----	0.2	meq/100g	**5.3**	**----**	**12.9**	**8.5**	**11.9**
Exchangeable Calcium Percent	----	0.2	%	**32.6**	**----**	**37.4**	**21.8**	**36.8**
Exchangeable Magnesium Percent	----	0.2	%	**31.7**	**----**	**38.4**	**41.9**	**36.0**
Exchangeable Potassium Percent	----	0.2	%	**7.0**	**----**	**1.4**	**2.5**	**1.5**
Exchangeable Sodium Percent	----	0.2	%	**28.6**	**----**	**22.8**	**33.7**	**25.6**
Calcium/Magnesium Ratio	----	0.2	-	**1.0**	**----**	**1.0**	**0.5**	**1.0**
Magnesium/Potassium Ratio	----	0.2	-	**4.5**	**----**	**----**	**16.6**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S011 EB1808528_011	S012 EB1808528_012	S014 EB1808528_014	S018 EB1808528_018	S023 EB1808528_023
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-011	EB1810208-012	EB1810208-013	EB1810208-014	EB1810208-015
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.010**	**0.007**	<0.005	**0.006**	**0.008**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**----**	**----**	**44.0**	**----**	**43.3**
Exchangeable Magnesium	----	0.1	meq/100g	**----**	**----**	**1.4**	**----**	**1.1**
Exchangeable Potassium	----	0.1	meq/100g	**----**	**----**	**0.2**	**----**	**0.2**
Exchangeable Sodium	----	0.1	meq/100g	**----**	**----**	**0.4**	**----**	**0.3**
Exchangeable Aluminium	----	0.1	meq/100g	**----**	**----**	<0.1	**----**	**0.1**
Cation Exchange Capacity	----	0.1	meq/100g	**----**	**----**	**46.1**	**----**	**45.0**
Exchangeable Calcium Percent	----	0.1	%	**----**	**----**	**95.5**	**----**	**96.2**
Exchangeable Magnesium Percent	----	0.1	%	**----**	**----**	**3.1**	**----**	**2.5**
Exchangeable Potassium Percent	----	0.1	%	**----**	**----**	**0.5**	**----**	**0.4**
Exchangeable Sodium Percent	----	0.1	%	**----**	**----**	**0.8**	**----**	**0.6**
Exchangeable Aluminium Percent	----	0.1	%	**----**	**----**	**0.2**	**----**	**0.3**
Calcium/Magnesium Ratio	----	0.1	-	**----**	**----**	**31.4**	**----**	**39.4**
Magnesium/Potassium Ratio	----	0.1	-	**----**	**----**	**6.7**	**----**	**5.9**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S025 EB1808528_025	S029 EB1808528_029	S030 EB1808528_030	S031 EB1808528_031	S032 EB1808528_032
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-016	EB1810208-017	EB1810208-018	EB1810208-019	EB1810208-020
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.007	0.006	0.009	0.009	0.010
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	6.6	----	----	3.9
Exchangeable Magnesium	----	0.2	meq/100g	----	2.7	----	----	3.2
Exchangeable Potassium	----	0.2	meq/100g	----	0.2	----	----	0.2
Exchangeable Sodium	----	0.2	meq/100g	----	0.9	----	----	1.3
Cation Exchange Capacity	----	0.2	meq/100g	----	10.5	----	----	8.6
Exchangeable Calcium Percent	----	0.2	%	----	63.2	----	----	45.4
Exchangeable Magnesium Percent	----	0.2	%	----	25.5	----	----	36.7
Exchangeable Potassium Percent	----	0.2	%	----	2.3	----	----	2.5
Exchangeable Sodium Percent	----	0.2	%	----	8.9	----	----	15.4
Calcium/Magnesium Ratio	----	0.2	-	----	2.5	----	----	1.2
Magnesium/Potassium Ratio	----	0.2	-	----	10.9	----	----	14.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.2	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	1.2	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Aluminium	----	0.1	meq/100g	0.2	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	8.3	----	----	----	----
Exchangeable Calcium Percent	----	0.1	%	74.8	----	----	----	----
Exchangeable Magnesium Percent	----	0.1	%	13.9	----	----	----	----
Exchangeable Potassium Percent	----	0.1	%	4.9	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	4.3	----	----	----	----
Exchangeable Aluminium Percent	----	0.1	%	2.0	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	5.2	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	2.8	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S033 EB1808528_033	S034 EB1808528_034	S035 EB1808528_035	S036 EB1808528_036	S037 EB1808528_037
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1810208-021	EB1810208-022	EB1810208-023	EB1810208-024	EB1810208-025
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.007**	**0.006**	<0.005	**0.006**	**1.30**
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	**4.9**	----	----	----	----
Exchangeable Magnesium	----	0.2	meq/100g	**1.6**	----	----	----	----
Exchangeable Potassium	----	0.2	meq/100g	<0.2	----	----	----	----
Exchangeable Sodium	----	0.2	meq/100g	**1.0**	----	----	----	----
Cation Exchange Capacity	----	0.2	meq/100g	**7.7**	----	----	----	----
Exchangeable Calcium Percent	----	0.2	%	**63.9**	----	----	----	----
Exchangeable Magnesium Percent	----	0.2	%	**21.1**	----	----	----	----
Exchangeable Potassium Percent	----	0.2	%	**2.3**	----	----	----	----
Exchangeable Sodium Percent	----	0.2	%	**12.7**	----	----	----	----
Calcium/Magnesium Ratio	----	0.2	-	**3.0**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	S038 EB1808528_038	S039 EB1808528_039	S040 EB1808528_040	S041 EB1808528_041	----
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit	EB1810208-026	EB1810208-027	EB1810208-028	EB1810208-029	--------
				Result	Result	Result	Result	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**1.72**	**0.756**	**0.927**	**0.010**	**----**

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CERTIFICATE BR18094590

Project: EB1810208

P.O. No.: MS41

This report is for 17 Pulp samples submitted to our lab in Brisbane, QLD, Australia on 26-APR-2018.

The following have access to data associated with this certificate:

SUB RESULTS - BRIS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LOG-22	Sample login - Rcd w/o BarCode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION
ME-MS41	Ultra Trace Aqua Regia ICP-MS

To: ALS ENVIRONMENTAL
ATTN: SUB RESULTS - BRIS
32 SHAND STREET
STAFFORD QLD 4053

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.01	0.01	0.1	0.02	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
S001		0.10	2.32	3.3	<0.02	250	1.31	0.15	1.99	0.03	43.2	8.3	31	1.71	15.4	2.25
S002		0.02	1.02	2.7	<0.02	380	1.30	0.37	0.25	0.09	61.4	4.6	21	1.18	39.9	2.51
S003		0.15	1.35	1.7	<0.02	120	4.17	0.41	6.98	0.67	94.2	11.4	43	3.02	35.0	0.56
S004		0.09	1.50	25.1	<0.02	110	0.71	0.37	1.25	0.04	45.1	1.1	37	0.71	13.4	2.17
S005		0.17	1.01	17.0	<0.02	30	0.63	0.25	2.73	0.03	31.4	0.6	22	0.70	20.7	1.83
S006		0.11	1.05	8.9	<0.02	70	2.52	0.57	0.32	0.14	57.7	2.0	31	1.32	28.7	1.56
S007		0.07	1.87	11.9	<0.02	200	7.22	0.36	0.76	0.19	48.7	5.0	50	1.10	27.4	1.27
S032		0.33	1.25	3.8	<0.02	380	0.89	0.32	1.46	0.06	43.2	5.0	23	0.60	15.1	0.76
S033		0.17	0.64	2.2	<0.02	180	0.47	0.24	1.10	0.03	26.0	0.9	19	0.31	9.0	0.16
S034		0.15	0.47	27.3	<0.02	80	0.46	0.28	0.17	0.17	32.7	3.0	27	0.27	86.1	2.02
S035		0.13	0.52	4.6	<0.02	230	0.62	0.58	0.07	0.07	87.9	2.3	25	0.33	58.9	0.53
S036		0.21	1.14	10.8	0.04	710	4.35	0.37	0.47	0.46	58.4	21.7	94	0.62	49.1	1.48
S037		0.30	0.50	18.2	<0.02	60	3.10	0.37	2.20	1.34	33.5	12.6	59	1.74	36.3	1.60
S038		0.28	0.78	22.2	<0.02	50	3.96	0.30	5.23	1.02	53.2	10.3	78	2.51	53.3	2.14
S039		0.64	0.42	15.5	<0.02	240	1.19	0.52	0.09	0.09	103.5	10.7	23	0.65	69.2	1.45
S040		0.25	0.45	24.6	<0.02	220	27.5	0.10	>25.0	0.18	140.0	2.7	39	1.39	21.4	1.17
S041		0.55	0.58	6.8	<0.02	390	4.64	0.15	4.58	0.73	39.5	2.5	72	1.01	48.7	0.73

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method / Analyte / Units / LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
S001		6.85	0.06	0.39	0.01	0.029	22.5	10.1	0.56	230	0.70	0.12	17.3	550	9.0	15.8
S002		3.67	0.06	0.41	0.01	0.022	31.2	9.3	0.29	57	0.75	0.11	25.5	320	15.0	7.6
S003		4.60	0.16	0.11	0.02	0.034	75.4	25.1	0.52	204	0.43	0.18	57.7	19900	14.3	15.2
S004		5.26	0.09	0.16	0.01	0.027	24.1	6.8	0.25	24	21.0	0.11	4.2	3030	14.9	7.8
S005		3.83	0.05	0.28	0.04	0.029	16.5	5.6	0.13	12	14.55	0.15	2.7	1880	10.7	4.8
S006		5.22	0.08	0.10	0.05	0.021	28.9	2.8	0.08	22	10.40	0.13	11.6	3780	26.9	6.4
S007		2.78	0.08	0.04	0.07	0.017	31.8	4.2	0.06	82	8.07	0.10	6.3	10600	12.5	6.9
S032		4.36	0.06	0.27	0.01	0.029	23.5	5.5	0.42	130	1.88	0.09	8.2	1640	24.9	7.9
S033		2.69	<0.05	0.32	0.01	0.034	13.2	3.1	0.20	19	1.20	0.05	3.1	720	13.6	4.2
S034		4.76	0.05	0.40	0.03	0.085	17.1	1.5	0.07	20	21.7	0.11	14.3	390	10.4	3.7
S035		3.15	0.08	0.30	0.04	0.041	51.5	1.8	0.08	19	7.79	0.08	11.6	820	27.4	4.0
S036		3.08	0.07	0.03	0.25	0.032	38.4	5.1	0.04	290	5.49	0.13	53.9	5620	20.6	4.2
S037		2.02	0.10	0.21	0.21	0.014	22.0	4.7	0.06	40	14.70	0.12	53.4	10600	20.0	6.4
S038		2.40	0.21	0.22	0.23	0.019	40.4	8.8	0.09	39	8.83	0.15	50.5	24600	13.7	10.3
S039		3.66	0.12	0.48	0.24	0.020	45.4	2.0	0.05	29	19.55	0.12	31.8	990	24.2	5.2
S040		2.77	0.39	0.30	0.15	0.010	138.0	7.6	0.10	152	7.40	0.13	25.6	>25000	37.0	10.4
S041		1.92	0.11	0.21	0.33	0.014	31.9	2.7	0.05	43	3.19	0.10	16.0	22500	6.5	6.3

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Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Tl	Tl	U	V	W	Y
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
S001		0.98	0.24	5.0	0.4	1.1	80.0	<0.01	0.04	6.6	0.013	0.24	2.36	70	0.23	23.5
S002		0.08	1.15	3.6	0.7	0.8	38.8	<0.01	0.07	11.1	0.005	0.17	3.63	63	0.18	18.40
S003		0.08	1.10	6.2	0.5	1.0	185.0	0.01	0.10	9.8	0.008	0.31	12.95	224	0.48	184.0
S004		1.03	3.31	5.7	1.7	0.8	368	<0.01	0.04	8.6	0.006	0.24	8.39	212	0.33	15.45
S005		2.23	3.64	4.9	1.4	0.7	152.5	<0.01	0.03	6.8	0.005	0.34	8.21	216	0.26	8.93
S006		0.19	2.62	4.6	0.4	0.9	158.0	<0.01	0.09	10.1	0.005	0.35	11.65	152	0.25	21.6
S007		0.21	3.56	5.1	1.2	0.5	606	<0.01	0.05	6.1	<0.005	1.59	21.9	257	0.19	108.0
S032		0.05	0.68	3.2	0.8	1.0	131.5	<0.01	0.03	7.2	0.007	0.11	4.15	51	0.63	22.9
S033		0.27	0.74	1.8	0.2	0.6	74.1	<0.01	0.04	6.0	<0.005	0.07	2.70	34	0.32	8.88
S034		0.03	10.70	5.9	1.7	0.8	90.9	<0.01	0.06	15.0	0.008	0.10	10.10	230	0.20	50.2
S035		0.04	9.03	7.4	<0.2	0.9	255	<0.01	0.09	21.7	<0.005	0.13	8.42	169	0.23	46.5
S036		0.08	1.21	5.9	0.3	0.5	454	<0.01	0.08	11.9	<0.005	0.99	20.2	161	1.10	31.4
S037		1.92	1.81	2.9	2.7	0.4	130.0	<0.01	0.05	3.9	<0.005	0.76	22.0	102	0.89	46.5
S038		2.71	1.48	3.9	3.5	0.5	188.5	<0.01	0.04	5.2	0.005	0.84	30.5	134	0.77	105.5
S039		1.08	3.07	6.9	2.5	0.7	225	<0.01	0.08	10.6	<0.005	1.22	11.25	138	0.18	49.2
S040		1.55	1.77	5.0	2.3	0.3	686	0.02	0.04	5.2	<0.005	2.09	98.1	85	0.32	375
S041		0.10	0.98	5.3	1.3	0.4	344	0.01	0.03	4.0	<0.005	0.26	26.9	151	2.61	101.5

***** See Appendix Page for comments regarding this certificate *****

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ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

Project: EB1810208

CERTIFICATE OF ANALYSIS BR18094590

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	ME-MS41 B ppm 10
S001		30	13.1	10
S002		77	12.2	10
S003		122	4.9	20
S004		11	4.9	10
S005		7	7.9	10
S006		40	3.8	10
S007		88	1.0	20
S032		17	8.5	10
S033		6	8.7	10
S034		32	15.9	<10
S035		30	9.9	<10
S036		176	1.1	10
S037		152	7.7	10
S038		161	8.4	10
S039		26	14.3	<10
S040		21	11.9	20
S041		100	8.3	10

***** See Appendix Page for comments regarding this certificate *****

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CERTIFICATE OF ANALYSIS BR18094590

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: ME- MS41

Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).

ACCREDITATION COMMENTS

Applies to Method: ME- MS41

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

LABORATORY ADDRESSES

Applies to Method: LOG- 22 ME- MS41

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 116 Delta Street, Geebung, QLD 4034, Australia



LEADERS IN MINING
GEOCHEMISTRY

APPENDIX E

Important information

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The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

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Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification

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MEMBER OF WSP

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